Compendia of Graduate Theses in Forestry and Allied Subjects:

Doctoral and Master Degrees related to Nepal

Compiled by :

Swoyambhu M. Amatya
Prakash Sayami
Tej B.S. Mahat

Research Report Series

IOF/ITTO
Training and Manpower Development in Community Forestry Project
Tribhuvan University, Institute of Forestry
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FOREWORD

It is my pleasure to express a few words on this valuable document the **"Compendia of Graduate Theses in Forestry and Allied Subjects: Doctoral and Master's Degrees related to Nepal"**, prepared by Dr. Tej B.S. Mahat, the Visiting Scholar, IOF/ITTO Project, IOF; Dr. Swoyambhu M. Amatya, Director, Forest Survey Division, Forest Research and Survey Center (FORESC), HMG/N and Mr. Prakash Sayami, Forest Officer, Forest Research and Survey Center (FORESC), HMG/N, all of whom worked very hard to bring this material in front of us. On behalf of the IOF/ITTO Project I thank them and all others who were instrumental in bringing all the scattered materials together so that they become available and useful to those willing to do research and augment knowledge in these areas

This work consists of abstracts of theses and summaries of research problems, methodologies, findings, suggestions for further research and recommendations for future action. It consists of works of many prominent researchers who carried out their works for the completion of their degree programs, mainly Master of Science and Doctor of Philosophy. It also includes works of more than 165 Nepalese and foreign researchers, concentrating on forestry and environment sectors in Nepal or areas related to Nepal. Existence of such works is less known and/or unknown and if known the works are unavailable to the professionals. This affirms the importance of this work

This work includes compendia of research works related to the biodiversity conservation, forestry, watershed management, soil conservation, wildlife and other aspects of our environment. The compendia cover from natural to plantation forests and their biodiversity along the altitude variation that is from Terai to high hills along the Himalayas. Moreover, there are dissertations that deal with various management systems, like Park and People linkage and Conflicts, Bufferzone Management, Common Property Resource Management and Community Forestry, which are linked to socio-economic development of the people of Nepal. Women's participation, land use capability, watershed modeling, use and management of NTFP, subsistence economy, and sustainability are other important issues that are captured in this collection of compendia.

I hope this document will serve as an excellent first hand reference material to the researchers as it covers quite a broad range of areas with examples and case studies from Nepal. It will be a good reading material for teachers and students in environment and natural resources and their management in Nepal. Also, I hope this will be a useful reference for professionals working in these areas. Its usefulness will be proved if used widely.

Shailendra N. Adhikary,
Project Manager
IOF/ITTO Project
Institute of Forestry (IOF), Pokhara.
1998.

PREFACE

A dictionary definition of the term 'thesis' is a dissertation resulting from original research, especially when submitted by a candidate for a degree or diploma, and substantiating a specific view. It may also refer to a theory maintained in the argument, or to a subject for discussion or essay.

In most cases Ph.D. and other doctoral degrees are awarded exclusively on the basis of the quality of the research and thesis submitted. Many universities also offer doctoral degrees on the basis of course work and credits earned, with the research work and thesis submitted in partial fulfilment for the degree. Some universities also require full research and thesis to attain a masters degree whereas in other universities a thesis is only a partial requirement. Which ever be the case, academic institutions providing post-graduate studies usually require a candidate for a higher degree to write a thesis setting down in detail the background to the research topic, a statement of the problem researched, a review of relevant literature and other research methods used, the results of the research, discussion of the research conducted and the results, indications for further research, and any recommendations arising from the research.

The forests are of critical importance both for sustaining the increasing human and livestock populations, and the dwindling wildlife populations of Nepal. They are also of enormous importance for preventing catastrophic environmental degradation through soil erosion, landslides, flooding and loss of bio-diversity in the fragile ecosystems of the country.

The responsibilities of those charged with managing the forests, so that the society derives maximum benefit from their productive function without detriment to their functions of preservation and regulation, are complex and onerous, and need to be discharged in the light of the widest possible knowledge of the research which has been conducted in recent decades. As significant amount of this research has been the work of candidates (mostly Nepalese) for Ph.D., M.Sc. and other higher degrees and 'buried' in their theses, having seldom been published and usually being available only from the authors or the institutions where they have been lodged.

Even the existence of such authors and their work is often unknown to people who could take advantage of it, not only in forest management but also in research, teaching and other scholarly activities, and in government departments, national and international NGOs and aid agencies both in Nepal and abroad.

It was therefore thought that the publication of a list of these theses and a brief summary of the contents of each would be a valuable supplement to the published literature, and thus help both in furthering research and in developing management policies and systems which will ensure the utilisation of forest products and does not further degrade the forests or reduce the wonderful diversity of flora and fauna which they still contain.

This compilation consists of compendia (i.e. brief summaries) of 35 doctorate and 131 masters degree theses written by Nepalese postgraduate students in forestry and allied subjects or foreign students whose work relates specifically to Nepal.

Most of the compendia include an abstract of the thesis and summaries of the research problem, methodology, findings, and suggestions for further research and recommendations for future action. However, where the work of a Nepalese postgraduate forestry student does not relate specifically to Nepal, only an abstract is usually provided. The compendia are presented in alphabetical order of the authors' surnames.

To make the compilation as complete as possible, theses deposited with various universities, libraries, government and non-government agencies in Nepal and elsewhere were sought, advertisements were placed in national daily press and known holders of relevant postgraduate degrees were individually requested to make their theses available. Although these approaches were very successful there must still be theses which did not become available for inclusion. This work is therefore only a start, and it is hoped that a later compilation can include further theses which may be discovered or submitted in future.

It is hoped, that the Institute of Forestry of Tribhuvan University in particular, will find this publication useful in developing its proposed provisions for postgraduate studies. It is further hoped that similar other institutions of higher learning in Nepal will also benefit from the publication.

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ACKNOWLEDGEMENTS

This compilation is a product of the IOF/ ITTO Project on Training and Manpower Development in Community Forestry (PD 103/ 90 Rev. 1 - F) funded by the International Tropical Timber Organisation (ITTO). Centring on the projects Social/ Community Forestry Visiting Scholar program component, extensive review and compilation of compendia of available graduate theses in forestry and allied subjects related to Nepal were undertaken.

Dr. Swoyambhu Man Amatya and Mr. Prakash Sayami, both of Forest Research & Survey Centre (FORESC), did the bull work in the compilation process, and Dr. Tej B.S. Mahat, Visiting Scholar, Social/ Community Forestry, IOF/ ITTO Project, provided the technical support and guidance in the preparation of compendia and edited the work. They all deserve sincere thanks and appreciation for their efforts.

The IOF/ ITTO Project, Pokhara and its Manager Mr. Shailendra N. Adhikari also deserve thanks for entrusting the compilers with the task of preparing the compendia and providing the financial support.

Thanks are also due to the following for their contribution in the preparation of the compendia:

Mr. Noel M. Semple of Canberra, Australia for going through the draft report and providing valuable comments to improve the compilation;

Mr. Narayan Singh Tamang, Assistant Librarian – Central Forest Library, FORESC, Kathmandu for untiringly and efficiently word-processing the publication;

All postgraduate scholars and libraries who responded to the compilers' requests and made their theses available for inclusion in the compilation; and

All those others who helped in many ways in the preparation of this compilation but could not be here individually acknowledge.

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PROCESSES OF FOREST AND PASTURE MANAGEMENT IN A JIREL COMMUNITY OF HIGHLAND NEPAL

Acharya, Harihar Prasad.
Ph.D. (1990)
Cornel University, USA

ABSTRACT

This dissertation examines the complex, diverse, and dynamic process of managing the use and availability of forest and pasture resources as conceptualised, practised, adapted, and evaluated by the Jirel people of highland Nepal over the last 200 years. Analysis of the impact of Jirel symbol systems, social organisation, household strategies and external linkages on forest and pasture management, showed that the Jirel have maintained a near balance between their needs for and the availability of wood and fodder resources. Shortage of labour during the rainy season, scarcity of fodder in the winter, and unequal distribution of resource ownership are three major constraints to Jirel management systems. The Jirel try to cope with these constraints by redistributing access, costs and risks in the community. Jirel reciprocity serves both self-interest and generosity and sustains their relationships with fellow human beings, supernatural forces and natural resources.

Prevailing conditions, institutions, opportunities, and strategies help the Jirel to economise in the use of resource, meet essential needs and protect the resource bases simultaneously. Throughout history the Jirel have been granted considerable autonomy in the use and protection of forests and pastures in exchange for their services for the royal herds. Private titles, joint ownership, usufruct and communal rights effectively regulate Jirel motivations, use patterns, social equity, protection methods and sanction structures. The Jirel plant trees, harvest from annual increments, allow resources time to repair and utilise substitutes. Most Jirel live in ground-floor huts; burn twigs, dead wood and recycled materials for fuel; feed leafy growths and crop residues to their livestock, practice rotational and selective methods of harvesting and apply restriction signs to protect resources. Recent off-farm employment opportunities have effectively reduced the need for clearing forests and pastures for food production.

PROBLEM

This study grew out of anthropological and development policy concerns for meeting human needs without destroying the natural resource base. It explores the complex, diverse and dynamic process of managing the use and availability of forest and pasture resources as conceptualised, practiced, adapted and evaluated by the people of Jiri, a mountain village in Dolakha District located about 190 km north-east of Kathmandu, the capital of Nepal.

OBJECTIVES

The major objectives of the study were to investigate: (a) how and with what effect the people of Jiri, called Jirel, have been managing forest and pasture resources; and (b) whether and how a development policy for sustaining a balance between natural resources and human needs could be built on pre-existing local institutional arrangements. From this perspective,

management involves those processes of cultural ideas, social organisation, household strategies and external linkages which affect the balance between the needs for and availability of natural resources in particular local communities.

METHODOLOGY

The research covered the forest and pasture resources of the whole of Ratomate, Ward number 6 of Jiri village panchayat. The people who were the subject of the research came from a total of 107 households.

Those families who cultivate land in Ratmate but live elsewhere and do not us the forest and pasture resources of this area were not included in the study.

Genealogical histories, histories of forest and pasture ownership as well as old chronologies provided information on the historical depth and changes in forest and pasture management patterns. Historical documents (letters, orders, records etc.) in Jirel households and the Jiri Agricultural Centre were searched, knowledgeable informants about past events and conditions were interviewed and an extensive survey of literature in libraries in both Nepal and the United States was conducted.

Sample surveys, measurements, and interviews were conducted to compare the use and consumption of wood and fodder resources with their local availability. This comparison is the basis of analysis regarding the efficacy of management practices: effective practices are those which meet local needs without destroying the sustainability of the resources base.

FINDINGS

The Jirel have maintained a near balance between their needs for and the availability of wood and fodder resources. Shortage of labour during the rainy season, scarcity of fodder in the winter and unequal distribution of resource ownership are three major constraints to Jirel management systems.

RECOMMENDATION

Policy planners should become more sensitive to cultural, social, individual and historical dimensions of all development issues.

Thus a prime goal of all development policy should be to preserve and promote cultural strengths, not only for humanistic and moral reasons but also for efficiency and pragmatic reasons. With a clear recognition that local people have not destroyed their own resources or threatened Government authority in any way, the Government should be willing to encourage local people in their sound management practices instead of putting legal restrictions on them or appropriating their resources.

Policy should respond to changing circumstances and unexpected events. It should be dynamic enough to innovate, motivate and adapt.

Because of diverse resource endowments, traditions, needs and histories in the different local communities, no single policy can be equally effective or beneficial everywhere. Thus development efforts are best decentralised and focused on relatively smaller geographic regions.

INDIGENOUS FODDER TREES, THEIR MANAGEMENT AND UTILIZATION IN THE TERAI BELT OF NEPAL

Amatya, Swoyambhu Man.
Ph. D. (1991)
Tribhuvan University, Nepal

ABSTRACT

The people of Nepal have a long tradition of farming, with tree fodder and agriculture being interdependent components. Tree fodder provides about 40 % of all animal feed but it is in short supply in the dry season. Farmers in Nepal have a considerable knowledge of fodder trees and their nutritional qualities. Preferences for fodder trees vary from one ecological zone to another, depending on their availability and their feed value. The concept of fodder trees for the hills and for the Terai belts are different. Unlike those in the hills, farmers in the Terai in general do not grow trees specifically for fodder because they have the practice of feeding agricultural by-products as one of the major components of feed stuff.

Most literature deals with the fodder situation in the hills and little or nothing has been reported on the management and utilization of Terai fodder trees. Studies on the interactions between fodder resources use and associated social systems can have a great bearing in understanding the indigenous methods used by village communities to maintain the livestock which are an integral part of farming systems in Nepal. This study attempts to bridge the gap between identification of fodder trees, their management and utiliztion in the Terai, taking into consideration the ecological constraints of the biological and physical environments in which they exist. Specifically this study aims to ascertain the farmers' knowledge and preferences regarding fodder trees, their management and utilization.

Three representative Terai districts (Udayapur, Bara and Kailali) were specially selected for conducting the study.These districts were chosen because they not only represent different geographical conditions but also have been recently settled by migrants from the hills. In each district two village communities were selected and within each village community one ward was selected at random. Household survey and participatory observation methods were carried out to capture 12 specific classes of quantitative and qualitative data. Firstly a sample household was chosen at random and after every third house another sample was taken. For this study a total of 180 farmers were interviewed from the three districts.

The survey suggested that Terai farmers could recall a total of 43 different fodder trees. The number of these fodder trees varies with the district, the highest (26) being recorded for Bara District and the lowest (15) for Udayapur District. The farmers of the Kailali District could recall a total of 24 different fodder trees. Male farmers knew more types of fodder trees than females. Religious background, lopping instruments, methods of fodder collection and season and intensity of lopping fodder trees were the main factors in the farmers' indigenous system for managing a given fodder tree. Of the 43 fodder tree species, farmers were found to lop most (28 species) of them during the winter, some (10 species) during the summer and the other (5 species) throughout the year, but there is a considerable overlap in the season of lopping. Basically, tender and mature leaves, obano and chiso ghans (dry and cool grasses), leaves shading periods and nutritional status of the leaves are the four major factors which determine the choice of a lopping regime for a given fodder tree species.

Although the contribution of livestock in terms of milk and meat is poor, every farmer keeps livestock, the reason being to obtain manure as well as milk and meat. The majority of farmers (101 out of 180) reported the changes brought about by feeding a particular type of fodder tree to their livestock. Milk yield and growth (in terms of meat) were the two important factors which farmers mainly consider when choosing fodder species.

Fodder from the government forests is not sufficient for sustaining the present livestock population. Yet only a few (37) farmers grew fodder trees on their farmland, the rest using agricultural by-products as a major alternative. Farmers are reluctant to plant fodder trees on their farmland because of the shading effect on their agricultural crops, pest problems, and soil infertility due to raising fodder trees on their farmland. Moreover, some fodder trees such as gayo *(Bridelia regusa)* are susceptible to insect damage. Although the nutritive value of phosro (*Grewia optiva*) is less comparrd to other fodder species, it is the most common fodder tree species planted by the farmers on their farmlands.

Farmers utilize fodder tree species for other purposes, such as making ropes and medicines. Species vary in their uses; for example bhorla (*Bauhinia vahlii*) is used for three purposes (ropes, leaf plates and leaf umbrellas).

Farmers suggested that protection of existing forest, public awareness about forestry, stall feeding of livestock, and planting more trees (including fodder trees) in the forest areas and on the farmland could improve the deteriorating forestry situation.

It has been reported that investment in forestry plantations is an attractive enterprise. The intangible benefits would be to check deforestation and soil erosion and help prevent environmental degradation.

PROBLEM

It has been noted that the Terai people, by comparison with those of the hills, do not grow fodder crops on their farmland. Yet there has been a long tradition of mixed farming with animal husbandry and agriculture being interdependent components. Livestock is also an integral part of the cultural life in this region. It is not known why the Terai people are less interested in raising fodder trees on their farms. How do they meet the fodder requirements of their livestock ? How do they manage and utilise the existing fodder resources ?

It is therefore important to study the interactions between resource use and the associated social system, taking into consideration the constraints of the biological and physical environments in which they exist. For this it is essential to understand the indigenous methods used by a village community to maintain livestock on the available fodder trees and pasture. All this must be carefully studied in research and extension work with a view to improving fodder management in the Terai. This study attempts to fill gaps in the knowledge of fodder trees and their management and utilization in the Terai.

OBJECTIVES

The general objective of the present study was to assess current practices of fodder utilization management adopted by rural communities in three Terai districts (Udayapur, Bara and ali).

In each district two village communities were selected, one requirement being that each community should fall within the limit of Terai and Bhabar zone. In order to demarcate the required communities for the study, ward maps were obtained from the local Topographical Survey Office. Village communities falling outside the Terai and Bhabar zone were excluded. Because of time and resource constraints, the study focused on only one of the nine wards of each selected village community.

METHODOLOGY

The research was carried out between September 1989 and April 1990 in the three districts. Its primary purpose was to investigate attributes of the indigenous system relating to the management, cultivation and use of the tree fodder resources. In order to plan the appropriate methodology for this kind of research, besides the collection of information from secondary sources (i.e. published reports, books) visits were made to accessible parts of the three Development Regions of Nepal. As a result of the field visits and discussions with the personnel engaged in the field of forestry and socio-economics a multi-method research approach was used to address the research problems. The main sources of information were:

i. household survey
ii. participant observations (i.e. taking part in the daily life of the villagers).

The first source involved the use of a formal survey questionnaire that measured socio-economic variables at the household level.

To overcome problems of local dialect and fears which would otherwise be entertained by the people, local residents were hired to conduct the surveys.

FINDINGS

It was found that 43 different tree fodder are used in the Terai. Farmers of the Central Development Region recognize more tree fodder species than those of the East and Far Western Development Region.

Farmers' opinions on the management of tree fodder vary, depending somewhat on their religious background. It appears that, in general, there is no common system of fodder collection, season and intensity of lopping trees fodder, but some farmers have a fair knowledge in these respects. Some species are lopped throughout the year and other are lopped during winter or at the beginning of the summer season. There are different reasons for this, such as type and density of livestock and nature of the trees.

Farmers, in general, do not lop young trees and they seem to have some empirical knowledge about the interrelationship between tree age and fodder yield.

Usually farmers feed tree fodder to their livestock immediately after bringing it home, but some species which have coarse leaves are left overnight before feeding. It was revealed that asna (*Terminalia alata*) is a good tree fodder as the fat content of the milk is higher when livestock are fed with this species.

Tree fodder from the government forests is not sufficient to feed the existing livestock population, the main reasons being increase in human and livestock populations, felling of trees, and migratory animals feeding in the forest.

Farmers, in general, are reluctant to raise fodder trees on farmland because of their shading effect, pest problems and resultiing soil infertility. Howeer, despite the ill effects some farmers do raise fodder tree seedlings on their farmland. It was reported that ginderi (*Premna latifolia*) is more susceptible to insect damage than other types of fodder trees such as kimbu (Morus alba), phosro (*Grewia optiva*) and khanyu (*Ficus semicordata*). Some species such as gaya (*Bridelia retusa*) are more demanding of soil moisture.

Kutmero (*Litsea monopetala*) and badahar (*Artocarpus lakoocha*) are the most preferred fodder trees in the Terai because of their yield, their nutrient status and palatability. Asna (*Terminalia alata*), dabdabe (*Garuga pinnata*) and phosro (*Grewia optiva*) are preferred for their high milk yield and high fat content in the milk. Shallow dung, urinary problems and reduction of milk yields are ill effects of certain tree fodders which causes farmers to reject them.

It has been estimated that investment in forestry is a attractive one. The intangible benefits of planting trees would be to check deforestation, soil erosion and help protect environmental degradation.

RECOMMENDATIONS

Policy recommendations

It has been reported that the supply of fodder trees seedlings, which are in high demand, from the government nurseries, is inadequate. It is recommended that an initial base-line survey should be carried-out to find out what species of seedlings are desired by particular village communities. The seedlings should not be distributed free of cost. It has been observed that farmers do not care for seedlings once, they have been planted out, even on their own farmland. Let the farmers realize that they must pay something for the seedlings.

- Government nurseries should not be fully oriented towards achieving the annual target only by producing seedlings which are not in high demand. Rather they should try to meet the demands of the villagers. Fodder trees that might have several desirable properties, such as adaptability, palatability, nutritive value, good productivity and growth, resistance to utilization and harmlessness to animals when eaten, should be considered when producing seedlings in the nurseries.

- Topics of forestry should be incorporated in the curricula of primary and secondary schools in order to make the younger generation realise the importance of forestry help check deforestation and environmental deterioration one hand and to achieve self sufficiency in forestry products in the other.

Research recommendations

- Research on fodder trees is a new concept and has been limited. It is desirable that this gap should be bridged by carrying out research on various aspects of fodder trees. At present it should concentrate on two aspects-firstly lopping strategies and secondly tree-

crop interactions.

- Many fodder trees are known locally only and have no botanical names. It have been reported that species such as ginderi (*Premna latifolia*) and khanyu (*Ficus semicordata*) shows intra-specific variation. These different varieties might yield different foliage biomass or different feed value at the different time of the year.

- Many fodder trees are multipurpose. While the leaves are used for fodder they may have other values also. The fruits of harro (*Terminalia chebula*) and barro (*Terminalia bellerica*) are extensively used in medicine. Similarly the bark of sal (*Shorea robusta*) is used for tanning hides, the leaves are used as plates and the seeds as a source of oil. Many other species have multipurpose potentials and need to be explored. Such trees are seldom managed for seeds, foliage and fruits exclusively. It is therefore recommended that they should be managed collectively and separately.

- Data on the fodder value of many species are scanty. Most data are available only for those species which occur in the middle-hills. In this thesis many species which are mentioned as indigenous fodder trees of the Terai belt, such as dumre (*Benthamidia capitata*), debre lahara (*Spatholobus parviflorus*) and hadchur (*Viscum articulatum*) have not been discussed. A multidisiplinary research involving livestock should be initiated to ascertain the feed values of such species.

- Fodder trees in general can be propagated through seedlings raised in the nursery, but unfortunately there are some such as badahar (*Artocarpus lakoocha*), which lose their viability very quickly. Incidentally *A. lakoocha* is one of the fodder species most in demand. Seedlings of such species are often difficult to get in large quantities.

- Cutting height is an another important aspect in lopping a tree. Large trees are difficult to climb. Research focused on cutting height and diameter of tree would help the management and utilizatation of important fodder tree species.

IMPLICATIONS OF FUEL AND FOOD NEEDS FOR DEFORESTATION AN ENERGY STUDY IN A HILL VILLAGE PANCHAYAT OF EASTERN NEPAL

Bajracharya, Deepak.
Ph. D. (1981)
University of Sussex, UK

ABSTRACT

The one-year study (1977-78) in Pangma Village Panchayat, Sankhuwa-Sabha District, analyzes influences on deforestation from supply and demand patterns of fuel and food by emphasizing local socio-economic characteristics. The panchayat is slightly less than 14 km^2 and characterized by many similar aspects as in other parts of the Hill Region in Nepal: (a) high population density; (b) distribution of four major and six minor ethnic groups at altitudes ranging from 600 m to 2,500 m; (c) vulnerable internal resource capability; (d) high degree of non-commercial economy; (e) overwhelming dependence on agriculture for subsistence; (f) almost total dependence on wood as the main source of fuel.

The research method combines questionnaire survey, participant observation and direct measurement to derive: (a) forest area and tree volumes to estimate sustainable fuelwood supply; (b) fuelwood consumption by type, source, and end-use; (c) arable land area and crop-yields to estimate food grains production; (d) land tenure and ownership patterns to assess food grains distribution; (e) food consumption patterns by type and quality; (f) forest areas targeted for future clearance. 182 out of 582 households and four subregions combining settlement clusters and forest subgroups constitute analysis units.

Main conclusions are: (a) deforestation is a serious problem; (b) forest clearance to supplement food production is the major reason for deforestation; (c) fuelwood extraction affects deforestation when forest size is significantly reduced by clearance for food production; (d) existing forests can provide a sustainable fuelwood supply but arable land cannot satisfactorily meet food needs. Implications of the analysis suggest that the control of deforestation requires: (a) improvement of food production and distribution practices in order to stop further forest encroachment; (b) better management of existing forests to maintain and preferably increase, sustainable fuelwood supply; (c) direct participation of local people is indispensable to instituting these improvements.

PROBLEM

The subsistence economy prevalent in the rural areas of Nepal is dependent, directly or indirectly, on the forest as an important provider of basic needs. Fuelwood, poles and timber, together with imperata grass (shiru), are extracted directly from the forest, and constitute the prime inputs to the supply of fuel and shelter for sustenance of human life. In an indirect way, food can also be considered as a contribution of the forest because forest clearance has to be instituted in order to compensate for decreasing land productivity and increasing population growth. The problem reaches crisis proportions when the area as well as the quality of the forest decrease to a point where, on the one hand, its ability to provide for these needs is curtailed and, on the other hand, the ecological balance is disturbed, causing severe side effects in the form of soil erosion, landslides, imbalances in the hydrological regime, etc.

The idea that the high productivity of the Terai could be exploited to alleviate the food problems in the hilly midlands seems to have been a miscalculation. Two specific reasons can be advanced for this conclusion. First by the higher productivity of the Terai itself is debatable. Evidence showed, in fact, that the productivity per unit of land in the Terai was less than that in the hills.

Secondly, that the resettlement had not worked as planned related to the questionable assumption that an increase in production through resettlement schemes in the Terai would lessen the land pressure in the hill areas. The flow of food grains to the hill areas was in fact extremely limited.

The reality today shows that no significant progress was made towards increasing production in the hill areas. This is indicated by the growing degradation of the ecology, resulting in severe soil erosion and landslides in Nepal.

METHODOLOGY

Questionnaire survey, participation observation and direct measurements were used to derive:

a. forest area and tree volumes to estimate sustainable fuelwood supply;
b. fuelwood consumption by type, source and end-use;
c. arable land area and crop yields to estimate food grain production;
d. land tenure and ownership patterns to assess food grains distribution;
e. food consumption patterns by type and quality; and
f. forest areas targeted for future clearance.

Tree counts were made on 13 sample sites in Pangma forests to carry out forest inventory during the course of the study. Only diameter at breast height (dbh) was measured, without distinguishing the height or species of individual trees. The volume of trees was estimated using the volume table.

Estimates of fuelwood consumption were made by interviewing 182 households (31 percent) out of a total of 582 households in Pangma. Every third household was chosen for detailed interviewing, whereas the other two were used for limited interviewing to obtain census information where necessary.

In addition to these one-time annual recall schedules, 14 households were selected to represent various ethnic groups, altitudes, settlement clusters and economic status. These were asked to keep a daily record of fuelwood consumption and collection. These information was then collected every week by repeated interviews, using the daily records as a guide. This schedule was carried out for one complete year.

Yields of paddy, millet and maize as well as the levels of food consumption were obtained from interviews. Rice, millet, and maize are the food items considered in the study since they constitute the principal components of what may be considered as staple diet.

FINDINGS

The finding of prime importance in the thesis is that food needs probably play the major role in the process of deforestation in Pangma, whereas fuelwood needs play a lesser role.

Other major findings of this study are as follows:

1. Deforestation is a serious problem.
2. Forest clearance to supplement food production is the major reason for deforestation.
3. Fuelwood extraction affects deforestation when forest size is significantly reduced by clearance for food production.
4. Existing forests can provide a sustainable fuelwood supply but arable land cannot satisfactorily meet food needs.

RECOMMENDATIONS

The following measures should be undertaken for the control of deforestation:

1. Improvement of food production and distribution practices in order to stop further forest encroachment;
2. Better management of existing forests to maintain, and preferably increase, sustainable fuelwood supply; and
3. Instituting these improvements through direct participation of local people.

FUTURE RESEARCH

One important aspect of the research, which was not ascertained or measured, but which was clearly implied, is the topic of deforestation itself. For future research, comparable aerial photographs would provide useful insights into these aspects.

Along the same lines, a complementary study of the forms in which soil erosion and landslides have been taking place, would be very valuable in assessing the implications of deforestation.

If the forest utilization pattern is further studied in more detail, a more realistic assessment of the nature of deforestation, if any, due to fuelwood extraction, could be made, and consequently a more realistic work plan for measures against deforestation could be developed.

Similarly, a better assessment of deforestation due to forest clearance for food production could be performed by making a detailed survey of the history of pakhobari cultivation and the practice of slash-and-burn agriculture.

A strong case can be made for a joint research effort involving pure and applied scientists and social scientists, who would look at integrating the various aspects of deforestation into one conceptual framework and thus contribute to a more definitive statement concerning this important issue.

THE NEPALESE HILL AGRO-ECOSYSTEM: A SIMULATION ANALYSIS OF ALTERNATE POLICIES FOR FOOD PRODUCTION AND ENVIRONMENTAL CHANGE

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ABSTRACT

This study investigates the problem of a deteriorating hill agro-ecosystem and the impact of alternative policies on food production, household energy supply and environmental stability. This problem is to be found in acute form in Nepal. The process of deterioration is evident in ecological stress, increasing shortage of firewood and declining food production. The rapidly growing population has put increasing pressure on local food and fuel supply systems. Increasing pressures on the local resource base are affecting the stability of the local ecosystem. Particularly important are the losses of forest, which reduce the availability of energy and fertility from forests, resulting in a decline in productivity of farm lands. Stripping of forest cover exacerbates the problem of soil erosion which further affects the ability of the land to support the increasing population. The objective of this study is to identify critical dimensions of this ecological and economic problem and to develop an analytical framework which can evaluate the interaction of some of these changes as well as the impact of alternative policies

The analytical model is an integration of different existing analyses relating to land-use changes in rural areas, environmental change, and food production. It focuses on the issues of food, fuelwood, fodder and soil erosion. So a simulation model is developed which contains eight submodels relating to land use , fodder supply, wood supply, soil erosion, household energy consumption, population and labor supply and foodgrains production. Emphasis is placed on food, fuel, fodder and environmental aspects.

While the model allows a test of the impact of a wide range of policies over different systems, the more significant implications of this study are in the methodology for analysing the problems of hill agro-ecosystems. The study provides quantified means for guiding specific policy choices, but its major contribution is as a tool for the evaluation of deteriorating hill agro-ecosystems. Planners increasingly need more adequate and comprehensive analytical means to identify and understand the more complex relationships in hill agro-ecosystems. This study provides one possible methodology for estimating the complex interactions of present trends and possible policy interventions or combinations of public and private action.

PROBLEMS

The problems of ecological stress, shortage of fuelwood and declining food production are the critical dimensions of the deteriorating hill agro-ecosystem in Nepal. These problems are not isolated. Increasing population creates the demand for more food and fuel. As pressures on particular resources like forests increase, this disturbs the transfers of fertility from forests, resulting in a net decline in the productivity of the farm land. Stripping of forest cover exacerbates the problem of soil erosion which futher affects the ability of the land to support an increasing population.

Much of this has been observed in hill agro-ecosystems. But from here on little is known. There are undoubtedly important trade-offs involved by addressing one set of issues and neglecting others. It is therefore necessary to identify and evaluate these linkages so that a more informed basis for policy decisions is available.

Because the problem in hill areas is complex, it is vital to consider the most important needs of the rural people and evaluate their interaction with the environment. This implics a study of the entire agro-ecosystem in its more critical dimensions, rather than a search for specific remedies.

In the past, studies dealing with rural areas have looked at different processes or systems separately, with a major focus on the use of modern technology to increase food production. The lure of some of the technologies was powerful enough to direct a large part of the rural and agricultural development thrust towards this goal.

Today, food production itself has suffered on account of the neglect of the resource base, ecology, energy, institutional and organisational aspects. While these areas have been recognized as crucial, their relationship with rural production and energy systems has only recently aroused an increasing interest. No systematic effort has been made to identify the different dimensions of the problems and their relationships for the hill areas of Nepal. In this study an effort in this direction has be made.

OBJECTIVES

The objectives of this study are:

1) To develop an analytical framework for assessing the interrelationships of the critical dimensions in the hill agro-ecosystem and;

2) To use the analytical framework to evaluate the impact of alternative policies relating to food and resources.

METHODOLOGY

The manner in which these objectives has been approached has been to integrate different previously used approaches and to develop new ones for other aspects based upon the prevailing understanding of the Nepalese hill agro-ecosystems.

FINDINGS

It is possible to test the impact of a wide range of policies over different systems The results of such a study can be used to evaluate policy decissions which the study has consistently treated as apolitical. However, the major contribution of the study has been methodological. It provides a tool for the study of hill agro-ecosystems.

It is possible to capture in quantitative terms some of the important aspects of the relationships between population, resources, technology and environment, and changes in one system are transmitted to others, although the nature and magnitude of these changes differ.

This type of approach for analysing rural development issues provides a better basis for increasing the effectiveness of planing as compared to those approaches that primarily focus on one aspect alone. In situations where certain types of pressures predominate, the tendency in the past has been to focus on just the areas of pressure and leave others alone. The problems with such approaches are not hard to imagine. By the time one system manifests pressures of some magnitude, the impact of this has already been transmitted to others, and it will not be long before similar magnitudes of problems become evident in other systems as well. The analysis has attempted to examine some of these relationships and interactions for the hill environments of Nepal. The framework developed has traced the differential impact of alternate policies on the stability (as identified by the index of soil erosion) and the productivity (as indicated by levels of foodgrains production and the supply of locally based household energy inputs) of the hill agro-ecosystems.

Once an integrated framework of this type has been established, evaluation of policy options can be pursued from different perspectives - environmental, household energy, foodgrains production and budget constraints. Highlighting the tradeoffs is an important benefit of this type of simulation analysis, as one option may have favourable impacts on some but not on other aspects.

Such an approach can significantly assist in a general evaluation of the inter-temporal outcomes of different policy mixes for the hill agro-ecosystems, and in areas where there are sets of pressing issues this approach can enhance the effectiveness of planning for rural areas.

Although the framework has been used for a hypothetical case of a fairly small area, there are no reasons why its usefulness should be limited to just small areas. As long as the basic structures of the larger regions are identifiable, such an approach becomes equally useful for establishing changes in resource bases, the nature and different types of pressures on the regions, and a broad idea of the likely impact of different policies over a wide ranging set of indicators.

FUTURE RESEARCH

There are two important areas for further work suggested by this study. The first has to do with the improvement of existing submodels. There are possibilities for improving the livestock and population submodels to include a more detailed consideration of such issues as increased number of livestock products, fodder demand by nutrient types, and migration. There is also the possibility for using a disaggregated production function to reflect foodgrains production on a crop by crop basis. Additional inputs like irrigation, plant protection materials and improved seeds can also be considered. At the same time it is also possible to undertake production analysis based upon farm sizes so as to reflect changes over different groups in the hill agro-ecosystem. The latter aspect will however involve a similar desegregation for other resources and household energy submodels.

The second area for further work has to do with additional submodels and relationships. There is also some scope here, but this will very greatly according to the nature of the areas and issues being considered. Within the general framework of this study, there are possibilities for introducing income and price based relationships, exports and imports of the area, some non-agricultural activities and a more careful look at the nutritional aspects of the local food production. It will be necessary to study these aspects empirically before appropriate relationships can be postulated.

PREDICTING SITE INDEX OF *SHOREA ROBUSTA* (GARTN.) FROM ENVIRONMENTAL FACTORS IN NEPAL

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ABSTRACT

A site index (SI) prediction model was tried for sal (Shorea robusta) in Nepal using environmental factors such as climatic factors, physiographic factors and soil factors. Data from 70 plots were obtained. The process involved the development of a site index guide equation and generation site index for the plots measured. The site index guide equation took the following form:

$\log H = 0.0725 + 0.8139 \log A$
The stand site indices were estimated using the equation:
$\log SI = \log H \pm 0.8139 \log (BA-A)$
Where: BA= Base age taken at 30 years
A = Stand age in years, SI = Site index,
log is to the base 10.

Correlation analysis between the stand variables showed that site index was significantly related with the total height (THT) and diameter at breast height (DBH) Likewise, THT and DBH were also significantly correlated with each other. Both THT = and DBH were significantly but negatively correlated with temperature. The topographic position (TOPOPOS) of the stand was significantly but negatively correlated with SI, which areas that the SI is higher or better in the lower plains than in the middle slopes. No other significant correlations were obtained between SI and other physiographic variables. THT and DBH were significantly positively correlated with altitude.

Very few significant correlations were obtained between the stand variables and soil physical properties. SI was significantly but inversely correlated with electrical conductivity, organic matter content and total nitrogen in subsoil.Total nitrogen content in top soil was also significantly and inversely correlated with SI.

The environmental variables were subjected to stepwise multiple regression analysis using site index as dependent variable and other environmental variables as regressors. The analysis revealed that the site index of sal is a function of depth of the topsoil (DEPTH1), electrical conductivity in the subsoil (EC2), potassium in the subsoil (K2), and action exchange capacity in the subsoil (CEC2). The relationship between the mentioned variables is given by the following equation:

$SI = 7.010257 \pm 0.46349 * DEPTH1 - 28.173675 * EC2 \pm 4.982982 * K2 - 0.207158 * CEC2$

The above equation has a coefficient of determination (R2) value of 0.7135 reflecting 71.35 percent of the variation in site index of sal can be explained. Of the four variables in the model, depth of the topsoil alone explained 52.97 percent of the variation in the site index of sal.

PROBLEMS

Forest site quality is the sum total of all the factors affecting the capacity to produce forests and other vegetation. A knowledge of the growth response of trees to factors of the environment is important to forest management, in that one can encourage growth either by modifying the environment or by concentrating on sites providing a desirable environment for the species of the total forest land of the country, 16.2 percent is sal forest which is dominant in the Bhabar and Terai zones except in areas of very high rainfall where it is replaced by mixed forests.

The area of sal forest is continually decreasing due to encroachment, conversion to agricultural fields and resettlement of people into the region.

OBJECTIVES

This study was conducted with the following specific objectives:

1□ to determine the relationships between certain site factors and growth of sal forest; and

2□ to develop a site index prediction equation for sal based on some measurable site variables.

There is not much problem with sal regeneration in Nepal. The regeneration comes profusely either from seeds or from the coppice. In case of unfavourable conditions the seedlings die back.

Its preference, market, and case of establishment make it a very important species Therefore, this study on the relationship between some site factors and growth of sal will help in making specific silvicultural prescriptions for the better management of the sal forest.

METHODOLOGY

The study area covered 13 southern districts in the sal belt of the Terai, Bhabar and dun regions. Altogether, 70 sample plots were established in these 13 districts. Out of 70 plots, 33 (47.14 percent) were in community forest areas and the rest (37 plots) were in national forests.Age of stand was taken from the existing records and verified by counting the growth rings of stumps. Altogether 70 circular temporary sample plots were established in such a way that stand age and environmental conditions of the area were covered. Furthermore, the sample plots are selected from stands that were fully stocked, even-aged, uniform, and with no signs of previous damage from destructive agents.

Five dominant trees were selected from each sample plot. DBH of the selected trees was measured at 1.3 m from the ground level using a diameter tape. The topographic position (TOPOPOS) of the sample plot in the stand was recorded according to whether it was on the ridge top, middle slope or low plain. A soil pit about 1 m deep was dug near the centre of each plot, and the boundary between the topsoil and the subsoil was determined from their colour difference. The depth of the topsoil was then measured.Samples of about 2 kg of soil

were then collected from the topsoil and subsoil separately and placed in separate plastic bags. These samples were then analysed in the soil laboratory for their physical and chemical properties. The data collected were then subjected to simple correlation analysis. Stepwise multiple regression procedure was then applied to develop a regression using the general equation:

$$SI = a + b1\ x\ 1 + b2X\ 2 + ... + bn\ x\ n$$

Where:

X = environmental variables

a, b = regression coefficients.

Only those environmental variables which have significante effect were included in the model. The response regression procedure were carried out to verify the type of relationship (linear or non-linear). The statistical analyses were carried out using a SAS (Statistical Analysis Systems) package. The derived equation was then verified for its predictive accuracy. For this purpose, data from 20 sample plots were collected independently. Then the site index was predicted using the model and verified by actual field measurement. Paired tests and Chi squared tests were applied to see if there site is a significant and different between the predicted and observed site indices.

FINDINGS

Of 24 equations tried, the following equation was accepted as the site index guide equation. The highest R2 value and the lowest MSE value were used as the criteria for selecting the guide equation.

$$\log H = 0.0725 + 0.8139 \log A$$

Where:

H = Total Height

A = Stand Age in years

log to the base 10.

Sal can be and should be managed for a rotation of 30 to 40 years.

RECOMMENDATIONS

Of all the factors, soil is the most significant and stable factor, and contributes most to site productivity. Measurement of soil factors alone also provides a good share of the level of productivity of a site. Sample correlation analysis may fail to give the real picture of the relationship between environmental variables and stand variables. As there are several variables which show significant relationships with the stand variables only when considered with several other variable, it is, therefore, suggested that to identify the relationships between the variables, partial correlation analysis should be carried.

With several variables being considered in such studies, it will be difficult to use all the variables at once for partial correlation analysis; thus it is better to go straight to the stepwise multiple regression analysis to find the appropriate combination of variables affecting the site index A response regression analysis should be run to verify the nature of relationship between the selected variables in the model. For the proper management of the sal forest, the

area should be divided into two zones (excluding the areas under national parks).The large parcels of sal forest should be managed intensively by the Department of Forest. Other areas, usually smaller in size, should be allocated for the management under leasehold forest or community forest. The sal forest of Nepal demands that its proper management will have to be done sincerely. The current model will help fill in this gap as the variables in the model are not very sophisticated to measure. This model will help considerably in assessing the site and to develop a proper management plan and prescription for the area. Moreover, developing a yield prediction model on the basis of the present model will highly enhance the prescriptions and efficiency of the forest management.

To fulfil the immediate needs of the community, it is suggested that the smaller forests should be managed under short rotation (usually five to eight years) coppice crop. This will greatly reduce the pressure on the remaining sal forest. The management of the coppice sal forest is slightly different to that of high forest system; thus it is recommended that a similar study be conducted in the case of coppice sal forest also.

It is recommended that the model be further validated and tested by using similar data sets from other studies. Yield prediction models should be developed using this site productivity model as base.

TREE CULTIVATION ON PRIVATE LAND IN THE MIDDLE HILLS OF NEPAL: A VILLAGE PERSPECTIVE PRIVATE

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ABSTRACT

This thesis offers a village-level perspective upon the cultivation of trees on private land in the middle hills of Nepal (the pahaad). It argues that enquiry into local knowledge, opinion and conditions is an essential prerequisite to the designing of appropriate initiatives on private tree planting, and that this has been generally lacking in forestry interventions in the pahad to date.The study focuses upon Sure, a collection of hamlets in Dolakha District, Central Nepal. Villager knowledge, activities, and opinions about the cultivation, management and utilization of trees on private land are described in the context of the history of settlement, the present way of life and use of tree products, and changes currently taking place in the area.

Information collected in the nearby village of Melung is also discussed.It is known that villagers vary in their attitudes towards the cultivation of trees on private land, but some of them display a great depth of knowledge about and interest in the subject.

Villagers most likely to plant trees were found to be those who perceive a recent decline in local tree product availability (especially species valued for quality fodder), who own sufficient land for food sufficiency, including some non-agricultural areas (the latter being particularly important at elevation over 1,700 m), who are male, and who have a personal interest in tree cultivation.

Caste and education per se were not determining factors.Broadening in perspective to the pahaad as a whole, a number of strategies that outside agencies might adopt towards the cultivation of trees on private land are discussed. The circumstances under which these may be appropriate are examined in the light of insights gained. Where pertinent, suggestions are made on the implementation of such strategies.

PROBLEM

There are numerous ways in which trees can be grown on private land in combination with crops, domestic animals, or both. Taking a socially orientated perspective, a number of writers have suggested that privately owned trees are particularly beneficial to the rural poor. Trees are said to play a significant role in the seasonal livelihoods of the poor and to act as a source of capital in times of financial need. As the existence of indigenous agro-forestry systems demonstrates, farmers in many parts of the world actively cultivate trees on their land if they perceive a need for, or advantage in, doing so.

Much has been learnt about the implementation of community forestry programmes in Nepal over the last 15 to 20 years. Yet in 1989, when there was so much talk about greater learning from, and greater participation by local people regarding forest management, the promotion of private tree planting was being advocated in the absence of any detailed information about villagers' views and knowledge on the subject. In many cases the private tree planting programmes seem to have been based simply on the assumption that if villagers were to plant trees on their land, they would need seedlings, therefore seedlings should be provided.

There is general agreement in many of the reports that farmers prefer to plant fodder and fruit trees on their own land, rather than pines. However, it was commonly noted that often only the latter were available in local nurseries and, furthermore, that there was tendency for the poorest quality plants left over from plantation activities to be supplied to private individuals. As a result, private tree planting initiatives were often not very successful. Specifically, this study sought to answer the following questions:

How does the use of tree products fit into the way of villagers' life, and from where are these products obtained ? Are present sources perceived as sufficient ? What trees are most valued by villagers, and why? Which of these are suitable for cultivation on private land ? What factors are important in influencing whether or not villagers are interested in planting trees on their own land ? Is anyone in the community already planting trees on their own land ? What lessons might be learned from them?

OBJECTIVES

The aim of this study was to address the subject of private tree planting at grass-roots level and to learn from villagers themselves how they perceive tree cultivation on their land.

METHODOLOGY

A multi-method research approach was adopted, combining techniques used in the social sciences and those more familiar to biological scientists. The use of a number of different methods served as a crosscheck on the reliabilty of information obtained from one method against another. Following are the research methods that were used for this study.

1) Detailed study of a few individuals to gain an understanding of their way of life, their use of tree products, and land ownership patterns.

2) Survey of the main uses of tree products (fodder and fuel), obtaining information on the relative use of public and private land, and the species used. Sample of as many randomly selected households as feasible. The sample was stratified by caste/ethnic group, known to be correlated to some extent with other variables such as economic status and geographical location. Stratification was conducted on a proportional basis.

3) Informal interviews with members of known households.

4) Inventory of all trees cultivated on the private land of known households, gaining information on species cultivated, tree source (natural regeneration or planted), location, and population structure.

5) General discussions and observations.

FINDINGS

Farmer knowledge about trees and their cultivation has been greatly underestimated in the past, and continues to be so by some researchers. The need to promote the planting of trees on private land has probably been generally overestimated by many workers, including the authors of the Master Plan for the Forestry Sector, Nepal. Interest in the planting of trees on private land may be highest in areas where forest resources are perceived to be reasonable but in decline, rather than in areas which have been subject to severe shortages of tree products for some time. The most active participants in any programme that seeks to assist farmers to cultivate more trees on private land are likely to be farmers who have at least sufficient land to be virtually self- sufficient in their food supply.

Farmers cultivating land lying above about 1,700m (or above the limit at which millet may be relay cropped with maize to give two summer harvests on baari) are likely to be particularly unwilling to cultivate trees in association with crops. There is no evidence for an interest in tree cultivation being determined by caste. To date, it has been common for organizations operating in Nepalese forestry to design private tree-planting programmes that bear little relation to the situation on the ground.

RECOMMENDATIONS

The provision of seedlings to villagers could be greatly improved by a more "bottom-up", participatory approach. The seedlings required by farmers for their own land might be better provided from smaller, local nurseries over which villagers have direct control and projects provide only materials and advice on request. So, the suggested new approach to seedling provision would combine better overall monitoring of nursery initiatives with greater villager participation in these nurseries. There should be clear, permanent and well publicized legislation giving villagers assurance on following points: the presence of trees on their land will not in any way adversely affect their claim to ownership of the land, and all the products of trees growing on their land will be owned by to use as they like.

MANAGING PUBLIC LANDS AS A COMMON PROPERTY RESOURCE: A VILLAGE CASE STUDY IN NEPAL

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ABSTRACT

This study addresses the problem of public land use in Nepal from an institutional perspective. In light of the distinction made between the open-access (devoid of any property rights) and common property (collectively shared rules of entitlement) in the use of natural resources, the present study develops an empirical basis to evaluate the relevance of these two alternative institutions in the context of all hill village economy.

The present analysis involves inquiries into the nature of extractive activities on public lands, the perception and awareness of public land-use problems and the current system of property rights on these lands. In addition, a series of hypothetical experiments were conducted on the repondents to test their willingness to contribute to the provision of, and refrain from extracting benefits from, collective resources. The data were gathered by interviewing 140 households in the study area.

Major findings of this study are that: (a) there is consistency between the individual behavioural intention and the collective interest among the households in the study area. This is true both in the cases of contributing toward the provision of collective resources as well as in expropriating benefits from an existing resource; (b) the willingness to contribute resource is attested to by their actual acts of contribution; (c) the villagers are aware of the external effects of natural resource use and are capable of devising institutional rules to minimise these externalities, if entrusted with that responsibility; and (d) this process of institution building could be strengthened by providing proper incentives on the part of the government, rather than by introducing policies that would disrupt this process.

These findings are consistent with the co-operative actions that have been sustained over generations among the rural communities. They also demonstrate the lack of support for the behaviour of "free riding," as predicted by the conventional wisdom.

The findings imply the need for promoting appropriate institutional arrangements in the local areas with respect to resource use practices and by involving local residents in decision-making. The community forestry program presently underway can be an important vehicle in achieving these goals.

PROBLEM

According to preliminary estimates in 1979, the largest proportion (29.1 percent) of the total land area (141,100 km2) was classified as forestland. Forest area had decreased by about five percent over a period of five years. On the other hand, cultivated land had increased. These opposite trends have raised concern among policy makers regarding the pressure on available land, and particularly on public forests, arising from an expanding population. This review of

past policies and development performance points to the fact that something has gone amiss in the basic approach towards planned development. That part of the problem lay in development being perceived by all as primarily the job of the government and in the failure to recognise the role of local institutions in allocating and managing resources.

Closely related to these two factors are the government policies and strategies that were adopted during the past plan periods. This study will explore the alternatives which can be adopted to ensure economically efficient and ecologically sound strategies for material property of the rural people of Nepal.

Given the alarming deterioration in environment and worsening trends in economic well-being of the population, there appears to be an urgent need to develop an analytical basis to devise alternative modes of resource management at the local level to stop the present trends and to improve the material well-being of the people in the future, within the given constraints of resource endowments and environment.

OBJECTIVES

To appraise the extent of land scarcity in the selected area of Nepal, to examine how alternative institutional arrangements and property rights affect the use of public lands, and to explore what alternative arrangements are possible for more effective use of these lands. Specifically the study aimed: to assess the extent of existing pressure on land in terms of the areas under different economic uses and the current nature of extractive activities on public lands; to develop an empirical basis to evaluate the individual willingness to contribute to, and expropriate benefits from, collective resources; to examine the nature of the conflict in public land use associated with the kind of externality involved, namely, open-access or common property; to appraise the current property rights on public lands; and to recommend, on the basis of the findings, appropriate policy measures at the national and local levels to ensure more effective utilisation of public lands both in the short term and in the long term.

METHODOLOGY

A comprehensive survey at the household level was conducted to gather information on landholding and land use, cropping patterns, livestock, biomass production and use, and other socio-economic and biophysical characteristics of the study area. Simple tabular analysis was used to characterise the existing resource base and the extent of land scarcity. A series of hypothetical experiments was conducted on the respondents' willingness to contribute resource to the provision of collective goods and to refrain from expropriating benefits from existing collective resources. Emphasis was given to examining local organisations such as the panchayat and communal/ethnic associations and the hierarchical preponderance of the local landlord/elite with respect to their structure and their effectiveness in local level decision-making and enforcement.

FINDINGS

Rural households are likely to continue to rely heavily on public lands to meet their needs for firewood, fodder and non-fodder biomass. Given the high concentration for population per unit of cultivated land, the role of public lands as the main source of non-food biomass is

bound to increase. Besides, growing land scarcity in the face of an expanding population is going to pose increasing threats to the area and quality of public lands unless some drastic steps are taken immediately.

The results from the hypothetical experiments conducted in this study strongly suggest that individuals in a group are willing to contribute resources to the provision of collective goods, including public lands. The same results were obtained when the respondents were asked about their willingness to contribute resources in a non-experimental and non-hypothetical situation. In fact, individual households had been contributing resources (mainly in the form of voluntary labour) for the provision of such collective ventures as road and trail construction, school building, digging of irrigation canals, and hiring of forest watchmen.

Parallel to the willingness to contribute resources to the provision of collective goods, the households were willing to curtail their level of extractive activities on existing public land when led to believe that such curtailment would help preserve the quality of these resources. They would actually extract slightly less than what was regarded as a "safe" level. While this result was slightly incongruous in the case of grazing on pasture, the evidence was strong in the case of cutting firewood from the forests. While most households did not consider the likely actions of others in making their own decisions regarding the extractive use of public lands, they were nevertheless interested in making provision for a collective resource and in preserving the quality of an existing resource, as shown above.

This led to the conclusion that, in a semi-traditional rural economy, the way in which the mechanism of assurance works may be different than that which is predicted by the theory. It was established, however, that free-riding based on strict dominance of individual strategy was non-existent The concern for protecting the collective interest existed despite the absence of a formal mechanism of assurance to co-ordinate individual actions. This phenomenon was explained on the basis of the background ethic which operates informally as a built-in set of beliefs and behavioural norms to regulate individual actions in a community. The background ethic serves as a bridge between the actions of an individual and the collective interest.

Property rights on public lands are not clearly defined at present. There is a gap in the legal versus the perceived status of these lands.

Government policies on public lands have, until recently, been predicated on stringent control of these lands by the government and on excluding local communities from using and managing them. Since 1978, however, there has been an official reversal of these policies by making provisions for establishing community forests and for involving local communities in their management. The new community forestry rules also require the government to provide free saplings and technical advice to communities desirous of establishing community forests. Yet the evidence from the study area showed that these policies have not been pursued with vigour, although the government has largely been responsible for replanting trees and employing forest watchmen.

RECOMMENDATION

It should be recognised that any policy has a space and time dimension and that policies dealing with public land use can be no exception The spatial aspect can be viewed in terms of local, regional and national level polices which complement one another in meeting the objectives stipulated at the various levels. In this regard, the National Forestry Plan of 1976

and the community forestry rules of 1978 have provided the necessary framework at the national level. The task now is to implement these policies earnestly at the local level.

FURTHER RESEARCH

There are several areas which are relevant to the understanding of the utilisation and management of public lands but which have not been addressed in the present study. Future researches in public land-use problems should be directed to these areas as described below.

Firstly, there is a need for improving the methodological basis to analyse the assurance mechanism as it applies to the use of collective resources in general, and public lands in particular. In addition to the hypothetical experimentation method used in this study, development of other alternative tools may enhance the analytics of assurance with regard to the way rural communities devise institutional rules to minimise the transaction costs -- the costs of information dissemination, bargaining, decision-making and enforcement -- associated with the co-ordination of individual actions. A better understanding of the mechanics of assurance would help one understand the role of local institutions and their efficacy in preserving public lands.

Secondly, a more comprehensive analysis is desirable in the area of the specific incentives that the government can provide at the local and national levels in order to promote the establishment of local organisations and encourage these organisations to devise appropriate rules consistent with the preservation of the long-term collective interests of the local communities.

Thirdly, with respect to the hypothetical experiment method used in the study, further refinements are desirable in order to account for the possible biases that are associated with such research methods.

To what extent such biases as strategic bias, information bias, instrument bias, hypothetical bias and other biases (sampling, non-respondent and interviewer biases) affect the overall results is certainly an important question.

Finally, the results from this study, and the conclusions derived from them, are based largely on a single case study. Are these findings generalisable to other areas of Nepal or are they specific to the sample used in the study? Only further evidence from other areas can provide a satisfactory answer to this question.

COLOGY OF THE HOG DEER IN ROYAL CHITWAN NATIONAL PARK, NEPAL

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ABSTRACT

Between 1981 and 1983, 95 hog deer were captured and measured and 21 were radio collared and monitored for 30 months. Maximum weights (mean for males = 42.7 kg; mean for females = 32.2 kg) and lengths (mean for males = 127.8 cm; mean for females = 120.6 cm) were reached at 2-3 years of age. Males were 32.6% heavier than females. Sex ratios generally favoured females. Groups of more than 20 deer were observed during February through April, after the first fires in the grasslands, but the basic social group consisted of an adult female and her juvenile offspring. The peak fawning season was March through April, but females gave birth from the end of January through April, about 7 months after copulation. Litter size was normally 1, and the recruitment rate was estimated at 13%. Population densities of hog deer in the study area, estimated by various methods, ranged from 15.5/km2 to 29.2/km2 in tall grassland habitats to 0.13/km2 in riverine forests. During all seasons, the deer fed in the mornings and evenings and bedded and ruminated during the hot part of the day. They were 41% active during the day and 26-29% active at night. Home ranges overlapped extensively and mean home ranges of females and males were estimated at 60 and 80 ha, respectively. Seasonal home ranges differed little from yearly home ranges. Home range shape was dictated by food and water. Small home ranges indicated that hog deer were sedentary, preferring grassland where food, cover, and water were available. Habitat use based on transmitter locations, pellet group counts, and direct observations showed that hog deer preferred grasslands to sal and riverine forests. Foraging and feeding behaviour, recorded inside an enclosure and from cafeteria trials, indicated that grasses, ferns, semal flowers, and vellor fruits were the most important food items. Saccharum spp., Imperata cylindrica, and Cynodon dactylon comprised 70% of the grass species available as food and cover, with an average mean green biomass of 2.6 kg/m2.

PROBLEM

Habitat destruction, human population pressures and food shortages are exerting pressure on the natural resources of southern Asia, and Nepal is no exception. Habitat destruction and related disturbances have become a serious threat to the survival of endangered species, such as the tiger (Panthera tigris), leopard (Panthera pardus), rhinoceros (Rhinoceros unicornis), gaur (Bos gaurus), sloth bear (Melersus ursinus), gharial (Gavialis gangeticus), and dolphin (Platinesta gangeticus), in the Chitwan Valley.

The hog deer (Axis porcinus) is listed as endangered in Thailand. Vietnam, and Bangladesh by many researchers, but no attempt has been made prior to this research to study them intensively. This study was initiated during September 1981 and continued until December 1983.

It investigated several aspects of hog deer ecology and behaviour. Specific objectives were to determine morphological features, population dynamics, sex and age ratios, group size and composition, reproduction, mortality, movements, activity patterns, home ranges, habitat use, food habits, food availability, and behaviour.

METHODOLOGY

Hog deer were trapped in the study areas between October 1981 and August 1983. Tangle nets were 100 m long and 3 m high. They were constructed from local jute material in 20 m sections with 25 cm mesh. The nets were hung on sticks or vegetation so that a light pressure would collapse them and entangle animals that "hit" the nets. White bhit cloths, 200-500 m long and constructed by tying 20 m x 15 m sections of muslin together, were hung on vegetation and formed the wings of V-shaped funnels with the ends toward the tangle nets. Such funnels were formerly used to shoot or capture tigers in Nepal.Hog deer were driven from the open end of the cloth funnel with the aid of 4 to 10 elephants and up to 18 people. Domestic elephants and crewmen were spread out across the funnel opening. The elephants were kept at equal distances from each other to locate dangerous species such as rhinoceros, tiger, leopard, sloth bear, and wild boar (Sus scrofa). Hog deer were handled by 2 people. All deer were fitted with plastic collars that identified each individual. From January 1982 to August 1983, 95 deer were captured and marked.

Twenty-one of them were fitted with radio collars.Nine deer caught in tangle nets were drugged with intramuscular injections of Rompun (xylazine) at the capture site. Rompun was used as a drugging agent because it was easily available and had a wide margin of safety. Therefore, doses could be repeated frequently. The drug was administered to hog deer at a mean dosage of 3.8 mg/kg to test its effect on the animals.Fawns less than 1 month old were located by the Tiger Ecology Project shikaries by walking through the grasslands and by observing the behaviour of adult hinds during the parturition season. Four fawns were captured by hand.Feeding and food habits of hog deer were recorded from: (1) direct observations of the deer feeding in the wild; (2) direct observations of 6 animals feeding inside an enclosure large enough to support them in semal/savannah habitat; and (3) from cafeteria trials. Food habits in riverine or sal forests were not investigated because hog deer avoided both.

FINDINGS

During all seasons, the deer fed in the mornings and evenings and bedded and ruminated during the hot part of the day. They were 41% active during the day and 26-29% active at night. Home ranges overlapped extensively and mean home ranges of females and males were estimated at 60 and 80 ha, respectively. Seasonal home ranges differed little from yearly home ranges. Home range shape was dictated by food and water. Small home ranges indicated that hog deer were sedentary, preferring grassland where food, cover, and water were available. Habitat use based on transmitter locations, pellet group counts, and direct observations showed that hog deer preferred grasslands to sal and reverine forests. Foraging and feeding behaviour, recorded inside an enclosure and from cafeteria trials, indicated that grasses, ferns, semal flowers, andvellor fruits were the most important food items. Saccharum spp., Imperata cylindrica, and Cynodon dactylon comprised 70% of the grass species available as food and cover with an average mean green biomass of 2.6 kg/m^2.

RECOMMENDATIONS

Illegal cattle grazing by local villagers, illegal grass cutting, and grazing by more than 30 domestic elephants occurs mainly in the grasslands. This may constitute excessive pressure on the grassland habitat, or may be beneficial to maintaining short grasses, but the ecology of the grasslands has not been studied. Therefore, research should be conducted to determine the effects of grazing by large ungulates on the grassland for hog deer. When designing such plans, the following points should be considered:

1) Further research should be conducted on large ungulates in Chitwan Park (chital, sambar, hog deer, barking deer, rhino, gaur, and cattle), including food habits, habitat use, and the quality and quantity of food required to maintain healthy populations.

2) A rotational grazing system for the 30 domestic elephants should be devised that facilitates research on the effects of heavy grazing on the grasslands. An elephant needs to feed for 17-19 hours a day to maintain its body condition and consumes an average of 150 kg (wet weight) of vegetation in a day; grass accounts for almost 80% of the diet. Thus, heavy grazing could easily be applied or removed by means of elephants.

3) Tall grasses such as Saccharum spp. are slowly invading the short grasslands. This will reduce the food availability but will increase escape cover. Experiments should be conducted on increasing interspersion of food and cover by burning small patches within tall grasslands. Salt in burned patches would attract ungulates, especially rhino.

4) More grassland habitat should be created by clearing 20-30 ha patches of sal forest on flat areas where danger of erosion is minimal. This would increase habitat diversity, food for hog deer and other ungulates, and ultimately food for the endangered tigers and leopards.

5) Hog deer should be introduced within the Park in such new habitats if they are far away from the present grassland.

6) Reintroduce wild buffalo and swamp deer to an isolated area of the Park, and study their interactions with grasslands. This should extend the range of these endangered species and eventually provide another food source for leopards and tigers.

7) Representative areas of 3 ha each within the various plant communities should be marked, and 1000-point surveys conducted on each at 3 to 5 year intervals to establish trends in plant succession, species composition, and basal area plant cover.

MANAGING PUBLIC LANDS IN A SUBSISTENCE ECONOMY: THE PERSPECTIVE FROM A NEPALI VILLAGE

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ABSTRACT

This study was designed to provide insights into one of Nepal's most pressing problems - how to stop public lands from deteriorating while meeting the basic needs of subsistence farmers for forest products from these lands. In this regard, it attempts to document the practices of forestry, grazing and agriculture that are competing to use public lands and the relation of these practices to land degradation and determine if present needs, distribution of benefits, and labour requirements could influence the co-operation of farmers with controls on public land use.

The tree centered quarter method was used to sample the Panchayat forests, and stratified sampling of house holds was chosen. The 31 chosen households were interviewed on a randomly selected day, weekly for a year. A time allocation survey also was conducted in all of the sample households to estimate accurately the amount of time devoted to different tasks each day.

Overgrazing is the major cause of degradation on public lands. The study also has shown that the present needs of small farmers for forest products from public lands and the conflict between these needs increased productivity on public lands can hinder the adoption of land management plans on these lands.

Meeting local needs will require trade - offs which will become increasingly difficult to make as the population increases. Although maximum amounts of food, fuel and fodder cannot be grown on the same ground, a recognition of the significant demands, as well as of their consequences on land degradation, may help planners design more workable and acceptable land management plans. Various recommendations were made based on the findings of this study.

PROBLEM

Over 240 million cubic metres of soil are estimated to be eroded from the hills of Nepal annually. The human and environmental costs of this erosion are staggering. Subsistence farmers in the Nepali hills are dependent on the fertility and stability of their agricultural lands, and on the quality, quantity, and constancy of their water supplies.

The main source of soil erosion in Nepal, however, does not appear to be terraced agricultural lands; rather, it is public lands--unterraced forests, scrub lands, and pastures. The Resource Conservation and Utilisation Project paper states: "Ecologically damaging land use practices are primarily conducted on public lands which are now legally owned by the government, lack systematic management, and for which the benefits from individual restraint (e.g. overgrazing, overlopping) or investment (e.g., fencing, plantation) are insecure and ambiguous."

Subsistence farming in Nepal is based on a man-land cattle-forest relationship. Forests and grazing lands are essential to this system because they provide tree and grass fodder for livestock feed, leaf litter for roofing and composting, wood for fuel, timber and poles, and various medicinal and food plants. Farmers' needs for these products are major causes of land degradation in Nepal.

Nepal can afford neither the environmental costs of allowing its forests and grazing lands to be wasted nor the loss of forest products from the subsistence farming system. The public forests and pastures of Nepal need to be managed so as to minimise the destructive forces of deforestation and soil erosion, and to maximise the amount of forest products available for consumption by farm households

OBJECTIVES

This study describes the public and private lands of a Nepali village and how they are used for meeting farm needs. The objectives of the study are to: 1) document the practices (agriculture, grazing, and forestry) competing to use public ands and the relation of these practices to land degradation; and 2) determine if present needs, distribution of benefits, and labour requirements could influence the co-operation of farmers with controls on public land use. In meeting these objectives, the study attempts to answer the following questions:

1) What land-use practices compete to use public lands, and what is the relationship between land use and land degradation ?

2) How important are forest products from public lands to subsistence farmers ?

3) Do farm-size groups have different interests in how public lands are used?

4) What are the labour requirements for collecting different forest products?

METHODOLOGY

Land-use and Land Area

The relevant land use categories in this study were considered to be: 1) arable lands, 2) sal forests, and 3) Schima-Castanopsis scrub/grazing lands.The area of forest and scrub/grazing lands was checked by mapping sample sites with a compass and tape measure.

Forest Inventory

The Panchayat's forests were sampled with the tree centred quarter method. In each of the two forest communities, 4 forest/scrub lands were randomly chosen. On each of these 8 pieces of land, 16 points were randomly selected. The tree closest to the point was then chosen as the base tree. In each compass quadrant from the base tree, the distance to the nearest tree, the tree species, and its diameter at breast height (dbh) were recorded.

Sample Population

Data on village demands for forest products were collected between December 1981 and December 1982. A stratified sample of households was chosen by compiling a census of village households with village informants. Households were interviewed on a randomly

selected day, weekly for a year.

Time Allocation Survey (TAS)

A TAS was conducted in all of the sample households. All individuals older than 5 years were observed at 3 randomly selected times each week. Their activities were recorded on a form listing most of the jobs and leisure activities in the village.

FINDINGS

This study has shown overgrazing is the major cause of degradation on these lands. The study has also shown that the present needs of small farmers for forest products from public lands and the conflict that can arise between these needs and the desire of larger farmers for increased productivity on public lands can hinder the adoption of land management plans on these lands. On the positive side, large and medium size farmers are interested in managing public land for increased productivity. Since village leaders are included in this group it is possible that a strong community land management programme can be initiated in the village.

Meeting local needs will require trade-offs which will become increasingly difficult to make as the population increases. Although maximum amounts of food, fuel, and fodder cannot be grown on the same ground, a recognition of the significant demands, as well as of their consequences on land degradation, may help planners design more workable and acceptable land management plans.

In terms of land-use practices, one of the major conclusions of this study was that a potential for conflict among farm-size groups exists over the use of public lands.

RECOMMENDATIONS

In terms of managed lands, more research is required on increasing forest productivity. Since tree fodder and firewood are the most important forest products, research is needed on planting quick growing species at close spacing for the fastest possible production of large quantities of biomass. Research is also needed to document the effects of controlled and rotational grazing programmes on grass production and soil erosion rates. Methods of increasing the productivity of fodder and firewood supplies on private lands also need to be studied more.

A careful study of decision making in the village and of how farmers participate in this process needs to be made.

In addition, studies of indigenous resources management systems, patterns of community co-operation, and ideas and institutions relevant to resources utilisation would be useful. Studies are also needed on the effects past development projects have had on the receptiveness of villagers to development projects, villagers' attitudes towards development inputs and extension agents, and their felt needs and interests in various proposed land management activities.

Finally more village-level studies such as the present one are essential for understanding the man-land relationship in Nepal. More intensive land-use studies are needed across Nepal under different environmental and cultural conditions.

SOCIAL REALITY, SOCIAL FORESTRY: THE CASE OF TWO NEPALESE PANCHAYATS

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ABSTRACT

A new paradigm has emerged within forestry termed social forestry. Social forestry assumes that the aggregate benefit of a project to a village leads to people within it. In particular it assumes that at least some of the benefits will percolate to the major users of forests-women and poor.

This thesis reveals that although an intent of social forestry is to help the poor and women, class and patriarchal structures limit their access to and control over forests, and their participation in social forestry projects. But the notion of gender and class as theoretical abstractions remain remote from the daily lives of individuals, and the experience of each person and the relationships into which they enter are constructed by the workings of these notions. Gender and class are shown to be real constructs which determine the way in which individuals interact and how resources are allocated between individuals. Social realist methodology is used here to explain the appearance of relationships at the empirical level.

The study is placed within the lived experiences of villagers in two panchayats in Nepal where forests are a resource essential to life. To understand the current formation of individuals' complex reality their relationships are placed within a wider historical framework.

The patriarchal construction of society places ownership and control of resources with men, and so women are subordinated through relations of production, and control over their labour power. Empirical experience reveals women of all classes are dominated through relationships of human reproduction. The class construction of society ensures that some women are dominated by women of higher class, and that some men of a lower class are dominated by men and women of higher classes. Thus each individual's relationships are determined by this complex reality of the articulation between class and gender.

ROBLEMS

Forestry is not about trees, it is about people. And it is about trees only insofar as trees can serve the needs of people.

A new paradigm has emerged within forestry which is termed social forestry. Social forestry subsumes a number of other forms of forestry which all have the common denominator of people.

Social forestry has a declared intention of helping the rural poor and involving women in the projects and the decision-making within them. Social forestry affects women's lives particularly because in many countries it is they who are the major users and labourers in the forest resources

Social forestry makes the assumption that the aggregate benefit of a project to a village leads to benefits to the people within it and that at least some of the benefits will percolate to those most in need. It also assumes women's participation in the benefits from projects.

The question is whether the assumptions of social forestry have any validity. Historical materialism alone does not allow for the emergence of the individual; rather it speaks of classes of human subjects and ignores their essential relations of gender. Although the man/woman contradiction cuts across social formations and modes of production, the particular form that relations take between men and women are historically and materially specific. Therefore an explanation of an individual's social reality is dependent on an understanding of the formation of an individual's relationships: For each individual is the synthesis not only of existing relations, but of the history of these relations.

The notions of gender and class as theoretical abstractions remain remote from the daily lives of individuals. However, the experience of each person and the relationships into which they enter are constructed by the workings of these notions. Gender and class are real constructs which determine the way in which individuals interact and how resources are allocated between individuals; who owns resources, and who controls them. It is the confluence between gender and class and the determination of access to and ownership of the major means of production - land, raw materials such as forests, and control over labour in and between households which forms the focus of this study.

METHODOLOGY

The fieldwork was carried out over a continuous period of 9 months, (from June 1986 to February 1987) divided between two village panchayats, Tukucha and Banskharka. The research methodology drew on techniques of oral history and popular memory. The use of oral history was to enable villagers to express their own understanding of their relationships. The foci of the research were the relationships between males and females and resource use decision-making, and personal experience as a white, female, single, middle-class researcher was obviously part of the nature of the problematic.

The focus was on the social relationships between individuals that determined their access and rights over land as a means of production and forests as a raw material essential to the maintenance of life.The theoretical relationships between class and gender were addressed at the empirical level through the lived experiences of individuals.

Realist methodology allows for the primacy of individuals and for the expression of their experiences of their relationships. Methods of oral history were used to allow individuals to reveal their perceptions of their relationships.The historical specificity of relationships necessitates an understanding of their historical formation. Historical materialist theory was used to posit individuals within their historically contingent circumstances.

FINDINGS

This study has revealed the real construction of the world by the universal categories of class and gender. It has examined this construction in two panchayats in Nepal to expose the relationships between individuals and the determination of their access to and ownership of

the major means of production - land and an essential raw material - forests, and the control of labour in and between households.

Social realist methodology provided a powerful framework with which to explain the appearance of these relationships at the empirical level by use of levels of abstraction. Class and gender as determinants of an individual's social reality are not observable at the level of appearances, but they are observable through the relationships that they engender. Thus the social realist methodology provided a framework to explain the mechanisms through which class and gender generate these observable relationships.

Levels of abstraction within reality allow for the articulation between other factors such as caste and ethnicity that operate at lower levels of abstraction. The complex reality of individuals is not just composed of class and gender relations, it is articulated with caste and other cultural factors. Through the empirical studies it was shown that class, gender, caste and ethnic group articulate as contradictions each with its own dynamics. These internal dynamics continue to operate, while elements from other contradictions dominate and obscure the ultimate appearance of the contradiction at the level of appearances.

The importance of this analysis lies in the conjunction and articulation between production and human reproduction.The patriarchal construction of society places the ownership and control of resources with men, and so women are subordinated to men through relations of production, and control over their labour power. Empirical experience reveals women of all classes to be dominated through relationships of human reproduction. These relationships gain their greatest expression through the working of the Hindu caste system. Here women are oppressed through the constructs of purity that define their relationships with men and ensure that they remain in an inferior position to men. Relationships which determine human reproduction tend to be subsumed by those of the production process.Thus women are subordinated to men who control the means of production,and women become an instrument of labour in both the reproduction and production process.

In the two panchayats studied, class is obscured to some extent by the operation of caste and ethnic groups. Gender relations transcend divisions based on ownership of the means of production, but women as a group are also divvied by class, some women dominating other women through their greater access to the means of production.

The emergence of Nepal as a tributary state within a world system dominated by the imperialism of Britain affected rural producers and determined the construction of mechanisms of surplus extraction. Control over land and labour was vested in those who supported the state, leading to the formation of the landlord class; a class founded on systems of extortion and exploitation. The formation of exploitative social relations between the owners and non-owners of the means of production and the reinforcement of these relationships through the over-arching Hindu caste code form the basis for mechanisms of current structures of exploitation and differentiation.

The social realist construction of forests makes the relationships that control access to and ownership of forests central to the thesis. The incorporation of local areas into larger systems, from the Gorkha empire to the British empire, to the modern world system and now the age of aid, has widened the relationships that women use and access to forests at the local level.

The construction of a global forestry was examined through the historical emergence of forestry as an institution, and the changes within the profession propelled by its incorporation

into wider development debates: from a forestry for 'modernisation' to a forestry which included notions of sustenance of 'basic needs'. The assumptions on which 'traditional' positivist forestry practice are founded have been questioned. The assumptions of a traditional forestry paradigm that insists on the primacy of trees and not people is challenged by social forestry which has as its intent people and theirinteractions with trees.

The changes within forestry practice are not seen in terms of a paradigm shift. The assumptions on which 'scientific' and positivist forestry are based are questioned from outside the traditional forestry paradigm. However, there are two stages in paradigm development: normal and revolutionary. In the normal phase the scientist's work is devoted to the understanding and wider application of the accepted paradigm, which is not itself questioned or criticised. Thus the forest scientist constructs the world order through the assumptions of a traditional forestry paradigm which insists on the primacy of trees and not people. Problems arising out of the practices of social forestry have their solution therefore within the explicit or implicit framework of this paradigm, and will direct the solutions to the problem accordingly. However, in those periods of revolutionary change, the base assumptions of the paradigm are challenged. Scientific revolution occurs when a new paradigm emerges with a new set of base assumptions which will direct understanding of problems. However, such a complete change cannot fully occur until the emergence of a new generation of proponents of the new paradigm.

POPULATION ECOLOGY OF GREATER ONE-HORNED RHINOCEROS (RHINOCEROS UNICORNIS) WITH PARTICULAR EMPHASIS ON HABITAT PREFERENCE, FOOD ECOLOGY AND RANGING BEHAVIOUR OF A REINTRODUCED POPULATION IN ROYAL BARDIA NATIONAL PARK IN LOWLAND NEPAL

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ABSTRACT

The objectives of this thesis were to examine habitats, diet, ranging pattern, habitat preferences and demography of a founder population of greater one-horned rhinoceros (*Rhinoceros unicornis*) released in Royal Bardia National Park in 1986, and to compare these ecologies of the founder with that of the donor population in Royal Chitwan National Park.

A microhistological technique of fecal analys is was assessed as a method to determine the diet of rhinoceros and was later employed to study the seasonal diets of both populations. Floristic composition of habitats and availability of food plants were determined by quadrat sampling along the transect lines in Bardia and in Chitwan. In Bardia, 10 rhinoceros were radio-collared to examine the ranging behavior and seasonal preference of habitats. Data on demography of the translocated population were obtained from the radio-marked animals and supplemented by observations derived from foot tracking by park staff before the main field study was initiated. Spacing behavior of the donor population in Chitwan was available from radio-tracking of five animals and information on demography of the donor population also was made available.

The microhistological technique provided satisfactory results for determining the diet of rhinoceros. More than 90% of the plant species were identified. Volumetric contribution of plant species that were moderately and less preferred in the diet was sensitive to sample sizes, and samples from $\leq$ 8 animals and reading of $\geq$20 slide transects/animal were required to estimate > 90% of the volume contributed by these species. Pooling samples and recording the frequency of fragment interception rather than measuring the size of each fragment, were less time consuming and had little effect of level of precision.

Floristic richness was higher in Chitwan than in Bardia (283 and 179 species, respectively). Among important food plants *Saccharum spontaneum* (grass) and *Mallotus philippinensis* (browse) were more abundant in Bardia, whereas *Saccharum bengalensis* and Narenga *porphoycoma* (grass species) and *Trewia nudiflora, Litsea monopetala, Coffea bengalensis* and *Murraya paniculata* (browse) were more abundant in Chitwan. The diet of both populations was dominated by grass species (> 60%), mainly *Saccharun spontaneum*. Animals in Bardia exploited more browse than in Chitwan during winter and hot seasons, probably due to lower productivity of *Saccharum*, attributed to lack of ample substrate moisture during these seasons.

Contrary to Bardia, Chitwan animals exploited more browse species during the monsoon, mainly due to better access to Trewia nudiflora fruits. Although some species were selectively eaten in each season, the general pattern of food plant consumption was related to the abundance of food plant species in the habitats, confirming that the greater one-horned

rhinoceros is a generalist feeder like other species in this family of megaherbivores.

The average annual home range sizes of the Bardia population were 25.1 (9.3 km2 for females (N = 8) and 41.8 (4.4 km2 for males (N = 2), whereas in Chitwan female (N = 4) and male (N = 1) home range sizes were only 2.9 (0.9 km2 and 3.0 km, respectively. Larger range size among males was explained by their seasonal ranges being further apart than those of females.

The pronounced differences in ranging behavior between the dense donor population (8-10 animals/km2) and the dispersed founder population (ca 0.3 animals/km2) were attributed to low density combined with a highly skewed breeding sex ratio, and to a fragmentated distribution and small patches of seasonally preferred habitats in Bardia. Khair-sissoo was the most preferred habitat during winter, riverine forest during both hot and winter seasons, and tall grassland during the hot and particularly during the monsoon season.

After translocation, the founder population bred at the same high rate as recorded in the donor population in Chitwan: mean calving interval was 4.3 years (N = 4), age of first potential breeding among females was 5 years (N = 1), and a young male bred successfully at 10 years of age. Furthermore, most translocated females conceived soon after they had been released. A total of 11 calves were born during the 8 year period. However, the total number of animals increased only from 13 to 15, mainly due to direct and indirect affects of poaching. Number of animals lost to natural causes (maximum 3) was minimal. The high breeding rate and low natural mortality rates of calves and adults indicate that habitat quality in Bardia is quite adequate. If poaching is brought under control, the population is expected to increase at maximal rate in the coming years. However, an increase in the rhinoceros population in the Karnali floodplain of Bardia is likely to escalate the conflicts with local people, as animals have already caused substantial damage to agriculture outside the park.

PROBLEM

The greater one-horned rhinoceros (*Rhinoceros unicornis*, henceforth termed rhinoceros) is listed as one of the world's most endangered species of megaherbivores. It once inhabited most of the Indus, Bramhaputra and Gangetic floodplains and nearby foothills of south Asia. Due to illegal hunting and habitat clearance, rhinoceros are now restricted to small isolated populations in protected areas on the Indian sub- continent, mainly in Nepal and India. At present only two populations contain more han 300 individuals, Royal Chitwan National Park in Nepal, and Kaziranga National Park in India.

In Nepal, Chitwan valley harboured about 1000 rhinoceros until 1950. Indiscriminate poaching and destruction of prime habitats between the mid-1950s and 1960s drastically reduced this population to about 100 animals. However, with the creation of a national park in 1973 and adequate protection the population at Chitwan has now revived to about 400 individuals.

To establish new viable breeding populations and to protect this species from natural calamities and disease several rhinoceros have been translocated from Chitwan to Dudhwa National Park in India and to Royal Bardia National Park in Nepal.

This thesis examines food ecology, habitat preferences, ranging behavior and demography of the population of rhinoceros in Bardia 4 to 6 years after translocation. These ecological attributes of the founder population are compared with those of the donor population based on similar data collected in Chitwan.

METHODOLOGY

Assessment of the Microhistological Analysis of Fecal Samples for Determining Diet

The study was carried out in the south-western corner of Royal Bardia National Park and the north-eastern section of Royal Chitwan National Park in lowland Nepal.Two sets of fresh dung samples (N = 10 from known animals and N = 20 from unknown animals) were collected in Chitwan over a 3 day period during the monsoon of 1993. The 20 samples from unknown animals were pooled into subsets of 5, 10, 15 and 20 to examine intraspecific variation. Five microscopic slides were prepared from each of the ten known samples and from each of the pooled samples from unknown animals. Various parts of > 100 plant species were used to prepare reference slides. Identification of each plant species in the fecal sample was based on epidermal characteristics. The line intercept method was employed to estimate the proportion of different plant species.

Comparing Habitat and Diet of the Donor and Translocated Populations.

Quadrat sampling (N = 280 in Bardia and N = 191 in Chitwan) along transect lines was employed to describe floristic composition and availability of food plants in both areas. The minimum number of quadrats needed to describe floristic composition of each habitat type was determined by constructing species area curves. In each 10 x 10 m quadrat, the percent cover of each plant species assumed to be available for rhinoceros (< 3m height) was estimated and later used to calculate prominence values. Diversity and similarity of plant species in the two areas were then compared.

Microhistological analyses of fecal samples were used to determine seasonal food habits of both populations. In Bardia, fresh fecal samples (N = 354) were collected between January 1990 and June 1991. Individual samples in each month were dried, ground and pooled. Food habit data from Chitwan (N = 480), collected during 1985-1986 were used to compare with the data for the Bardia animals.

Ranging and Habitat use of the Translocated Bardia Population

Ranging behavior and habitat preference by the translocated Bardia population were examined by recording the movement patterns of 10 animals captured and radio-marked beween 1990 and 1993. All animals were immobilised. A total of 1641 locations were obtained over a 3-year period. Spacing behavior of the Bardia animals was compared with that of the donor population (Chitwan) based on tracking data (N = 652) obtained in Chitwan during 1985-1987from five radio-marked animals.

Performance of Translocated Bardia Population

Data on initial dispersal of the translocated animals in Bardia were obtained mainly by park staff who tracked rhinos on foot until this study was initiated in 1990. Data on demography were collected from 10 radio-instrumented animals intensively monitored during the 3-year (March 1990 - March 1993) field study, supplemented by data collected by park staff before the study was initiated.

FINDINGS

Microhistological Analysis

Microhistological analysis was found to be a reliable method for estimating the composition of the diet. However, sample size (slide transects and number of animals) was found to be critical for estimating the range of plant species and their volumetric contribution in the diet.

Habitats and Food

In general, species richness was higher in Chitwan than in Bardia (283 and 179 species respectively). Among all habitat types, tall grassland in Chitwan was the most diverse (131 species), whereas this habitat type was least diverse in Bardia, consisting of only 79 species. Mild grazing and availability of adequate substrate moisture were explained as the two major factors contributing to such a high diversity in this habitat in Chitwan. Availability of food plants varied between the two areas. Among the staple food plants, *Saccharum spontaneum* (grass) and *Mallotus phillippinesis*, *Caamus tenuis* and *Dalbergia sissoo* (browse) were more abundant in Bardia, whereas Saccharum bengalensis and Narenga *prophorycoma* (grass) and *Trewia nudiflora* and *Litsea monopetala* (browse) were more abundant in Chitwan. Two important browse species, *Murraya paniculata* and *Coffea bengalensis*, were not recorded in the study area in Bardia.

The annual diet of rhinoceros was dominated by grass species (> 60%) in both study areas, but the proportion of plant groups varied markedly with the seasons. The highest proportion of grass species was recorded during the monsoon (92%) in Bardia and during the hot season in Chitwan (86%), and the lowest during the winter season in both areas (42-57%). Browse constituted the highest proportion during the winter and hot seasons in Bardia and during the winter and monsoon in Chitwan.The higher proportion of grasses during the hot season in Chitwan was explained by the availability of high quality *Saccharum spontaneum* which keeps sprouting immediately after grazing, cutting or burning, due to high substrate moisture. In Bardia, low substrate moisture retards grass species from sprouting until the first rains in latter part of the hot season. As a result, animals here exploited more of browse species during the dry seasons than they did in Chitwan. The higher proportion of browse species in Chitwan during the monsoon was due to better access to preferred *Trewia nudiflora* fruits. Although rhinoceros fed selectively on some species in each season, animals in both areas exploited food plants in proportion to their availability, thus confirming that this rhinoceros is a generalist feeder.

Ranging Behavior and Habitat Preference

Five years after translocation, the annual home ranges for males and females in Bardia were estimated at 41.8(4.4 km2 and 25.1 (9.3 km2, respectively, whereas in Chitwan they were only 3.3 km2 for one male and 2.9(0.9 km2 for females. In Bardia, the larger annual home range of males was due to seasonal ranges being spaced further apart than those of females and more extensive movements presumably in search for mates. Within social groups, there were no differences in seasonal range sizes in different seasons, except females with small calves (< 1 year old) had smaller home ranges than other social groups during the hot and monsoon seasons.

In Bardia, habitat preferences varied with the seasons, with riverine forest generally being preferred during the two dry seasons, khair-sissoo forest during winter and tall grassland during the monsoon. During the dry seasons, good quality grass is less available in the tall grassland habitat in Bardia than in Chitwan. As a result, animals switched to browse species basically confined to khair-sissoo and riverine forests.These habitat types are fragmented into smaller patches throughout the north-south elongated floodplain, resulting in increased movement during the dry seasons. Besides, longer distance to agriculture during winter also increased animals' range size in Bardia. During the monsoon, animals were mainly confined to the tall grassland habitat, like in Chitwan. However, due to smaller relative size and a more fragmented distribution of this habitat type in Bardia, seasonal range size was larger than in Chitwan. In contrat to Bardia, the Chitwan habitats consisted of alarge block of riverine forest surrounded by a continuous large tract of tall grassland which is productive throughout the year due to adequate soil moisture.

Annual and seasonal home ranges were all more than 8 times as large in Bardia. At the same time, animal density was more than 25 times larger in Chitwan. However, the difference in ranging behaviour was most likely due to the different spatial distribution of preferred habitats. In Bardia, seaonally preferred habitats were fragmented into small patches and cultivated fields were located further away from the natural core areas than in Chitwan.

Performance of the Translocated Bardia Population

Following extensive and erratic dispersal after being released, five years later the Bardia population had settled in a large home range of ca 28 km2 after the release in 1986 nearly all breeding age females had calved by 1994. Two females were pregnant before translocation and calved within expected time intervals in the new environment. Four females calved twice with a mean calving interval of 4.3 years, similar to the calving interval reported among the donor population in Chitwan. One or two breeding age founder females did not conceive during the 8- year period, probably due to their very scattered distribution combined with a highly skewed breeding sex ratio of 1 male to 8 females.

Considering the good breeding performance and high natural survival rate of calves and adult animals, the habitat in Bardia appears to be of adequate quality to sustain a small viable population of rhinoceros. Recent habitat and food studies also support this. However, problems of conflict with local people have already emerged as animals frequently move outside the park boundary and raid agricultural crops. With protection from poaching, the population is expected to increase at maximal rate which will escalate the problem of human conflicts in the future.

FACTORS INFLUENCING PARTICIPATION OF MEMBERS OF FOREST USER GROUPS IN COMMUNITY FORESTRY IN THE HILLS OF NEPAL

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ABSTRACT

This study examined the extent of participation of members of forest user groups (FUGs) in community forestry programme, namely decision making, implementation and benefit sharing. The study, which was conducted in the hills of Nepal, also examined the factors associated with participation.

Adopting the survey research method, a pre-tested interview schedule was administered to a randomly selected of 200 respondents from 10 selected FUGs. Office records, informal interviews, direct observation and small group discussions were the other sources of information.

The forest users who formed a heterogenous group in terms of the socio-demographic attributes, perceived the current community forestry programme as being a better approach to forest management because of its more people-centered nature. The shifting of forest management authority from the government to the FUGs was the most appreciated aspect of the current community forestry programme. Hand-over of forests was also strongly felt by the local residents as the need for managing forests.

By and large, the level of participation was medium and/or low. High level of participation prevailed only among a small proportion of forest users.

The more active participants included those forest users who had pluralistic organizational membership, those who belonged to smaller FUGs, who percieved adequate government support, who had better linkage with their peers as well as executive members of forest user committee (FUC) and government forestry personnel, who were better informed of programme activities, and those who derived satisfaction from the community forestry programme. The study indicated that those who perceived greater administrative decentralization and empowerment of individual participants as important aspects and those who had favorable attitude towards government intervention also tended to demonstrate a higher degree of participation. Various suggestions were made based on the above findings of the study.

PROBLEM

People's participation is the basic strategy of the community forestry programme. It aims at involving people in planning, implementing and decision-making aspects of forest management, development, production and protection. Various reviews have shown however, that despite continuous and conscious efforts towards promoting the level of participation, active participation of the real forest users in the programmes has been quite low. But none of these have pointed out to any specific reason for the emergence of such disappoiting situation, nor any proof has forwarded in an empirical manner. The extent of people's participation in benefit

sharing and evaluation of the programme have not been pointed out either.

OBJECTIVES

It is reasonable to expect that there exist certain factors that affect people's participation. Therefore, one of the major concerns of this study is to look, at the empirical level, whether participation can be enhanced by identifying the factors related to it. Given the reality that people's participation is a must for the successful implementation of the community forestry programme, this study attempted to address the following questions:

1) Is it the heterogeneity among local participants in terms of socio-demographic composition that often lead to variation in levels of participation?

2) Is the existing institutional arrangement conducive to the forest users and the Forest User Groups for participation?

METHODOLOGY

The study was conducted in three selected village development committees (VDCs) of Dhading District. A multi-stage sampling technique was adopted for selecting the subjects. From these VDCs, 10 FUGs were puposively selected. A total of 200 respondents were proportionately selected through a simple random sampling method from an accessible population of 570 household members from the 10 FUGs. The household members so selected served as the unit of enquiry and analysis for the study.

A multi-method approach of data collection was utilized in order to accomplish the research objectives. However, the study method constituted the main tool of information gathering. Other methods employed for gathering additional data were personal observations, informal interviews and group discussion. Data were also sought from secondary sources.

Both descriptive and inferential statistics were used to describe the data and draw meaningful conclusions. Cross-tabulations were carried out to set up frequency distribution of one attribute against another. The dependent variable for this study was participation. There were three aspects of participation examined, namely decision-making, implementation and benefit sharing. Five clusters of variables, namely socio-demographic, institutional, stuctural, linkage and situational were the independent variables.

FINDINGS

1) Forest Users and Forest Management

Forest users formed a heterogeneous group in terms of their socio-economic and demographic characteristics. This social group was heavily dependent on tree products to meet their basic fuel and fodder needs. The major sources of these products were the national forests and community forests. In general, the local inhabitants perceived the current communiy forestry development program (CFDP) as an appropriate approach for the management of forests with involvement of the local community. Satisfaction expressed by a majority of the FUGs members, provision for shifting of management authority over the forests from the government to the FUG, rather than

to any other units within the government administration, and improved situation of forests were some of the significant aspects indicating the present CFDP as a right approach. On the other hand, the feeling among the forest users for the necessity of handing over of forests to the user groups was very strong, as a number of FUGs have not had the forests handed over to them. The low level of participation among some FUG members could be attributed partly to this fact.

2) Organizational /Structural Elements of FUG

General assembly' was the kind of decision-making pattern that was perceived as being the most influential as well as preferred by most of the FUG members. Almost all the FUG members indicated the need for their FUGs to be in more formal mode rather than being in informal or less formal one. They also meant that the more formal their FUGs, the more accountable the group members held for their responsibilities.

3) Communication and Extension in CFDP

A majority of the forest users had frequent interactions among themselves and with the office bearers of the FUG. But their interaction with the government forestry personnel was not as frequent. Most forest users preferred the `radio programme' as a medium of communication to the `printed material'. Similarly, `rangers and assistant rangers' were preferred to `forest guards' as the source of information. Most forest users had not undergone any training in forest management and related aspects. A strong feeling indicating a need for such training among forest users was very explicit.

4) Situational Aspects of Participation

The physical conditions in the study area did not seem to be favourable to all of the FUG members for them to participate in forest management activities. Although the majority of the local people appeared to be satisfied with the current community forestry programme, there were still a good number of them who were not able to derive satisfaction from their participation. Dissatisfaction on the part of the participants could be one of the reasons for low level of participation.

5) Extent of Particiapation and Associated Factors

By and large the level of participation, measured along five clusters of factors, was medium and/or low. High level of participaton was found only among a small proportion of forest users. The more active participants were among those forest users who had pluralistic organizational membership, who belonged to smaller FUGs, who perceived adequate government support, who had better linkage with their peers as well as executive members of forest user comittee and government forestry pesonnel, who were better informed of programme activities, and also those who derived satisfaction from the community forestry programme. Those who perceived greater administrative decentralization and empowerment of individual participants as important aspects and those who had favourable attitude towards government intervention also tended to demonstrate a higher level of participation.

RECOMMENDATIONS

1. A monitoring system should be established within the FUG for periodical appraisal of participation performance of its members. The implementing agency's role in establishing such a monitoring system could be of pivotal importance.

2. Much closer attention should be paid towards gender-sensitive planning and its materialization for the integration of women in community forestry.

3. Efforts on the part of the DFO in making the field staff readily available to assist FUGs in developing an operational plan and handing over of the forests to them would enhance the extent of participation. However, achieving self-reliance should be a continuous effort by the FUG for its long term sustainability and to reduce dependence on external assistance.

4. Encouraging local people to develop private forestry may be a desirable step to reduce the pressure on national and community forests.

5. The appropriateness of structural elements should be taken into consideration in forming any FUG for it to be more productive as different structural elements of an organization are effective under different situations.

6. In view of the training as a tool for creating awareness, improving skills and bring about desirable changes in attitudes, the training component should be integrated as a part and parcel of CFDP, rather than just as an occasional programme.

7. It is necessary to create conditions for socio-economic empowerment of those who are at the bottom of the social structure by providing opportunities and enabling them to participate.

8. The distribution of benefits of CFD should be on equitable basis, aggreeable to most FUG members.

9. In view of the low or medium level of participation among forest users as found out by this study, a coerced as well as intensive type of participation study, but a voluntary and organized, could be adopted as a mechanism to involve forest users.

FURTHER RESEARCH

For generating a wider information base for the use of planners, policy makers and programme implementers, further participatory research on a national representative scale would be needed. Therefore, a study covering more FUGs in other parts of the country using similar variables would be helpful to further validate the present findings.

Information pertaining to institutional factors generated in this study are from the perspective of local communities. It would also be of interest to generate such information base from the perspective of the personnel working for the implementing agency. This would help substantiate the findings that have greater relevance to planners and policy makers.

Additional research using more variables within the present study setting is also needed in the light of the fact that the variables included in the present study could not explain more than 68 percent variance in the dependent variable (participation). More studies undertaken in this direction would help identify other contributing factors.

This study has used interview schedule as the main tool for gathering the data, which were of more quantitative nature. Integrating qualitative data more intesively in order to fortify accurate interpretation of variables should be attempted in future research undertakings.

Community forestry as one of the forest development approaches will lead to considerable success, if it acknowledges the creative intiatives of the people as an important source of development. This necessitates the orientation of community forestry more towards development of forest resources through sustainable human development, rather than merely production for economic gains.

FARMER AND TREE LINKAGES IN THE TERAI OF NEPAL

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ABSTRACT

An attempt is made to develop information that will be useful to policy makers in their on-going efforts to improve the contributions of trees to farmer welfare in the Terai and, more broadly, to the welfare of Nepal. Both primary and secondary data were used in the study. Primary data were collected from 228 households selected randomly and were used to analyse the relationship between the number of trees raised on the households' farms and the resources (inputs) these households own. Secondary data were used to analyse the linkage at the regional and district level.

Policy instruments such as a hierarchy of permits to harvest trees, process tree products and trade wood products have unnecessarily created a barrier in the wider adoption of trees on farms. The demand and supply analysis of sissoo timber in Nepal and India shows that there is a substantial demand for timber in Nepal and India, and that Terai farmers can efficiently produce timber on their farms.

Regional analysis of tree planting on farms in the Terai indicates that as the population increases, farmers tend to plant more trees on their farms. A regression model shows that the number of trees on farms of these households is significantly associated with the area of irrigated land and the number of cattle and buffaloes owned by these households. Various recommendations were made based on these findings.

PROBLEM

Interpretation of recent aerial photographs and satellite images of the national forests of the Terai indicates that there is a continuing trend of deforestation in the Terai region. Presently, it is estimated that the rate of deforestation in the Terai is about 1.3% per year.The latest agriculture sample survey of Nepal indicates that there is a increased interest in planting trees on farms of the Terai. This information may provide some solace to those worried about the increased rate of deforestation in the developing countries. However, there exists a substantial knowledge gap regarding the factors and process of deforestation afforestation in developing countries in general, and in Nepal in particular.

A decision to plant trees can be considered as one of the choices available to farmers. One need to know contextual variables and motivational factors in order to understand the adoption of trees on the farms. Some of the questions are: What are these contextual variables that affect the adoption of trees on farms? What are the roles of land, labour and capital in the increased cultivation of trees on farms of the Terai? What types of policies and policy instruments can be crafted and implemented that might sustain the benefits from tree growing and management on farms of the Terai?Thus there is little knowledge about why and where farmers plant trees, and what socio-economic and policy variables link farmers to the trees

grown on their private land. Similarly, how the proximity of natural forests and nurseries affects private tree planting in the rural areas of Terai is also not known. Sustainability of forestry programmes and project benefits is a major policy issue in the development of Nepal, but it has not been adequately addressed in any of the forestry projects of the Terai.

OBJECTIVES

The objectives of the study were: -

1. to increase understanding of the contextual environment within which farmers decide to plant and grow trees on their farms in the Terai;

2. to increase understanding of the processes and factors that directly influence farmers' decisions to plant trees on their farms; and

3. to assess the implications in terms of potential policy interventions that could help to improve and expand the benefits from farm forestry in the Terai.

METHODOLOGY

The contextual variables such as agro-ecology, policy, market and socio-culture were analysed and described mostly in qualitative and descriptive terms since there is a lack of empirical data on these variables. However, quantitative data were also analyse these four components where-
ever such data are available.

The household tree production decision component was analysed using a multiple linear regression model. Secondary data were used to analyse the linkages at the regional and district level. Primary data were collected from 228 households selected randomly and were used to analyse the relationship between the number of trees raised on farm by these households and the resources (inputs) these households own.

The trees planted on farms of the Terai were the focus of attention in this study, although there seems to be an inverse relationship between the area of national forests and the number of trees grown on farms. Dhanusha, one of the twenty Terai districts was selected for in-depth study in order to understand the factors that are associated with the number of trees grown by the farmers of the Terai.

FINDINGS

The subtropical climate, fertile land and small-scale diversified farming are the important elements of the agro-ecology of the Terai. Other components of the contextual environment that affect tree planting on farms are the policy, market and socio-culture of the area. Policy instruments, such as hierarchy of permits to harvest trees, process tree products and trade wood products have unnecessarily created barriers so the wider adoption of trees on farms. However, the land tenancy regulation has provided a strong incentive for large land owners and landlords to plant sissoo trees on their farms. The demand and supply analysis of sissoo timber shows that there is a substantial demand for timber in Nepal and India and that the

Terai farmers can efficiently produce timber on their farms. This analysis also shows that Nepalese farmers have a comparative advantage over Indian farmers in producing timber in the Terai.

Farmers of the Terai of Nepal are planting and protecting trees on their farms. Regional analysis of tree planting on farms of the Terai indicates that as the national forests are depleted and the population increases, farmers tend to plant more trees on their farms. The analysis shows that the number of trees on farms of these households is significantly corelated with the area of irrigated land, and the number of cattle and buffaloes owned by these households. These households are planting trees in different configurations and are managing them for multiple uses, but mainly as a cash crop.

RECOMMENDATIONS

Since conversion of forest land to farming seems to result in increased cultivation of trees on farms, and since it is difficult to enforce strict protection measures in the national forests, it might be possible to convert some of the national forests to agricultural land use. There would not be any significant adverse environmental impacts of this land use conversion because (a) the naional forests are being illegally converted to farm land anyway, and (b) providing private legal ownership would induce farmers to cultivate trees on such land.

The government should cancel the executive orders for the existing permit system and allow farmers to sell and trade their trees in the same way as other agricultural crops. As the supply of farmer-grown sissoo logs increases, Nepal should relax the current ban on exporting wood products to India.

Intercropping of trees with food crops does not seem to reduce on-farm employment, and also assists in creating off-farm employment opportunities by supplying more tree products to the market. Dual ownership (due to tenancy rules) of land seems to create a wedge between private and social benefits of tree planting. Therefore, the Government should remove the dual ownership and tenancy rights on a piece of land.

The Government of Nepal should consider the relationships between revenue collection from excise duty, employment generation from wood processing, and the inability to export sawn timber to India. One of the possible policy interventions is to reduce the tax rate so that sawn timber becomes competitive even in the Indian market. One of the possible options is to remove sales tax and charge VAT only. It is also easier to collect VAT at industrial locations.

The Government should stop distributing free seedlings to the farmers of the Terai. The operation of nurseries should be completely privatised. However, the government should provide better quality seeds to these nursery owners at a suitable price.

Provision of subsidised wood, even to construct houses, make agricultural implements or undertake development activity is questionable, and should be stopped.

Farmers should be involved in farm forestry research programmes since, (a) they have indigenous and practical knowledge of tree planting and farm management and (b) it is easier to extend the new knowledge to other farmers and researchers.

A few agro-forestry studies that have been completed in theTerai are related to the production of agricultural and forestry crops on state-owned land. What is happening in the farmers' field

is not known. Research on this area is urgently needed in Nepal.

Applied research into better ways of lopping and thinning is urgently needed, as the farmers of the Terai, wood, consumers, forest-based industries and the Government could greatly benefit from such work.

Research into the benefits of tree planting and management at household level is needed.Similarly, research on the types of perceived security which trees on farms provide to different categories of households is also necessary to understand the reasons of tree planting on farms of the Terai..

Socio-economic research on the wider implications of household tree planting on farms, is needed as a basis for formulating and implementing better policies in the future. More research on the existence and creation of employment opportunities arising from the planting, management, and processing of trees on farms is also needed.

Also there needs to be better rapport between foresters and farmers in order to sustain and increse the benefits of trees grown on farms in the Terai.

It is essential, that local volume tables of the most important tree species should be published in the local languages so that the farmers of the Terai know the volume of saw-logs and fuelwood that can be obtained from the trees. Similarly, local market prices of saw-logs and fuelwood should be made available to the farmers so that they know the value of their trees.

IMPROVED FODDER TREE MANAGEMENT IN THE AGROFORESTRY SYSTEMS OF CENTRAL AND WESTERN NEPAL

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ABSTRACT

Ten, 3-year-old, fodder tree species were evaluated at four on-station and three on-farm sites in Nepal. *Ficus semicordata* (Buchattam. ex Sm.) growth was found to be significantly higher ($p = .01$) than the rest in diameter and dry foliage weight values. Species were significantly ($p = .01$) different in height, diameter, and foliage and wood growth. Sites were significantly ($p = .01$) different in total height growth only. On-farm species evaluation indicated that *Artocarpus lakoocha* and *F. semicordata* had significantly higher growth.

Allometric regression equitions wee developed to predic foliage, total wood and total biomass yield of *F.semicordata*, and *Bauhenia variegata.* Individual - tree models were developed from the data collected from experimental plots and farmers' fields. Logarithmic transformations gave better fitted models. For *B. variegata*, diameter at 50 cm, and for *F. semicordata*, crown diameter and height, gave the best fitted equations. Regression equations for three sites did not differ significantly ($p=0.05$) in their slopes and intercepts. Therefore, data were pooled and a common model was estimated for each species. In on-farm regression models, height and crown diameter were the best predictors for *F. semicordata* and dbh gave the best fit for *Bauhenia variegata.* The models for the two species were used to construct regional fodder and fuelwood biomass tables.

An improved crop-livestock-fodder agroforestry system was designed for a village in Nepal, based on the research and survey data. Linear programming was used to demonstrate the use of a tool to optimise land allocation, maximising net returns while satisfying the supply of minimum needs of food, fodder, and fuelwood. The optimal solution indicated that, by improving the returns to labour and by applying more compost, the village should be able to increase the annual net farm returns from the current NRs. 2.94 million to an estimated Nrs. 3.85 million. The food, fodder and fuelwood production levels were shown to increase by 17%, 130%, and 537% respectively. The labour and compost requirements were up by 138% and 59% respectively, over the five year period. The soil loss through run-off was estimated to decrease by about 15% over the same period.

PROBLEMS

Several studies have indicated that the exploitation of forest resources in Nepal is not intentional and reckless but stems from understandable human needs and anxieties. Forests and other vegetation supply some of the basic needs of rural life. These include tree foliage, grasses, and herbs as animal forage; fuelwood for cooking; fruits, nuts, honey and tubers for food; timber for building shelter; forest litter as compost; shrubs and vines as fencing materials; bamboo for cottage industries; thatch grasses for roofing materials; and herbs for medicine. Recent government policies are based on the premise that increasing demands for fuelwood and fodder can only be met through intensive plantations of multipurpose trees on private land.

Currently only about 64% of the total feed requirements of the livestock are met in the Hills. A deficit of 20 to 30% is estimated in fodder supply at the national level. One of the major reasons for the shortage is the continuing shrinkage in grazing and forestland.

While fodder consumption alone does not directly reduce the forest area it is the main cause of forest degradation which leads to increased erosion as a result of depleted ground cover and soil compaction. One way of reducing environmental damage by animals is through stall feeding or confining the animals to corrals. Combined with this approach, if productivity of the fodder trees could be increased and the associated tree fodder production could be better managed, the current deficit could be reduced substantially.

Specifically, there is a need to assess the fodder potential of most commonly grown fodder tree species (FTS), develop biomass yield tables and growth functions, establish improved harvesting schedules and make this information available to planners and extension personnel as quickly as possible. This points to the need to carry out species evaluation trials, accurately estimating their growth and yield and developing local and regional FTS biomass tables. Utilisation of such information in designing and implementing more productive agroforestry systems, especially in the Middle Hills, the Terai and the Inner Terai regions, is another challenge. This research project focuses on these topics.

OBJECTIVES

The three major objectives of the research project are described as follows:

1. to evaluate the silvicultural characteristics of commonly grown native and exotic FTS over a wide geographical area;

2. to develop fodder and wood biomass tables for two top performing species in order to generate quantitative information about their growth potential ; and

3. to study the impact of intensively cultivating the "best" performing species in the traditional agroforestry systems in the Middle Hills.

METHODOLOGY

The focus of the study was limited to the western Middle Hills and the central Terai. Based on a reconnaissance survey of the area, 16 species were selected for inclusion in the trials. Out of
this species pool, each site was allotted between eight to ten species depending upon each species' ecological requirements. At least seven species were included at all four sites.

Trial design was based on the treatments selected and land availability at each of the four sites. Trial lay-out was arranged in a completely randomised block design (CRBD) involving 1200 trees per plot. On-farm research trials were also designed to complement the data expected from the research stations. Lopping intensity trials were carried out on these on-farm trees and the information derived was used as input to construct growth and yield models for commonly grown FTS by the farmers of the area.

Farmers in the study areas were intensively surveyed to find out the nature of their fodder cultivation methods, preferred species, and common problems related to FTS management. Attempts were made to find out the type of lopping regimes the villagers desired the research trials to test. Information was also collected on the topics related to the agroforestry systems prevailing in the area, particularly those related to crop and food grain production.

FINDINGS

Out of the ten species tested at four sites located in three ecological zones, three FTS - *Ficus semicordata*, *Leucaena leucocephala*, and *Bauhenia variegata* - have consistently shown better performance in all aspects of growth and yield. A few species, including *Ficus hispida* and *Ficus lacor*, that did show good height and diameter growth at Pokhara could not be compared with other FTS due to their very early stage of growth, as well as being grown only at the Pokhara site. Nevertheless, the results indicated that the common practice of growing a large number of FTS as opposed to a few high yielding FTS may not be an ideal decision from the fodder production point of view. It is argued that farmers plant many species to stagger the fodder yield throughout the 4-month-long dry season. However, the study found that farmers' decisions were made more on the basis of what was growing on the farm before they started farming and which species were most easy to propagate than on long-term planning for a regular fodder supply scheme. In other words, in the study areas, the farmers either retained the naturally regenerated FTS or grew only those which were easily propagated. At most of the sites the farmers reported that they did not plant the FTS growing on their farms. They were all naturally regenerated and protected and managed by the farmers to use as FTS.

RECOMMENDATION

Biomass modelling has been shown to be a promising new area in fodder tree research. The study has developed separate allometric equations for foliage, total wood and total biomass for *Ficus semicordata*, and *Bauhenia variegata*. These equations have been used to prepare fodder and wood biomass tables. These tables were validated separately for each of the four sites and therefore, are recommended for regional use. These tables should be particularly useful to the extension and development agencies, and so farmers for quick estimates of the fodder yield. Site validation is strongly recommended, although these tables have been found to predict biomass within a reasonable limit.

Improving the management of FTS in Nepal will require a sustained research effort to generate information on the growth potentials and climatic suitability of over 100 species of shrubs and trees known to be grown in Nepal. In this study only species that were readily available and commonly known to the farmers were tested. Some of the common hill species such as *Ficus lacor*, *Bridelia retusa*, and *Garuga pinnata* could not be tested in the Terai and Inner Terai plots due to the lack of adequate seedlings. However, their performance at one site did indicate their potential for further investigation. Nevertheless, this study has, for the first time in Nepal, tested a large number of species in a multi-location trial. Preparation of fodder and woody biomass models for these species had not previously been attempted on large scale. The next objective should be to prepare comprehensive biomass tables applicable to the whole region. The presentation of fodder and fuelwood yield tables encompassing a large height and diameter range is expected to be a useful resource in the fodder-tree database. The demonstration of agroforestry design and analysis provides the ways the

research information can be used to improve the management of these valuable trees in improving the supply of fodder and fuelwood. The sequential combinations of species selection, biomass modelling, and agroforestry design demonstrate an appropriate approach to improving the agroforestry management in the central and western regions of Nepal. Finally, the report opens a whole new area of research and study opportunity in the areas of FTS in particular and agroforestry systems of Nepal in general.

ECOLOGY OF THE HIMALAYAN MUSK DEER IN SAGARMATHA NATIONAL PARK, NEPAL

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ABSTRACT

The ecology of Himalayan musk deer was studied in Sagarmatha (Mt. Everest) National Park, Nepal, from 1986 to 1989. These animals, among the most primitive and endangered, deer-like ruminants, do not bear antlers; but males have well developed, sabre-like canine teeth. They live at altitudes between 3000 and 4200 m in Sagarmatha National Park.

A modified drive net technique was developed to capture Himalayan musk deer. A total of 16 individuals were captured. A combination of 1.5 mg/kg of 2% xylazine and 4.5 mg/kg of 10% ketamine hydrochloride was injected intramuscularly, to immobilise each animal for approximately 30 minutes. All captured animals, and also the musk extracted from males were measured.

Adult females were significantly longer (97.4 vs 92.7 cm; $p < 0.05$) and heavier than adult males (10.7 vs 10.2 kg; $p < 0.05$). Musk deer are well adapted to snow because of their low weight on track ratio (83.6 g/cm2). Musk deer were observed climbing trees to feed on lichen during winter and to avoid predators.

The animals in Sagarmatha National Park were found to be very selective feeders, utilising mostly easily digestible tree and shrub foliage and inflorescences, and forbs and fronds during summer. Two species of lichens (Usnea spp.) were very important in winter diets, although deer also consumed dry foliage and forbs. Crude protein in the forages consumed ranged from 13 to 25% during summer and from 3 to 5% during winter. Although lichens contained low crude protein (5.8%), frequency of lichen feeding was very high in winter. Of total foraging time during winter, 52% was spent foraging on lichen compared to 16% during summer. Forages selected by musk deer year round were high in cell solubles, ranging, from 37% in winter dry foliages to 68% in summer flowers.

The musk deer were non-migratory. Average home ranges for males and females were 14 and 13 ha, respectively. Males were highly territorial with no home range overlap, but extensive home range overlap occurred among females.

Seven different habitat types were identified within the musk deer range. The habitats most frequented by were the 'birch and rhododendron forest' and 'dwarf rhododendron shrubs', where arboreal lichens were available during winter. Habitat preservation and esablishment of semi-captive populations of Himalayan musk deer are recommended.

PROBLEM

The Himalayan musk deer (Moschus chrysogaster leucogaster, Hodgson 1839), one of the most primitive and least studied of the deer-like animals, is listed as vulnerable by the International Union for Conservation of Nature and Natural Resources (IUCN), and as

endangered by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), His Majesty's Government of Nepal and the United States Department of Interior. It is a small forest-dwelling species that weighs about 10 kg, is approximately 100 cm long and 60 cm tall. In Nepal, Himalayan musk deer inhabit mainly birch (Betula utilis) and rhododendron (Rhododendron spp.) forests on moderate to steep slopes at elevations of 2500 m to 4500 m.

METHODOLOGY

A modified drive net capture technique was developed to capture Himalayan musk deer. Locally woven nets made from coconut fiber and cotton fiber ropes were used. Each net was 6 m long, 1.8 to 2 m high (when fully stretched) and had a 10 cm^2 mesh. Usually two to four nets are used, depending on terrain, for 20 of 25 successful captures. Here a total of 16 individuals were captured using 3 nets.

A combination of 2% xylazine (trade name - ROMPUN) and 10% ketamine hydrochloride (trade name - VETALAR), was administered intramuscularly to immobilise the captured animals. This dasage was estimated from data for smaller ungulates immobilised in the Kathmandu Zoo. The purposes for immobilisation were to measure physical characteristics of the animals and to fit them with a telemetry collar. So an induction time of 3-5 minutes and a recovery time 30-50 minutes were aimed at. All captured animals, and also the musk extracted from males, were measured.

FINDINGS

Himalayan musk deer in Sagarmatha National Park were very selective, feeding mostly on easily digestible foliage of shrubs and trees, flowers and inflorescences, and forbs and fronds during summer. Only one graminoid and one lichen species were observed being consumed during summer. In winter, deer consumed dry leaves of shrubs and trees, forbs, and one grass species. Two species of arboreal lichens (Usnea spp.) appeared to be very important in the diets of musk deer during winter when ground vegetation was covered with snow.

Crude protein in the forages consumed ranged from 13 to 25% during summer, and from 3 to 5% during winter. Although lichens contained low crude protein (5.8%), frequency of lichen feeding was very high in winter. Of total foraging time during winter, 52% was spent foraging on lichen compared to 16% during summer. Forages selected by musk deer year round were high in cell solubles ranging from 37% in winter dry foliages to 68% in summer flowers.

Himalayan musk deer are essentially solitary animals. Males are highly territorial, but females appear to be noticeably tolerant of other individuals. Average home range of males was larger than that of females. Seasonal migration among adult Himalayan musk deer was not observed. Birch and rhododendron forest, and dwarf rhododendron shrub were selected over other habitat types at all times of the year, wherever available.

RECOMMENDATIONS

Further investigations on the diet of the Himalayan musk deer in different seasons is needed.

Slow growing sub-alpine vegetation on the northern slopes which harbor the epidendric lichens, the most important food of the musk deer in winter, must be given a high priority for protection. If these food sources are lost, Himalayan musk deer will disappear from the area immediately.

An alternative source of energy, probably hydro-electricy should be developed to meet the demands for energy for local households and increasing mountain tourism and thus preserve the habitats of musk deer.

The knowledge gained from this study regarding the nutritional quality of the forages consumed by these deer, and Chinese experience in raising musk deer in captivity should be applied in establishing and managing semi-captive populations of the Himalayan musk deer.

SURVEY, IDENTIFICATION AND DISTRIBUTION OF LEGUMINOUS AND NON-LEGUMINOUS NITROGEN FIXING PLANTS VIS-A-VIS NODULATION BEHAVIOUR IN RELATION TO ALTITUDINAL VARIATIONS FROM TERAI TO TREE-LINE IN THE FORESTS OF EASTERN NEPAL

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ABSTRACT

Forest soil in the eastern part of Nepal has been distinctly low in available nitrogen and the productivity of forests has been actively under decline due to ruthless irregular tree cutting and erosion processes. Unfortunately, no effort has been made to regenerate the area with the introduction of suitable nitrogen fixing plants (NFPs) and there is no available information on the occurence of such plants in this region. Hence this study attempted to collect preliminary information on the distribution of leguminous and non-leguminous NFPs in this fragile area of Nepal, from the terai plain in the south to the upper limit of trees in the north, so that the distribution pattern of such species in the various agro-bio-climatic zones could be identified and utilized in various forestry and agro-forestry activities in the region.

The study was based on three types of survey: main transect, complementary transets and random survey. Sample plots were laid out at about 6 km horizontal distance in the terai up to the *churia* foothills and at 200 m altitudinal difference in the hills with 50 m side running north-south. Where a plot was within or near to a village a paricipatory survey was conducted along with the primary survey on that plot, to collect farmers' information on NFPs and their pattern of utilization in different physiographic regions.

The study showed that often soils are too low in available nitrogen and organic matter for optimal plant growth. Nitrogen fixed biologically is a cheaper and more viable way to upgrade soil fertility compared to industrial nitrogen, and since, legumes particularly can add substantial amounts of nitrogen to the soil and establish strong symbiotic associations, those could be vital in maintaining the nitrogen levels in the long term.

PROBLEM

The forests of Nepal are rapidly deteriorating in both quantity and quality. More than 300,000 hectares of forest have been over the last 15 years, and still the process of destruction is continuing due to heavy biotic pressure for fuel, fodder, timber etc. It is estimated that at present the rate of forest destruction is 1.3 % per annum. This persistent destruction has aggravated soil erosion and downstream sedimentation. It is estimated that annually 1.7 mm of fertile top soil vanishes from Nepal and every year about 240 million tons of soil moves through rivers from Nepal to the Bay of Bengal. Besides this, it has caused reduction of agricultural productivity at least by 20%. These facts and figures indicate an alarming situation and a need for urgent measures to combat the problem. On the basis of the topography and the extent of the area, with cost-effective and socio-economically viable methods, a possible viable alternative is to revegetate the watersheds or degraded forest areas with self-sustaining indigenous, multipurpose nitrogen-fixing herb, shrub, climber and tree

species to check soil erosion and frequent floods as well as to meet the immediate fuel, fodder and timber requirements of the local inhabitants.

Regular cutting of forests generally upsets the nutrient cycle, and especially the nitrogen balance, although the effects may not be noticed immediately because of the nitrogen reserve remaining in the soil. In the near future, problems may thus arise in attempts to establish new forests on these lands if they become deficient in nitrogen and other nutrients. During the the establishment of a forest, soil nitrogen moves from forest floor to tree. There is evidence, that the presence of NFTs in inter-cropping trial with non-nitrogen fixing trees may improve the biomass production.

The eastern part of Nepal is prone to floods and land slides causing a continuous erosion of precious top soil of fragile Himalayan ecosystem. This phenomenon has been always a serious threat to the government and the people of this region. Hence, the introduction of appropriate indigenous, domesticated and multipurpose nitrogen fixing species in this region, deserves special attention and suggests a viable alternative measure for establishment of the degraded sites and check persistent floods and soil erosion during rainy seasons.

Hitherto unfortunately, not much research on the behavior of such species or their use for afforestation purposes has been carried out in this country. Therefore an attempt has been made in the present study to survey and identify nitrogen fixing leguminous and non-leguminous herb, shrub, climber and tree species for their nodulation and nitrogen fixation behavior along with their distribution pattern from the Terai to timber-line so that such species can be utilized for the afforestation and stabilization of degraded watersheds as well as forest areas under various plantation programmes, depending upon the socio-economic needs of the local people.

METHODOLOGY

The study was mainly based on three types of surveys: main transect, complemen tary transects and random surevys. The main transect survey was conducted in the centrally located Koshi zone, from 72 to 4080 m altitude with 72 sample plots. Two complementary transect surveys were conducted, one to the east in Mechi zone from 650 to 4570 m with 66 sample plots and the other to the west in Sagarmatha zone from 140 to 3800 m with 47 sample plots. Outside these transects were 64 random sample plots. The transect sample plots, 50 □ 100 m, were spread at about 6 km horizontal intervals.

The transects ran from the Terai through the Churia hills, and the plots were at 200 m altitudinal difference in the hills. Field identification of the nitrogen fixing plants was chiefly based on the floral characteristics and presence of easily separable nodules from the roots.

The identified plants were uprooted, their morphological characters were recorded and herbarium specimens were prepared for valid identification. Samples of leaves, stems, roots nodules were also collected, weighed and kept for analysis, and some times seeds were also collected to raise seedlings for various studies, as discussed later. W-shaped soil samples from the root rhizosphere and from outside the root zone were taken at 10 cm depth.Each sample was mixed and packed separately for chemical analysis. The minimum horizontal distance for outside the rhizosphere soil was between 1 to 2 m in case of herb, shrub, and climber species. Nodulation behavior of each individual leguminous and non-leguminous

species was observed under field conditions. Roots of the nodulated plants were washed with water and nodules were separated, counted, weighed and kept for dry weight and chemical analysis.

Nurseries were set up at three different altitudinal locations to study the nodulation and nitrogen-fixation behavior of some of the species. Nitrogen-fixing activity of nodules, chemical estimations of organic carbon and nitrogen content and soil anlysis for in leaf, stem, root and nodule samples, and soil analysis for texture, pH, organic carbon, N, P and K were carried out at various laboratories. A participatory survey was also conducted along with the primary survey where a plot was situated within or near a village, to collect farmer's information on nitrogen fixing plants (NFPs) and their pattern of utilization in different physiographic regions. A total number of 686 farmers were interviwed.

FINDINGS

1. Geographical barriers, climatic and metereological conditions, physiological and biochemical reactions, rhizobial strains etc. influence the nodulation and nitrogen-fixation behaviour of individual species.

2. Nodulation without a nitrogen fixing host plant was observed in *Santalum album* for the first time in this region. No nodules were observed in Rosaceae during this survey.

3. Among the leguminous NFPs encountered in the surveys, the majority of them dominated in the subtropical region and actinorrhizal species in the temperate region and as alitude increased the NFPs species decreased gradually upto 2400 m, and sharply above this level.

4. Among leguminous species observed below 2400 m altitude, two herbs, *Cajanus platycarpus,* and *Trifolium alexandrium;* three shrubs, *Crotalaria capensis, Desmodium elegans,* and *D. multifolium;* two climbers, *Entada rheedei* var. *sinohimalensis,* and *Vigna mungo,* and a solitary tree species, *Albizia chinensis* were recorded. Other herb species recorded were: *Smithia ciliata* from 600 to 3000 m.; *Trifolium repens* from 1200 to above 3,000 m; and *Astragalus donianus, A. sikkimensis* and *Parochetus communis* from 1800 to above 3000 m.

   Among actinorrhizal shrub species, *Elaeagnus infundibularis* was recorded between 600 and 3000m and *Hippophae tibetana* from 2400 to above 3000m. Among tree species *Alnus nepalensis* was recorded from 600 to 3000m, *A. nitida* from 1200 to 1800m and *Myrica esculanta* from 1200 to 2400 m. The remaining species were recorded below 600m altitude. But no herbs and climbers were recorded in this group.

5. During the nodulation behavior study, the ratio between the active and dead nodules recorded was 11:1, 9:1, 8:1, and 4:1 in leguminous herbs, shrubs, climbers and trees respectively and 5:1 and 2:1 in non-leguminous tree and shrub species respectively. The study indicated that degeneration of nodules was less in herbaceous plants as compared to other plants.

6. In Caesalpinioideae, the maximum number of non-nodulating species was recorded in *Cassia* (9), followed by *Bauhinia* (5), *Caesalpinia* (4) and one each in *Acrocarpus,*

Delonix, Parkensonia, Saraca and Tamarindus .

7. Of the 12 species examined, *Crotolaria tetragona* recorded the shortest time for nodulation after germination (6 days) followed by *Crotolaria pallida* (7 days), *Leucaena leucocephala* (10 days) and *Albizia chinensis* (19 days). Such testing could provide a method for recording indigenous NFPs for rapidity of nodulaion in different agroclimatic zones.

8. In most species studied, a straight increasing trend in nodule number and biomass per plant was noticed up to 6th week. Maximum nodule number per plant was noticed in *Albizia chinensis*, *Flemingia macrophylla* and *Sesbania sesban* during summer and *Dalbergia sissoo, Indigofera atropurpurea* and *Leucaenia leucocephala* during the rainy season and in all the species minimum during winter.

9. In all leguminous NFPs, the maximum nitrogenase activity was recorded in trees and the minimum in herbs, whereas in non-leguminous NFPs, there was more in shrubs and less in trees. The variation may be due to soil heterogenity, photosynthetic rates and site variation.

10. The maximum N content was observed in nodules and the minimum in stems, whereas, maximum total nitrogen contents per plant was observed in leaf, followed by stem, root and minimum in nodules.

11. Soil N concentration was uaually higher in the rhizosphere than outside it for the NFPs. The highest soil pH (7.9) was observed for *Abrus precatorius* outside the rhizosphere and the lowest in *Desmodium podocarpum* and *Piptanthus nepalensis* in the rhizosphere. However soil organic carbon content was usually higher in the rhizosphere.

12. With large number of NFPs, phosphorus was significantly higher in soil outside the rhizosphere than inside it. P being a key factor for nitrogen fixation, it might be utilized in the rhizosphere than outside it. Correlation between the C:N ratios in leguminous and non-leguminous species was significant.

13. The information collected from farmers confirmed that NFPs are uniquely suited to agro-forestry systems in east Nepal, as they provide more than one product from a single tree. The pattern of utilization of such species varied from one region to other regions according to availability of other plants. Although the farmers have little knowledge of the utility of NFPs in fixing nitrogen. they are nevertheless interested in the products they obtain from them and place in their economy.

RECOMMENDATIONS

The information on nitrogen-fixing plants encountered and described from various altitudinal ranges in the eastern region of Nepal will be helpful in bridging the gaps in the knowledge of biological nitrogen fixation. The plants recorded to be nodulated should be beneficial in forestry extension activities and agroforestry programmes to rejuvenate degraded sites and improve soil fertility as well as in meeting basic needs of forest products to the people and should thus help fragile Himalayan ecosystems area to be conserved and preserved simultaneously.

THE ECOLOGY OF WARM-TEMPLERATE FORESTS IN HE CENTRAL HIMALAYAS ACCROSS HUMAN-INDUCED DISTURBANCE GRADIENT

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ABSTRACT

Interest in the effects of natural disturbances upon ecosystems is not new to ecologists. Previously, concerns related to human impacts upon natural forests were dominated by global deforestation, primarily occurring in the tropics as a result of commercial logging and conversion of forests to various types of agricultural uses. More recently, interest has begun to expand beyond concern over the rate of destruction of tropical forest toward a broader interest on the integrity and health of forest ecosystems in both developed and developing countries. Because of the impacts of increasing human populations on forests, management of degraded forests is becoming a matter of significant concern. There is a growing need for research targeting degraded forests under different ecological and socio-economic settings.

This dissertation deals with the major influences of biomass harvesting in the lower temperate mixed broad-leaved forests in Nepal's central middle hills. The focus of the study is on the structure, composition, and productivity potential (i.e. site quality) of differentially disturbed forests. The primary goals are to identify relationships between human-induced disturbance caused by biomass extraction for subsistence purposes and various ecological attributes measured in the forest communities and to use the observed relationships for testing selected hypotheses pertaining to the effects of disturbance upon ecosystems. An ultimate goal of the study is to aid forest management in the region by summarising and synthesising collected data into a form which has potential applicative value.

Because of a dearth of intensive ecological research projects in the Nepalese forests, quantitative information concerning the ecology of most forest types in Nepal is largely undocumented to date. This project aims to make an additional contribution by documenting the detailed ecology of an important forest type in the sub-Himalayan region namely the warm (lower) temperate mixed broad-leaved forests in the central middle hills.

Two relatively undisturbed forests (references) and three forests at different levels of disturbance (low, moderate, and high) were selected for study.Four research questions were addressed in the study:

(1) to what extent are the natural forests in Nepal's middle hills being disturbed by man?

(2) are there differences in such disturbances among forest stands?

(3) what ecological variables associated with such disturbances may have potential value in the development of a system to classify forests according to various categories of degradation?

(4) do the properties of (relatively) similar forest communities subjected to varying intensities of human disturbance support general theories and hypotheses regarding effects of disturbances upon ecosystems.

OBJECTIVES

This study aimed to provide reliable and valid quantitative information in the main on the "obvious" ecological attributes as distinguished above, but also on some of the more "subtle" influences, resulting from subsistence harvesting of forest biomass in the central Himalayan foothills.

Specific objectives of the study covered three major aspects. The first objective was to simply document the detailed ecological attributes of these forests, and establish a database against which other studies across space and time could be compared.

The second concerned the advancement of the general scientific understanding of relationships between various types of disturbances of ecological systems, and the integrity of such impacted ecosystems.

The third and final objective concerned the identification of key ecological variables which appear to be strongly associated with disturbance.

METHODOLOGY

Study area:

Five natural forests in the general area of the Kathmandu Valley were surveyed by sampling. The forests ranged from relatively undisturbed to severely disturbed, and represented well the range of forest conditions in the study area. The forests studied were, in reality, forest stands selected from the larger forest, and subsequently surveyed, mapped and sampled. These forest stands comprise significant portions of the locally named forests.

The fieldwork component of the study encompassed 12 months (September 1993 to August 1994). In order to minimise seasonal influence, all forests were surveyed during the pre-monsoon dry period. The main survey work was carried out between mid-January and the first week of May 1994. The remaining days till August 1994, were spent in preparing soil samples for analysis, air-drying and weighing leaf litter samples and identifying plants from samples which were removed from the survey plots.

Study design and field method:

The study design was an analytical sample survey, comparing forests at different intensities of human disturbance in order to: (1) discover where important differences exist among them, and (2) to form or verify hypotheses about the reasons for these differences.

FINDINGS

The hypothesis of no differences in disturbance intensities among the study forests was strongly rejected. A useful definition of subsistence disturbance of forest by humans and an index (the SAD-Index) to quantify such disturbance have been proposed. From a list of 18 different measures of disturbance, five specific measures were selected to develop the index,

these being (in descending order of importance): estimated proportion of cut basal area of overstorey trees, proportion of cut overstorey trees, proportion of cut tree samplings, proportion of lopped overstorey tress, and proportion of lopped tree samplings.

The discriminatory ability of the SAD-Index was found to be excellent for classifying forests into two disturbance groups, low (SAD-Index value <0.25) and high (SAD-Index value >0.25), with an overall classification accuracy of (92.35%). A relatively good classification accuracy (overall accuracy of 75.29%) was obtained for four disturbance classes (values inside parentheses show SAD-Index values associated with each disturbance class): relatively undisturbed (<0.25), lightly disturbed (0.25 to <0.5), moderately disturbed (0.5 to <0.75), and severely disturbed ((0.75). Relatively high classification accuracies ranging from 70.00-91.53% were observed for three of the four disturbance categories (severely disturbed, lightly disturbed and relatively undisturbed). However, a relatively low classification accuracy (33.33%) obtained for the fourth disturbance class, the moderately disturbed condition, suggested that it may be better to pool the forests to form three disturbance classes rather than four. The *Schima-Castanopsis* association was found to be dominant in all four forests. The relative importance of this association at all three major strata (overstorey, understorey and ground vegetation layer) within the forest indicates that these forests will continue to be dominated by this association.

The hypotheses of no difference among forests in stand density, architectural heterogeneity, and natural regeneration were all rejected. When woody plants were compared across the five forests, the largest differences were found among the oerstorey variables and the smallest differences were observed among the woody ground-vegetation variables. Not all of the woody plant variables appeared to track the disturbance gradient. Among the overstorey variables, tree basal area, canopy over, and aboveground biomass tracked the disturbance gradients and therefore appear to be the best candidates for inclusion in any index of forest degradation. In general, tree density was observed to be highest at the moderate disturbance level, intermediate at the low disturbance level and lowest in severely disturbed forests.

The following species of shrubs and woody vines were found to be the most promising species for use as indicators of disturbed forest conditions: *Osbeckia stellata, Phyllanthus parvifolius, Lantana camara, Inula cappa, Crotalaria cystoides, Hypericum uralum, Ardisia macrocrpa* and *Sarcococca coriacea*.Natural regeneration potential seemed to be very high in all of the forests.The relatively high sprouting ability of cut stumps in these forests could also be a significant means of naturally regenerating the forests and improving degraded forests. Therefore, regeneration does not appear to be a problem for management. Large budgets and forestry activities in Nepal currently being devoted to seedling nurseries appear to be unnecessary if the goal is to regenerate degraded forests with local species of trees.

The general characteristics of the forest floors, soils, and stand productivity differed among the study forests, and were found to be associated with large differences in disturbance. Of the 18 variables representing various ecological properties associated with forest site productivity, a monotonic relationship with disturbance intensity (SAD-Index) in the five study forests was observed for the following ecological attributes: relative herbaceous plant cover, Index tree height, mean height asymptote of all *Schima-Castanopsis* tree, and mean height asymptote of dominant and co-dominant *Schima-Castanopsis* trees.

Although all five study forests were similar types of forest located within a homogenous bioclimatic and physiographic zone of Nepal, considerable difference were observed among the forests in a variety of aspects of plant diversity. Both unimodal and monotonic

relationships between vascular plant diversity and disturbance intensity were observed, but the patterns were associated with different measures of diversity and different plant groupings. In general, species diversity of vascular plants appeared to be positively and monotonically associated with disturbance intensity.

RECOMMENDATIONS

SIt is recommended that the overall framework used in this study be adopted as a starting point for developing an assessment and monitoring programme to evaluate the productivity potential of natural forests in Nepal's central middle hills. The mean values obtained for the two reference forests are recommended for denoting relatively undisturbed, reference conditions of mature, *Schima- Castanopsis* dominated warm-temperate forests in the Central Himalayan foothills. Variable subset 1 is recommended for use if approximate assessments of forest site productivity will suffice. Variable subset 2 is recommended for use if a higher degree of classification accuracy is desired.

FUTURE RESEARCH

There are two areas where the findings of this study could have implications. The first area is research. This study was largely limited by its size. Although a great deal of information was collected, it came from one time period and from only five forest stands. This information should be used to develop additional studies covering more forests and different time periods.

Research is particularly needed in order to develop a protocol for classifying forest degradation in the region. Such a classification protocol is urgently needed to assess and monitor what is happening to the forests. A classification protocol, such as recommended in this study will also assist in management work, the second area where the findings of this study could have implications. An ability to objectively classify forests into degradation classes would allow forest managers to target specialised programmes for various classes of degraded forests. It would then be relatively easy to monitor and evaluate progress and re-adapt management plans. In classifying forests into degradation classes, it is important to first define degradation according to management objectives and then select the appropriate variables and indices to make an assessment of a forest's condition. This suggests that different indices of degradation, incorporating different variables and with different importance weights attached to them, need to be developed to suit various management objectives. Researchers can carry out the scientific and technical work of measuring variables and developing indices, but it is the forest managers and the users (society at large) who will have to decide what the management objective will be for a particular forest and what aspects need to be emphasised. Clearly, a tremendous amount of work remains to be done in this regard in the middle hills of Nepal.

THE ECOLOGY OF A SOUTH-ASIAN TALL-GRASS COMMUNITY

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ABSTRACT

Landscape dynamics, habitat succession and grass productions were studied for two years in a tall-grass and riverine forest mosaic in the Royal Chitwan National Park, Nepal. Ten grassland and three forest associations were identified on an edaphic and successional gradient. *Themeda arundinacea, Narenga porphorycoma, Saccharum bengalense, Saccharum spontaneum*, riverine forest, and *Shorea robusta* forest types were identified. A linear model of landscape dynamics showed that fluvial action controlled landscape organisation. The landscape was not a "shifting mosaic" with constant properties; simulation showed *S. spontaneum* grassland area doubling over the next 50 years. Indirect gradient analysis suggested soil moisture, soil development and fire as the underlying gradients of among-habitat organisation. Succession was a complex function of life history and population processes, and increasing soil resources over time. Large mammals were important as ecosystem regulators.

Experiments were conducted in three grassland types to determine the effects of early (February) and late (May) dry season brning and wildlife grazing on grass standing biomass and above-ground net primary production (ANPP). Grazing had a negative effect on *Imperata. cylindrica* biomass, but not on *N. porphorycoma* biomass. Sites burned early had higher production, than late-burned or unburned sites. Increased production was attributed to high post-burn soil temperature. Annual above-ground grass production on sites burned early, the norm in Chitwan, was 1.2 kg m^{-2} for *I. cylindrica*, 1.6 kg m^{-2} for *N. porphorycoma*, and 1.65 kg m^{-2} for *S. spontaneum*. Field studies showed domestic elephants each consuming 25 kg Dry Weight (DW) cut-fodder and 20 kg DW grazed forage daily. Humans legally harvested 11,132 t grass valued at NRs. 10 million (US$ 4,50,000). ANPP on a village pasture, or grazing lawn, was measured at 872 g m^{-2}, with 100% consumption by domestic livestock; ANPP inside an adjacent enclosure was 1,410 g m^{-2}, A defoliation experiment indicated a negative non-linear production response. Total grass production and consumption for the study area was projected using the landscape model and assuming current conditions. Simulations projected little change in *I. cylindrica* biomass over the next 20 years, a 28% decrease in *N. porphorycoma* biomass, and a 15% increase in S. spontaneum biomass. Minimum consumption of ANPP by herbivores was 6% for the study area, with minimum consumption of 12% for *I. cylindrica*, 4% for *N. porphorycoma*, and 10% for *S. spontaneum*.

PROBLEM

The subjective of grasslands, large ungulates, and grass-ungulate relationships in the tropics usually conjures up the image of an East African plain teeming with wildebeest, zebras, antelopes and lions. One does not think of Nepal, or south Asia, as teeming with wildlife. Nevertheless, the region has had an amazingly diverse and abundant wildlife community in which ungulates and their predators have held a large role since Miocene times.

"Incredible numbers" of "game species" were reported in the tall grass Terai jungles at the

foot of the Himalayas near the beginning of the twentieth century. A fraction of these vast herds now are found only in national parks and reserves.

Very little research has been done on the plant communities that support these impressive vertebrate fauna, and literature on the organisation of the grassland-riverine forest-sal (*Shorea robusta*) forest complex in north India and Nepal has been largely superficial, inferred from casual observation and general treatments of similar grasslands types or by gneral survey.

Hence, research into the ecology of the riverine grasslands and forests was sorely needed for a complete understanding of the large mammal community and for park management. The potential was great for contributing as well to the basic understanding of grass-ungulate relationships in a system much different from the African grasslands, where much research has already occurred.

METHODOLOGY

Black-and-white aerial photographs from 1964 and 1981 were used to examine landscape dynamics and 13 habitat types were recognised. Flood plain and other areas outside the Park were included if they could later become part of the Park through erosion, or to examine the expansion of floodplain at the expense of agriculture.

Sample points for systematic sampling were determined from a 250 m (ground measurement) grid on an aerial photograph of the research study area. Approximately two-thirds of the area, extending 6 km west from Sauraha, was sampled with 188 plots. Two-thirds of the plots were spaced equally on the 250 m grid; the other third of the plots on the west side of the study area were measured on every other north-south transect of the grid for a 250 x 500 m spacing.

Minimum area plots of 8.5 m x 8.5 m were marked for grassland sample points but 11 m x 11 m plots were used in riverine forest. All under-storey species were described, numbered and collected for later identification.

An experiment was also designed to investigate the methods of grass colonisation on new river sandbars. A 100 m2 area of new sandbar was enclosed with barbed wire, and 49, one metre square plots were laid out with 0.5 m buffers. Seven propagation treatments were arranged in a randomised block design with seven replicates.Treatments were: (1) *Saccharum spontaneum seeds*; (2) *Saccharum spontaneum* stolon nodes buried 5 cm deep; (3) *Saccharum spontaneum* stolon nodes on the surface; (4) *Imperata cylindrica* seeds; (5) *Saccharum bengalense* seeds; (6) *Narenga porphorycoma* seeds; and (7) a control with no seeds or nodes planted.

To find out fire and grazing effects on ANPP, three experimental sites were selected in homogenous stands of *Imperata cylindrica, Saccharum spontaneum*, and *Narenga porphorycoma*. Grazing treatments were grazed and ungrazed. Burn treatments were early burn (early February), late burn (mid-May) and no burn. Each treatment combination was replicated twice with 20 x 20 m plots in a randomised split-block design. The 12 treatment plots were laid out in a 3 x 4 arrangement, with each replicate consisting of a block of 6 plots. Plots were separated by a 5 m wide fire lane; a 10 m wide fire lane surrounded the entire site. Adjacent ungrazed plots for the two replicates were seperated by a 5-strand electric fence powered by a 12 volt car battery.

FINDINGS

The flood plain and upland habitat inside the Park was the main landscape subsystem. This subsystem displayed dynamics different from those outside the Park, because the river channel was primarily cutting outside lands and depositing on the Park side of the river. *Saccharum spontaneum* flood plain habitat increased 73% since 1964 to become the most abundant vegetation type. Model simulations show that *Saccharum spontaneum* habitat area will double over the next 50 years, if rent trends continue and dominate the landscape.

Ten grassland associations, with 6 phases, and 3 forest associations were identified. The majority of types, with *Saccharum spontaneum* and *Saccharum bengalense*, but also some with *Naranga porphorycoma* were considered stages in succession to riverine forest.

Indirect gradient analysis suggested that soil moisture, soil development, and fire were the primary gradients underlying community organisation and succession.

Fire and grazing had significant effects on standing biomass of *Imperata cylindrica*. Early burning, without grazing, produced the greatest biomass. Grazing removed the greatest biomass from the late-burn plots, probably because burned plots were surrounded by older and less palatable forage.

No significant grazing effects were found with *Narenga porphorycoma* standing biomass. Sites burned early had higher production than late burned or unburned.ANPP of Chitwan's grasslands appears to be among the highest in the world.

RECOMMENDATION

A list of priority research topics and questions should include:

1. Studies to examine large scale floodplain dynamics for the entire Rapti River floodplain in the Chitwan valley. Remote sensing techniques would be ideal. LANDSAT images spanning 10 to 15 years are probably available for better estimating model parameters.

2. Effects of grazing and defoliation on production. How do grasses compensate for grazing? What are the effects on competitive and successional relationships ?

3. What are the effects of climatic variation (rainfall and temperature) on annual production ?

4. How does fire effect tree and woody shrub survival ?

5. Will staggered burning through the dry season increase species diversity by providing critical hiding or thermal habitat for mammals, or nesting sites for grassland birds ? Does staggered burning of *Imperata cylindrica* and tall grasses attract large herbivores away from agriculture and decrease crop depredation ?

6. Investigation of grassland management techniques that will increase landscape diversity and biomass production of *Imperata cylindrica* for wildlife and human consumption. Does the resulting higher landscape diversity increase wildlife populations, movements, or habitat selection ?

HUMAN IMPACT ON FORESTS IN THE MIDDLE HILLS OF NEPAL

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ABSTRACT

This dissertation seeks to set in a historical context man's influence on the forests of the Nepalese Pahad (the Middle Hills and montane areas). This is a complex task because the forests have never stood apart as a separate sector in Nepal but have always been interwoven with other land uses and with political, social, demographic and economic change.There are three depths of consideration, associated with three sources of information. In the first, sources of information are almost entirely secondary but they enable a general picture of Nepal as a least developed country to be given, with emphasis on those aspects that have any bearing on forests. In the second, the attention is focused on Sindhu Palchok and Kabhre Palanchok districts, for which the author was the Divisional Forest Officer from 1973 to 1980. Here, much material is derived from the author's personal knowledge. Finally, ten village panchayats in the two districts, centred on the village of Thokarpa, are examined in detail largely using data gained from the author's own field work undertaken during the course of his Ph.D. studies.The study leads to a number of conclusions. First, that the deforestation of the Pahad is not a recent phenomenon but has a long history, being well established by the late 18th century at least. Within the two districts there is now no forest land suitable for conversion to arable land, with the possible exception of some areas on the southern slopes of the Mahabharat Lekh. It appears that the situation has been the same for many decades and probably for more than a century. Second, that deforestation in much of the Pahad, and certainly in Sindhu Palchok and Kabhrepalanchok, was caused mainly by the joint attack of government land use policy and subsistence agriculture. Government policy promoted the conversion of forest to agriculture in order to maximize agricultural surpluses and land taxes. Further, the forest was used extensively for many purposes that extended beyond simple subsistence living, e.g. fuel for many manufacturing processes and timber for the construction of the towns of the Kathmandu Valley. Subsistence living involved a multi-faceted use of the forest, mainly for timber, fuelwood and fodder, the latter closely linking the forest to agriculture. Thus the productivity of the agricultural land depended significantly on the manure of animals fed on tree leaves. In many areas the combined effects of lopping, browsing and fire have caused the degeneration of the surviving forest.

The study also showed that the condition, distribution and extent of forests in a district can only be understood in the light of a comprehensive historical survey of all the factors that have had effects. The factors have different effects in different areas, so that extrapolation from one area to another is fraught with danger. Thus, deforestation is likely to have occurred earliest and most intensively in areas where government pressure was most easily and continuously applied, such as in the heartland of Sindhu Palchok and Kabhre Palanchok, including the Thokarpa area.

The dissertation also records factors which led to the emergence of community forestry in the Chautara Forest Division, a development that has since spread through much of Nepal. In the light of much evidence of neglect of the welfare of the peasants of the Pahad by the government through much of Nepalese history and of the state's poor custodianship of the nation's forests, the emergence of a sense of local, community-based responsibility for the forested land is seen as

the most likely way to arrest, and even reverse, the slow deterioration of the forests with all the adverse environmental impacts this entails.

PROBLEMS

Deforestation has in recent decades become a topic of wide-spread concern to a great diversity of people, amongst whom are forest conservationists, biologists, watershed manages, commercial timber traders and, above all, those in lesser developed countries whose lives depend directly or indirectly on forest products such as fuelwood. Numerous articles in newspapers are evidence that this topic is also seen to be of general interest to many not immediately affected.Despite the holding of many conferences and workshops and development of a large literature, there has been great confusion on such fundamental issues as the amount, rate and causation of deforestation.If such problems exist in establishing the extent of the current resource they are even greater in determining causation in relation to the rate of deforestation. Who, or what, are the villains and how serious and rapid are their depredations? To begin to provide answers to such questions requires the development of some historical depth of knowledge, but all too often this is least available where it is most needed. The real rates of change are seldom known accurately and the current rates cannot be set in an historical context. Causation both current and historic, is ofen equally debatable. In the absence of such essential background it is impossible to establish a well-based forest policy for a country or even to produce an adequate appraisal of a proposed assistance project. The question can, therefore, be asked 'Can historical research be of help in forest policy decisions?There is a direct link between community welfare and the use of forested land through the needs for fuelwood and fodder. Fodder is fed to animals which provide almost the only manurial inputs to crop production. Many common agricultural practices and cottage industries are damaging to the forest. The collection of fuelwood results in a serious drain on forest resources. Fuelwood use will exceed forest production unless important efforts are made to establish new forests. Fodder use from the forest is also considerable. Fire has been an agent of forest destruction. Weeds, such as Banmara (*Eupatorium adenophorum*), also threaten the welfare of forest areas. There is only 0.27 ha of forestland and 0.21 ha of cultivated land per capita in Nepal, making it one of the most densely populated areas in the world. The area of forested land has been decreasing at an alarming rate in recent decades but this loss of forest is confined mainly to the Terai (about 4% annually) and the Siwaliks (a little more than 1% annually) but is negligible in the Pahad where land use is relatively stable.

OBJECTIVE

A major aim is to support this contention by attempting to establish the place of forestry in the developing context of Nepalese history. This is a complex task because the forests have never stood apart as a separate sector in Nepal but have always been inextricably interwoven with other land uses and with political, social, demographic and economic change.

To faciliate a better understanding of the rationale for this dissertation, the two major theses arising from it were set out early in its introductory chapter. First, that deforestation of the Pahad is not a recent phenomenon but has a long history. Second, that deforesation in much of the Pahad was caused by the joint attack of government landuse policy and subsistence agriculture. The desertation is concerned with these two main themes. In addition, the dissertation records factors which led to emergence of communiy forestry in Nepal.

METHODOLOGY

Special attention is to the Pahad because of the subsequent development of the dissertation. The Pahad lies between the high Himalaya to the north and the low elevation, flat Terai zone bording India to the south. It comprises the heavily-populated Middle Hills and the higher Montane zone to the north, at the altitudinal limit of human activity.

The main body of this dissertation divides into three parts reflecting three depths of consideration and three sources of information. The source of information are almost entirely secondary, the field of vision is reduced and attention is focused on two districts, Sindhu Palchok and Kabhre Palanchok. The author was Chautara Divisional Forest Officer from early 1973 to early 1980 and much of the material is derived from his personal knowledge and observations, although secondary sources are also utilized. The content of this part is based on information gathered by the author in the field between November 1982 and February 1983.

This information includes specific field observations and the results of an extensive series of personal interviews with local residents conducted by the author.The details of these personal interviews are given in appendices in Volume-II of the disertation. A photographic appendix is also included in Vol.II. to help the readers gain some visual appreciation of the field study area.

FINDINGS

The major findings of the study are:

1. Enormous variation in elevation, slope, aspect, climate and soil has resulted in a very complex mosaic of forest types in the Pahad.

2. Most of the forest types occurring from the valley bottoms to the limits of cultivation at around 2,400-2,600 m have been modified due to use and abuse and some types have been almost eliminated. Much of the forest land is shrubland and generally of low quality with small valumes of timber per unit of area. Its forests have degenerated in quality, and fuelwood, fodder and timber are all in short supply.

3. It is very difficult to obtain accurate statistics on land use, and especially for the forested land, because of inadequate survey and assessment and conflicting definitions of forest type.

4. The widespead deforestation of the Nepalese Pahad occurred not because of high population density but largely as an offshoot from deliberate government policies.

5. Forest administration, as with other administration in Nepal, concentrated on revenue collection during the Rana period and subsequently. Post-Rana lesislation concerned with forests was often interpreted by the local people as not being in their best interests. Past ruling regimes have been poor custodians of the forest resource and used it not at all for local benefit, and as a consequence the forests suffered.

6. Reclaimation of forest was generally open to anyone who understood to bring it under cultivation. Extensive areas of forests were also allocated to individuals and orgainsations as land grants and endowments called birtas, jagirs and guthis. These have often been held very tenaciously by the original grantees inspite of recent legislation.

7. An undeveloped philosophy on forestry in Nepal has led to an inadequate policy framework, week institutional foundation and an inappropriate use of skilled manpower so that the forest administration was unable to stem the tide of forest destruction. These factors have rendered those in the profession in Nepal not only 'guilty of not taking enough and not listening sufficiently to the community at large' but also frustrated, timid, and perhaps the 'most demoralized of the new administrative elites' in the country. They are, therefore, poorly placed to withstand pressures for short-term or personal gain which arise from many sources.

8. More recent legislation, the 1977 Amendment of the Forest Act in particular, dealing with the allocation of forested land to be a administered by the village panchayat communities themselves has sown the seeds of effective community forestry in Nepal.

9. Many common agricultural pursuits and cottage industries are quite damaging to the forest, often due to the need for fuelwood. Fodder, fuelwood and even timber are generally harvested as free goods, but local households use little timber for construction.

10. The collection of fuelwood within Sindhu Palchok and Kabhre Palanchok, represents a serious drain on forest resources, but fuelwood use of about 350 to 450 kg per person per year is one of the lowest recorded in Nepal, and probably in the world. Fuelwood use will exceed forest production unless considerable efforts are made to establish new forests.

11. Fodder use from the forest requires about 2.8 ha of accessible unmanaged forest for every 1 ha of agricultural land. Sindhu Palchok and Kabhre Palanchok districts do not have forest areas sufficient to satisfy this ratio and, due to the inequitable distribution of the remaining forest, many village panchayats were found to have quite inadequate forest areas for local needs.

12. Fire has been an agent of forest destruction in the past, but the incidence of deliberate and accidental fire has declined in recent years, often as a result of community forestry initiatives.

13. Serious weeds, like the Banmara (*Eupatorium adenophorum*), may prove a major problem in the establisment, protection and maintenance of forests.

14. An involvement in the market economy and loss of 'primitive purity' is sometimes seen as a cause of environmental deterioration. However, unlike the western Himalaya of India, it has no validiy for the Nepalese Pahad.

CONCLUSION

The two major theses of this dissertation were: First, ' that the deforestation of the Pahad is not a recent phenomenon but has a long history, being well-established by the late 18th century at least.' The second thesis was 'that deforestation in much of the Pahad, and certainly in Sindhu Palchok and Kahbre Panalchok, was caused by the joint attack of government landuse policy and subsistence agriculture'. Both the secondary sources and the first-hand interviews strongly support these two theses.

Some corollaries arising from these two main theses are: First, that the condition, distribution and extent of forest in a district can only be understood in the light of a comprehensive historcial survey of all the factors that have had effects. A second is that these factors will have different

effects in different areas.

The dissertation is concerned with the two main themes. In addition, this dissertation records factors which led to the emergence of community forestry in the Chautara Forest Division, a development that has since spread through much of Nepal. Community forestry was seen as the most likly way to arrest , even reverese, the slow deterioration of the forests with all the adverse environmental impacts this entails.

RECOMMENDATIONS:

This dissertation has shown that successive ruling regimes in Nepal in the past have been poor custodians of the forest resource in the Pahad. It is unlikely that the situation would change significantly unless future governments and power groups change their attitude radically. However, local communities have proved capable of taking appropriate action in their enlightened self-interest. The 1977 Amendment of the Forest Act was thus seen to be particularly appropriate for it allowed for forest areas to be placed in the hands of local communities. The innovative thinking embodied in this community forestry Act must be boldly extended to establish a partnership in forestry between the central government and local communities for all the forest lands of the Pahad.

The study further showed that, with land pressure as it is, it would be foolish to assume that land, under whatever legal ownership, would be readily given up to forestry unless it is in the local interest to do so. Procedures need to be established to introduce the local interest into planning for government-owned forests and especially into their utilization. In this way, a productive partnership could be established between the state, with its technological manpower and financial resources, and the local communities, with their local knowledge and interest in protection and conservation of resources for their own use.

THE CHANGING ROLE OF THE FOREST RESOURCE IN THE HILLS OF NEPAL

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ABSTRACT

This thesis attempts to establish the present place of forestry in the life of the people of the Middle Hills of Nepali and to reconsider its role in the light of the changing rural economics and environment. The results presented are based on research conducted in four areas representing a continuum from remote area with near-to-subsistence economy based largely on agriculture and livestock production, to an area with access to motor roads, markets and other economic opportunities.

There has been a profound impact in some rural areas as a result of various initiatives by the Government since the 1950s, particularly the development of infrastructure such as the building of motor roads, and the spontaneous adaptation by people to development from outside the village. In areas with access to motor roads, agricultural and livestock production activities are increasingly becoming market oriented, and farm produce, including forest and tree products, is being monetised rapidly. In addition, more rural people are becoming involved in off- farm employment. and as a result the off-farm income has begun to play a key role in changing rural household economics. All this, in turn, is resulting in rapid changes in:

- rural people's economic and resource management strategies,
- the pattern of demand for some important forest products, and, more importantly,
- the traditional farming systems, especially in areas closer to motor roads and markets.

The evidence of change documented by this study gives rise to a number of important issues concerning the Government's present policies on rural development including community forestry. Approaches to planning and implementing community forest management adopted in the past 15 years have been heavily protection oriented, allowing for utilisation only to support the traditional farming systems and to meet the rural people's basic needs of fodder, firewood and construction timber.

The present policies governing community forestry, and the approaches taken to implement them, have certainly contributed to an improvement in the overall situation of the forest resources in the country. Nevertheless, it is argued that they have failed to consider the changing demand placed by new household strategies and the need to meet the demand of purposes beyond subsistence requirements. In contrast, some rural households have already made initiatives to respond to the changing demand and have been able to generate substantial income by growing trees on private land and selling forest products in the market. The present approach of the government to community forestry has, therefore, seriously underestimated the penitential role of the forest resource in the overall economic development of rural Nepal. Further, the indifference to market forces has not only decreased the value of common forest

resources to government, communities and individual rural households, but has also contributed to prolonging the suffering of the rural people, particularly the poorer people.

The thesis concludes with a discussion which identifies some of the major policy and institutional constraints on the development of more effective, flexible and responsive forest management approaches to the changing demands of the rural economy. Some strategies for future policy directions are outlined.

PROBLEMS

It is believed that community forestry can contribute greatly to raising the level of rural people's income and thus alleviating poverts. In some parts of Nepal, the rural people have responded to the rapidly developing market and the growing number of commercial enterprises using forests products by opting to grow trees on their private land for sale in the market. Some rural people are growing trees on their farmland to the extent that the whole process is leading to a change in their strategy of land use.

It is in such a context that this particular research has been conducted It is a study of the structures and economics ofchanging rural agrarian settings in Nepal, the processes by which change takes place withinthem, and the ways in which these changes affect the lives of the rural people and their use and management of local resources, particularly forest and tree resources. Major aims of the study were to establish the present place of forestry and to reconsider its continually evolving role in the changing context of rural land household economics.

The work was based on four hypotheses. The first is that the recent growth of transport and communication links, towns and markets, and other spontaneous developments in the region, have all led to the rapid transformation of some rural agrarian societies from a closed subsistence economy to one which is open and under the increasing influence of market activities. Some rural areas are experiencing more rapid changes than others and are becoming more dynamic in nature.

The second is that as a result of these developments agricultural activities are becoming increasingly market oriented. Rural people have increased access to sources of income other than from agriculture, thereby bringing about changes in rural people's household economies to the extent that the traditional farming systems are breaking down rapidly.

The third is that the changes in rural and household economies have led to changes in the pattern of use of some resources, including the use of forest and tree resources.

The fourth is that as long as community forestry in Nepal is confined to the narrow objectives of meeting subsistence needs for fodder, firewood and construction timber and excludes the domestic market, the potential contributions of community forestry to the socio-economic development process will not be fully realised.

A number of corollaries arise fromthe above hypotheses. One is that the present and potential role of forest and tree resources in the changing rural societies of a developing country like Nepal can be understood only in the light of a comprehensive socio-economic study in the context of past and present situations. A second is that the focus of forest development and management cannot be uniform across different areas. Extrapolation from one area to another may, therefore, be fraught with danger. In other words, the objectives of forest development and

management in a market-influenced area should be different from those for an area which is predominantly based on the subsistence agriculture economy. Therefore, the four areas which are the foci for this research have been chosen essentially to include:

- a fairly remote area with a quasi-subsistence (or near to subsistence) economy largely based on agriculture, with limited external input for its development and with almost no (or very little) market activity,

- an area with substantial external input for development activities and with considerable market activities,

- an area lying between the above two extremes, where some market activities and limited external inputs for its development are to be found.

The fourth area chosen is one where there have been substantial external inputs in the development of its forest resource in order to reflect the approaches taken by the intervening agencies, including the Forest Department, to management and development of forest resources.

The research focuses on the Middle Hills region of central Nepal, particularly on Kabhre Palanchok district.

METHODOLOGY

The research involved a total of 10 months fieldwork over two time periods: September to December 1989 and August 1990 to February 1991. About 75 percent of this time was spent living in the villages.

A combination of several methods and techniques was used for gathering information. Some of the major ones are as follows:

- use of aerial photographs for determining the general land-use patterns.
- field investigations of both physical and socio-economic factors of each areas using:
    - informal surveys,
    - semi-structured interviews, and
    - direct observations.

- Literature review

The physical survey of common forest resources was conducted using a designed pro-forma.

FINDINGS

The overall socio-economic development and the increased market activities, including theemergence of several enterprises using forest products (particularly wood), have resulted in a great alteration in the overall pattern of demand for forest products In general, there has been:

a reduction in the demand for certain forest products, particularly fodder and leaf-litter, for quasi- subsistence needs, an increase in the demand for certain other forest products, specially timber and firewood.

It is clearly evident that unless the communities are really in control of the forest resource, it is not possible for them to manage forests.

It seems that if utilisation of the common forest land in response to the market demand is to occur, and to occur equitably, the initiative must come first from the highest levels of government.

The importance of trees on private land is not denied. However the increased emphasis by government and other development agencies on private planting programmes gives rise to some serious policy implications, mainly because equity in tree ownership is impossible in the context of the skewed land holding pattern.

Further, the emphasis of both the Forest Department and village leaders on the protection of common forest resources and their limited utilisation for subsistence needs only means that only private tree growers, especially the large landholders, will be able to sell forest products and benefit from the opportunities provided by the market.

Village leaders and large landholders are usually ahead of the rest in seizing the opportunities. Once a common forest management begins torespond to the market demands, these very leaders and large landholders may take the opportunity to capture the benefits to the exclusion of the smaller landholders and poorer members of the user group. Any future government policy on community forestry will need to address the issue of equity within user groups.

Further, the growing market forces place emphasis on different kinds of forest products. In the past, at least in the Middle Hills region, the subsistence economy based on agriculture always placed heavier demands on forests for fodder and firewood, whereas the increasing market activities led to a greater demand for wood, and increasingly so for timber. Thus, the new market demand for timber may result in conflict in the management objectives of given common forest resources. This new dimension to forest management may even eventually demand decisions to change the whole structure, species and composition of the forests.

The critical problem is that there has so far been no experience whatsoever of either the rural hill communities or the foresters, in managing common forests to meet the demands of the market. So far the various approaches or systems for managing common forest resources in Kabhre Palanchok district, have essentially been oriented toward protection and subsistence needs.

Clearly, the desired changes cannot be achieved in practice in a short period of time. Although government forest policy in Nepal made provision for community forestry some 15 years ago, there has hardly been any change in the attitudes of the majority of the foresters and in the traditional way of working in forestry organisations. Communications between forestry field staff and community members are still very poor, and indifferent attitudes and mistrust towards each other prevail.

An important reason for the ineffectiveness of community forestry is that the foresters do not trust villagers to manage forests properly. Foresters see themselves as the ones who have a monopoly of knowledge about forests and trees They are reluctant to hand over the authority for managing forests to communities. Thus, forestry and watershed management projects in Nepal often include programmes to teach farmers about the importance of trees and forests and to motivate them to plant and protect trees, especially on private lands.

The effort which the government is making to motivate farmers to plant trees (something they are already doing) is misplaced, at least in terms of priority. However, government action to support private tree growers with advice on species selection and provision of appropriate seedlings, by removing legal and institutional constraints and by relaxing regulations that restrict the cutting of trees for the market is needed.

Another reason for the ineffectiveness of community forestry, especially in handing over forests to communities, has been the tendency for foresters to collect very detailed information about forests, such as boundaries and species of the forests, through full surveys and inventories. Such information is not required by the local people for users-group management as they already know about the forest because they have been using it.

On the other hand, villagers do not trust foresters, who have always acted as a police force rather than as a technical service and have denied villagers the right to cut trees even from their own lands. However, although villagers have been planting trees on private land and protecting their common forests themselves, it is true that the local knowledge, like any scientific knowledge, is not perfect. Case studies showed that indigenous forest management is also not without problems.

Thus, both foresters and gets will need to change their negative attitudes towards each other, develop understanding and learn from one another. The need is to change the education of foresters to make their understanding of forest management in the hills appropriate.

For any development policy to provide sound guidance, it is important to have an appropriate vision. In Nepal, community forestry in its initial stages had a vision, but that seems to have been lost in an undue concern with bureaucratic, administrative and technical problems. Because of the lack of current well thought out aims there is much confusion, resulting in misleading policies and in inappropriate approaches to planning and implementation of community forestry. The Government's current forest policy, particularly community forestry policy, has been emphasising the planning and protection of forests and trees and meeting rural people' subsistence needs for fodder, leaf-litter, firewood and construction timber. There are no provisions for the supply of forest products to the rapidly developing domestic market. Yet the increased domestic market for forest products cannot now be ignored. Not only private tree growers but also common forest users will certainly respond to the forces of the market. Appropriate government policies will make these responses more orderly, more lawful and more likely to be equitable. Unfortunately, there are few signs that appropriate policy changes are being considered.

So far, policy makers and planners have been attempting to hit a moving target and constantly missing it. One fundamental reason for this has been the perceived role of the forest resource. Throughout the history of Nepal up to the present, the potential role of the forest in socio-economic development has been seriously underestimated.

While the "fodder-firewood-timber" concept may be still applicable in some parts of rural Nepal, it is less appropriate for other areas, particularly those which are coming under the increasing influence of market activities and where people have chosen to reduce their livestock numbers.

Forestry activities such as afforestation, production, harvesting, processing and trading of timber and other forest produces can be significant sources of employment and income, especially in rural areas with limited economic opportunities. The demand placed by the market on the forest

and tree resources should be seen here as an opportunity, rather than a problem, for community forestry.

RECOMMENDATIONS

First, rural societies are dynamic, not static, so that the Government's rural development policies in general and forest policy in particular must keep pace with these changes.

Second, the Government's current emphasis on protection of the forest resource and the ban on the felling of green trees from the common forests is misdirected, and its result may be the exact opposite of that desired. Attempts to ignore the expanding domestic market for forest products will not only decrease the value of the forests and trees to government and private owners, but may well result in even less protection of the common forests than currently exists. More importantly, such an approach has the potential to slow the pace of development, and thereby prolong the suffering of rural people, particularly the poorer people.

Finally, Nepal's present policy governing community forestry must change its objectives from being merely to meet the subsistence needs for fodder, firewood and simple construction timber to increasing the income of the rural households. For this, the new strategy should aim to develop new, and to support the existing, forest-based enterprises.There should be a much stronger commitment to realistic forestry, and especially community forestry, from political leaders and planners than there has been in the past. This includes commitments not only to the allocation of funds and other resources and to removing institutional constraints but also to socio-economic development of the nation, with forestry and forest-based industries playing their proper parts.

MOVEMENT AND SURVIVAL OF CAPTIVE-REARED GHARIAL GAVIALIS GANGETICUS IN THE NARAYANI RIVER, NEPAL

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ABSTRACT

A field study of the gharial (Gavialis gangeticus) was conducted in the Royal Chitwan National Park, Nepal, to determine the status and ecology of this species in the Narayani River. Systematic surveys conducted in December 1986 and May 1987 revealed that a minimum of 103 (0.93 gharials/km) wild and released gharials survived in the Narayani River. The sex ratio of wild gharials, 1 male: 9 females, was critically low. The low number of males was attributed to heavy poaching of males in the past.

Habitat surveys conducted in June 1987 and January 1988, indicated that rocky banks were the most available habitat (0.55-0.50) in the Narayani River, followed by sand banks (0.34-0.17), grass banks (0.19-0.06), sand-grass banks (0.11--.03), and river channel (0.03-0.01). Larger gharials were observed on sand banks more frequently (mean = 79, SD = 15.1, n = 1658) than on rocky banks (Mean = 12.6, SD = 9.6, n = 410), whereas small gharials used rocky banks more than larger animals. Gharials are synchronised nesters with egg-laying occurring from March 25-April 18. A total of 73 nests observed during the years 1977 and 1987, yielded a mean clutch size of 35.2 with SD of 1.1. The mean incubation periods and hatching rates of eggs from the Kali Gandiki and Narayani rivers were 78 days SD=9 and 60.9%, and 81 days SD= 11.5 and 67.7% respectively. From 25 to 80% of the hatchings died within the first year of life.

Two areas were evaluated for reintroduction of the gharial in the Narayani River. Primary criteria used to evaluate the release sites included deep, fast-flowing, clear water; high banks; deep pools; and undisturbed sand banks at the river edge. A total of 218 juvenile gharials had been released (183 into the Narayani and 35 into the Kali Gandiki) between 1981 and 1987; 52 (23.8%) of these still survived in the Narayani as of December 1987. Movement of released gharials was quite variable with respect to both distances travelled and directions of movement. Large gharials (> 1.2 m in length) moved upstream (23%) more frequently than small (< 1.2 m) animals (8%). The future success of the gharial reintroduction programme in Nepal will be contingent on the adherence to three strategic elements: the release of gharials > 1.2 m in length; the selection of release sites that provideprimary habitats suiting the principal dispersion age of the released gharials; and release of gharials in late winter to facilitate the establishment of site-fidelity bonds by individuals prior to the monsoon season.

PROBLEM

Until the early 1960s, gharials were found in all major rivers of the Indian sub- continent, but by today this population has virtually disappeared. In fact, the gharial probably would be on the verge of extinction were it not for the recent gharial conservation programme implemented in India and Nepal. Many factors contributed to the decline of the gharial population: habitat loss and disturbance; lack of strict enforcement of existing laws; killing the animal for its hide (leather) and for the ghara of the male; entrapment in nylon gill netsintroduced for fishing;

construction of reservoirs and dams in suitable habitats; and poaching of eggs by the local people for medicine and food. Collectively, these factors have resulted in the gharial becoming one of the rarest and most endangered crocodilians in the world. A high priority was given to this species by the IUCN/SSC. Gharials are listed as an endangered species in the IUCN Red Data Book (1975).

In Nepal, gharials were once widely distributed in all major river systems of the country, but currently the species is found only in isolated populations in the Karnali, Babai, Kali and Narayani rivers.

The recent decline in the numbers and distribution of the gharial has prompted considerable concern for its future. Remnant populations are presently confined to relatively small areas of the major river systems of Nepal and India. Very little is known about its ecology and behaviour. Nest flooding, caused by man-induced hydrological changes, is now thought to be the principal factor limiting the population in the Narayani River.

Restocking of depleted populations of crocodilians has been discussed as a viable management techniques. Artificial hatching and rearing can greatly reduce mortality rates of crocodilian eggs and young, and subsequently the animals can be reintroduced to natural populations at a size and age at which mortality is low.

OBJECTIVES

This study was designed to elucidate the factors which interact to influence the survival of the gharial and to assess the success of its conservation efforts. The conponents of the study were:

1. literature review of the current status of the wild gharial;

2. establishing the distribution of remnant populations and habitat use of gharials in the Narayani River;

3. establishing values of wild nest parameters and captive hatching success of gharials in Nepal;

4. determining dispersal patterns, movements, and survival of gharials released in the Narayani River; and

5. recommending a management programme based on the results of the study.

METHODOLOGY

A survey of gharials in the Narayani and Kali Gandaki rivers was conducted during 1983, 1984 and 1987, using four dugout canoes and a team consisting of two observers and eight boatmen who were members of the local ethnic group, the Bote. During the 1987 study period, the entire lengths of the Kali Gandaki and the Narayani were surveyed once each month. Surveys were conducted between 0900 hrs and 1600 hrs. Each survey required 10 days to complete. During each survey, the estimated size, sex and location of sighted animals were recorded. Observers used 7x50 binoculars to observe gharials. The monthly census statistic was the sum of the daily census counts.

FINDINGS

Before 1960, gharials were abundant in the Narayani River and its largest tributary, the Rapti River, in the Chitwan Valley of south-central Nepal.

The visually observed sex ratio of the gharial in Nepal, which strongly favours females, represents a problem of paramountconcern. The highest sex ratio, 1 male to 6 females, was recorded in 1984, and the lowest ratio, 1 male to 9 females, was recorded in 1987. The low number of males can be attributed directly to (a) heavy poaching of males in the past for ghara and (b) temperature effects on incubation and hatching in the hatchery. Because earlier superstitious beliefs about the ghara have diminished, modern poaching may not be as selective.

Gharial eggs are believed to have medicinal value in parts of India and Nepal. In Nepal, the local Tharu people believe that the eggs have aphrodisiacal and medicinal values, for example, the dry powder of the egg is considered to be effective as a cough medicine.

RECOMMENDATIONS

Since the gharial population has continued to decline, conservation measures are necessary to protect the surviving population. It is recommended that the existing rehabilitation programme in the Chitwan be expanded to the Karnali, Babai and Koshi rivers and monitored in the Koshi and Karnali rivers, and the efficacy of these programmes be monitored.

Based on the 10 years experience of the Gharial Conservation Project in the Royal Chitwan National Park, certain guidelines should be followed in the continuation and expansion of the project. The following recommendations are submitted:

1. Since survey counts made in summer (May) and winter (January) indicated that winter counts provided higher numbers because of low water conditions and increased basking and were considered more reliable, it is recommended that survey of existing wild populations and released gharials in each suitable river of Nepal should be conducted annually in winter (December to February) to maintain and update the status of the species.

2. All important habitats for the gharial should be identified and, the Kali Gandaki and Babai rivers should be declared as special gharial reserves as soon as possible. The existing gharial populations there are eminently endangered because of continued poaching and habitat disturbance.

3. In some stretches of the Narayani River, the local fishing contractors recently have used nets which extend entirely across the river. For the protection of the gharial as well as fish and other valuable aquatic resources, such large-scale fishing activities should be stopped in the Narayani River. Fishing by free permit should be restricted to floating baits and throw nets.

4. It is recommended that gharial eggs be collected and artificially incubated to avoid natural losses of eggs and hatching. However, in the future, some nests which appear safe from flooding should be left undisturbed to evaluate success and survival of wild hatchings.

5. Data from gharials released in 1981, 1982, 1983, 1984 and 1987 indicated that larger animals (> 1.2 m in length) had a higher probability of survival than the smaller ones.

Larger gharials should therefore be released in future to improve the success of the release programme.

6. Hatching success is dependent upon careful handling of the eggs. Nests should be opened in either early morning or late afternoon; original orientation of the eggs should be maintained by marking the top of each egg, but away from the white egg band to avoid any toxic effect on the embryo; collected eggs should be transported rapidly, avoiding vibrations and shock, in a strong box with sufficient sand to maintain constant incubating temperature and humidity during transport.

7. Incubating pits should be dug above the high-water mark and not be subjected to strong ground vibration. A predator-proof fence as well as guards should be provided to protect eggs from predators and humans.

8. Re-introduction sites should be chosen in protected areas within the known geographical range of the species, and should be free from detrimental human disturbance such as fishing, poaching of eggs, illegal hunting, and habitat destruction.

9. The future release site in the Narayani River should be shifted 45 km upstream, near to Sikrauli.

10. Buffalo or chicken meat is the recommended diet for captive animals.

11. Animals should be released at the upper ends of the rivers to allow them to establish themselves there rather than being washed down to the Narayani River.

12. From experience in the Narayani River, gharials should be maintained in a temporary enclosure adjacent to the release site for two weeks prior to release to acclimatise them to the wild.

13. All released animals should be tagged and measured prior to release to enable better estimates of survival, mobility and growth rate.

14. Regular long-term monitoring of released animals is vital for measuring such factors as distribution in relation to food, water depth, sand banks, survival, and movement patterns. Public education is an essential component of a gharial rehabilitation programme in Nepal. People residing near the Narayani River should not consider the gharial to be an animal which conflicts with local interests.

15. A programme similar to that for the gharial is needed to re-establish healthy populations of other repile species in the river. In conjunction with management programmes, much needed biological data could be gathered on these species.

THE ECOLOGY AND BEHAVIOUR OF CHITAL *(AXIS AXIS)* IN THE ROYAL CHITWAN NATIONAL PARK

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ABSTRACT

The Royal Chitwan National Park in southern Nepal is one of the few areas where the four species of deer-chital, hog deer, sambar and barking deer-still co-exist. The objective of this study was to investigate the habitat utilisation, breeding seasons and social organisation of these species, with particular emphasis on the chital. Detailed information is also given on the daily, seasonal and annual home range behaviour of chital based on the use of radio-telemetry. Data are presented on the annual mortality of chital, the importance of the four deer species in the diet of tigers and leopards, and their anti-predator behaviour. Future research priorities and management options for the future of Chitwan National Park are appraised.

PROBLEM

Throughout the Indian sub-continent many animals species that were once widespread have now become greatly reduced in numbers and distribution as a result of human expansion. The trend has been most noticeable amongst the large mammals, and many of these are now severely threatened. At present they are mostly restricted to national parks and reserves and their future in areas outside these sanctuaries is at best uncertain. Their future depends mainly on the success of attempts to maintain small and more or less isolated populations in national parks and reserves. To manage these areas properly and so conserve the animal species, a profound understanding will be needed of how the populations and the ecosystems in which they live function and of how human activities affect the systems.

The Royal Chitwan National Park in southern Nepal was set up originally to protect and conserve one such large mammal species, the Great Indian one-horned rhinoceros (*Rhinoceros unicornis*), since it was one of only two last strongholds of this species in the world. However the park contained many other endangered species, notably the tiger (*Panthera tigris*), leopard (*Panthera pardus*), gaur (*Bos gaurus*), Gangetic dolphin (*Platanista gangetica*), gharial (*Gavialis gangeticus*), Great Indian Bustard (*Chloriotis nigriceps*) and number of ungulates, including the chital or axis deer (*Axis axis*).

The main emphasis of this study was to produce part of the scientific base for conservation of deer and tiger in Royal Chitwan National Park. There have been many studies of deer in various parts of the world with the advent of the British "Raj" in India, the chital and other deer were described in journals and books published since the last century, but most of these only provide interesting historical records and some useful summaries on distribution, weights, and body or antler size.There have been only three major studies of deer species in the region and these were conducted a decade or so ago in severely man-altered environments where the forests were constantly disturbed by human activity and large predators were reduced in numbers. Thus this is the first detailed study within the region in an area of maximum diversity of deer species and a full complement of predators, and competitors, and it is hoped that it will give some insight into how populations of deer operate in such conditions.

This study focused on the chital (*Axis axis*), the most important of the tiger prey species, and provides comparisons with the three other species of deer (*Axis porcinus, Cervus unicolor* and *Muntiacus muntjak*) that share the national park with the chital and are also preyed upon by the tiger.

METHODOLOGY

1. Direct Observation

Direct observation was used extensively to investigate habitat utilisation, social structures and breeding seasons.the best strategy being to go out and search for the animals. Thus the observations were made by traversing quietly through the forest on the back of an elephant along a grid 1 metre wide cut specifically for the study. The grid line was marked at regular intervals to estimate the proportion in each habitat.

2. Capture Techniques

The following capture techniques were used:

a) drive technique;
b) darting;
c) common net

3. Drugs, Doses and their Effects on Chital

Sedative drugs were administered to 31 chital of different sex/age classes and the effects of sedation were recorded. Drugged animals were weighed to estimate the doses in mg/kg of body weight. Xylazine solution (Rompun) (100 mg/ml) was the main drug used either alone or mixed with other drugs. Xylazine alone was administered to 26 deer that were caught by the drive technique or the cannon net.

4. Radio Tracking

The capture deer were fitted with radio collars. The radio collar had a two-stage transmitter and emitted pulse signals at the rate of 65-80 pulses per minute. Each collar transmitted at a different frequency within the band of 164 to 165 MHz. Power was provided by two 2.8 V lithium batteries.

The receiver weighed about 1.8 kg. and had a frequency control synthesiser in 1 kHz increments over 1 MHz band. A Telex Model 610-2000 headphone was used with the receiver.

Radio tracking was done mostly from elephant-back but occasionally by foot or motor vehicle. Time, date and notes about the habitat, locations and where each reading was taken were recorded. The collared deer were sighted at times and their herd composition and notes on their behaviour were recorded. However no attempts were made to pursue visual observations with the aid of radio, to avoid disturbing the animals or shifting their position.

FINDINGS

The tiger is the largest of all the carnivores in the park and thus is at the top of the food chain. It is linked to the deer for its survival. It has been shown in this study that riverine forest and grassland are the habitats that contain the greatest diversity and concentration of deer. Large areas of pure sal forest or grassland contain much lower densities of prey.

The shape of the national park is elongate, and the riverine forest and grassland habitats occur mostly along the northern edges, separated only by the rivers from adjacent farmland. The rivers do not form an effective barrier to the movements of either deer or tiger. Loss of livestock and life increases antagonism towards the tiger, and some have been poisoned in forest or grassland in close proximity to villages.

Most of the interior of the park is sal forest and is therefore the poorest habitat for deer and tiger. Much of this is on steep-sided valleys where attempts to alter the habitat could prove disastrous. The lower lying flatter ground below the hills on the northern side offers more potential for habitat manipulation. It would not be possible with present knowledge to change any of this into riverine forest. However it seems a workable possibility to convert patches of it into grassland.

The greatest increase in chital would occur if the grassland were kept permanently short and the palatability of the vegetation therefore kept high. Hog deer would, however, require at least some grass kept permanently high and dense for cover. There is no reason why a balance between these could not be struck. Rhinoceros (*Rhinoceros unicornis*) can also be expected to increase with the increase of grassland habitat.

Both fire and grass cutting are, and will remain, an important part of the park management. Little is known of the long-term effect of these practices. Fire probably has been part of the ecosystem for thousands of years but intensive grass cutting is relatively new.

FUTURE RESEARCH

A top priority must be to learn as much as possible about the feeding behaviour of all four species of deer. Although some information is available for Chitwan and elsewhere this is superficial. There is a need for highly detailed studies. Only in this way will we ever be able to understand fully the significance of many of the findings of this and other studies.

Although this study provided some information on all four species of deer it concentrated on the chital. There is an urgent need for much more detailed studies of the other species, especially sambar and hog deer.

At present almost nothing in detail is known about the social system and population density of the sambar. How large are their home ranges ? Are individuals restricted to separate patches of Riverine forest? Do home ranges overlap ? Are adult males territorial ? These and many other questions need to be answered.

The hog deer needs to be studied because it is probably more endangered than any of the others. It relies on extensive areas of tall grassland, usually in the flood areas of the rivers. This is exactly the kind of area that is most in demand for agriculture. Again little is known about its social structure and density. It is essential to know these so that one can assess the adequacy of sizes of existing suitable habitat.

More research is needed, especially on leopards, to find out how much they rely on deer and other species and how much they rely on domestic animals caught close to or outside the park boundaries.

It is also important to undertake research into how the park/people conflict can be minimised and how the local people can be involved in and derive benefits from the national park. Unless a symbiotic relationship between the needs of conservation and the needs of local people can be developed it is doubtful if any park or reserve will survive well beyond the next few decades. Then it will not be only the endangered species in any particular park or reserve that will be extinct but the whole ecosystem.

DISTRIBUTION AND MOVEMENT PATTERN OF DEER IN RESPONSE TO FOOD QUALIY AND MANIPULATION OF GRASSY HABITAT: A CASE STUDY WITH EMPHASIS ON AXIS DEER (*AXIS AXIS*) IN LOWLAND NEPAL

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ABSTRACT

The main objectives of this study were to investigate changes in grass quality following cutting and burning of grasslands and the response of the axis deer (*Axis axis*) to spatial and temporal variation in food quality resulting from this habitat manipulation. The grasslands dominated by matured *Imperata cylindrica* were sampled in December, and resprouted grass following different treatments of cutting and burning were sampled and analyzed for lignin, silica, hemicellulose, cellulose, total ash, N, K, P, Ca, Mg and Na. Deer response within the grassland was studied using experimental plots with different treatments of cutting and burning. Seventeen axis deer were radio-collared to study annual habitat preferences and spacing behaviour. The mineral content and wildlife use of soil licks and aquatic vegetation were recorded to reveal alternative sources of minerals which were low in the grass forage.

All treatments of cutting and burning improved grass forage quality compared with matured December grass.The present practice of cutting followed by burning gave the best overall quality improvements. Compared with matured December grass the reduction in lignin and the increase in N, P and Na were particularly important, since the concentrations of these elements were generally low in mature grasses.

Cut/burned areas were also preferred by axis deer when given the opportunity to select between uncut/unburned, cut/unburned and cut/burned grassland. When no burned-over areas were available, axis deer were also attracted to areas that were only cut, although the numerical response was more rapid in the burned areas. In the late dry season, areas burned in late February were preferred to areas burned six weeks earlier. However, provided newly burned areas were unavailable, density of deer on cut/burned areas did not decline from January to March.

On an annual basis, axis deer used the grasslands preferentially only at night during February, March and April. Males were more associated with forested habitats throughout the year than were females. During the cool and hot-dry season, riverine forest was the preferred habitat whereas sal forest was the preferred habitat during the monsoon and in the cool part of the dry season. Both seasonal and annual movements of axis deer were small. Female and male annual home ranges averaged 135, SD33 ha and 204, SD38 ha, respectively. Evidence is presented that the home ranges found in this study were smaller than those in another study in Nepal, due to the fine-grained habitat mosaic in the area.

The concentrations of Na in the grasses were low throughout the year. Twelve species of mammals used soil licks rich in Na found in the area. Axis deer preferred licks with high concentrations of Na and used them more frequently during January, just after grass resprouting, than in March. Barasingha (*Cervus duvauceli*) compensated for the low mineral content of grasses by consuming aquatic vegetation with 3 to 100 times higher Na content and 11 to 128 times higher Ca content than terrestrial grasses.

The present practice of cutting and burning has positive effects on grass forage quality. It is recommended that evenly distributed patches covering about 50% of the grasslands be burned in early January, immediately after the grass cutting period. Remaining grass patches could be burned in late February and March for the provision of high quality forage towards the end of the dry season. In view of the extremely low Na content of terrestrial grasses in the area, special care should be taken to protect the soil licks and the sites with aquatic vegetation in the park.

The study was conducted in the south-western part of the Royal Bardia National Park.

PROBLEM

Cutting grasslands is common in lowland Nepal during the dry season. This practice has also continued within national parks because of local people's needs for thatch grass. After cutting, much of the grassland is burned. The removal of old herbage by cutting, burning, or both, stimulates grass growth in the dry season. Axis deer (*Axis axis*), barasingha (*Cervus duvauceli*) and hog deer (*Axis porcinus*) congregate on the grasslands and forage on the emerging green shoots. Axis deer, the dominant large herbivore in the area, is classified as an intermediate feeder, feeding on a mixture of browse and grass. Axis deer utilize the grasslands opportunistically when high quality forage is available there. It is therefore a suitable species for studies of selection patterns within different management practices of burning and cutting, and for seasonal preferences for grassland.

METHODOLOGY

Forage Quality Studies

The contents of N, K, P, Ca, Mg, Na, total ash, lignin, silica, hemicellulose and cellulose were selected as indicators of grass forage quality. Samples of matured grass (n =18) were collected from three *Imperata cylindrica* dominated experimental sites in December. The locations sampled in December were resampled in February and April on cut/unburned, cut/burned and uncut/burned sections of the grasslands.

Repeated grass sampling at 12-day intervals was done for three months on four locations previously cut and subsequently burned, to study the temporal effects of cutting and burning on grass quality.

Axis Deer Selection Experiments

The numerical response of axis deer to cutting and burning was studied by first cutting a 2.7 ha grassland and then burning the entire grassland 30 days after cutting. Deer densities were recorded daily for about two months after the burning started.

Spatially mixed uncut/unburned, cut/unburned and cut/burned experimental plots were used to record axis deer treatment preferences.Twelve different experimental plots were marked out on a 124 ha grassland to study deer selection of plots burned at different times during the dry season. Deer numbers on the different plots were recorded regularly (n = 20) at sunset for about three months.

Axis Deer Spacing Behaviour and Habitat Use

Seasonal habitat use and movement patterns were studied using ratio-instrumented animals. A total of 17 animals were radio-collared and 1921 female and 605 male locations were obtained during a 2-year study period.

Alternative Sources of Minerals

Soil samples from 15 mineral licks were sampled and analysed for extractable P, K, Mg, Ca, Na and S concentration and pH. Sixteen control soil samples from sal (*Shorea robusta)* forest, riverine forest and grasslands were also analysed for the same mineral elements. Wildlife use of the soil licks was recorded during two 10-day periods in the dry season.

Aquatic plant samples eaten by barasingha were sampled during dry season and analysed for N, K, P, Ca, Mg, Na, lignin, silica, hemicellulose and cellulose. The contents of the aquatic plants were compared with those of three dominant species of terrestrial grasses-*Imperata cylindrica, Vetiveria zizanoides* and *Saccharum spontaneum*-which were collected in the cool-dry season, the hot-dry season and the monsoon.

FINDINGS

Both the herbivore selection pattern and forage quality analysis showed that the present practice of cutting and burning has positive effects on the grass pasture quality. However, in the period after grass resprouting the grass quality was gradually reduced and higher densities of axis deer were found on areas burned in late February compared with areas burned six weeks earlier. Furthermore, on an annual basis axis deer used the grassland preferentially in February, March and April.

The grasses were chronically low in Na. In managing the park, soil licks and sites with aquatic vegetation need to be given attention. Both the licks and the sites with aquatic vegetation may be important in sustaining high populations of wildlife in this area. Present government plans to build a large hydroelectric-power plant and an irrigation channel upstream from the barasingha range in the Karnali River accentuate the need for protecting the aquatic plants in this area. Changes in the Karnali river flow may adversely affect the aquatics and subsequently the small remnant population of the endangered barasingha.

RECOMMENDATIONS

Based on the above findings, it is suggested that evenly distributed patches of grassland covering about 50% of the total grasslands should be burned in early January following the 2-week grass cutting period. Remaining grass patches should be burned in late February and March for the provision of high quality forage towards the end of the dry season.

Further studies are needed to determine the long-term effects of fire both on the nutritional qualities of the grasses and on successional patterns.

COMMERCIAL NON-TIMBER FORESTRY IN CENTRAL NEPAL: EMERGING THEMES AND PRIORITIES

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ABSTRACT

Quantitative and qualitative data on commercial non-timber forestry, with the focus on medicinal and aromatic plants, were collected in Gorkha District. The research emphasised: (i) analysis of resource base related issues; (ii) analysis of trade and marketing issues; (iii) analysis of policy and legislation issues; and (iv) evaluation of the impact of trade on the resource base.

A general model describing the commercial non-timber forest product (NTFP) resource base in Central Nepal was developed. It allows extrapolation of experiences and research results; provides a basis for making stratified sampling of villages; and makes it possible to integrate commercial NTFPs into rural development planning.

Average daily income from collection of commercial medicinal and aromatic plant was competitive with other income generating activities and constituted an important part of annual income of poor households' in the northern and middle parts of the district. There was well-established market for a wide range of products and the demand was generally increasing. Analysis of marketing margins and price data indicated that there was limited market information and poor market integration for medicinal and aromatic plants.

A review of forest and forestry related policies and legislation revealed that policies have not been translated into legislation. The impact of the new forest legislation on rural collectors was found to be diametrically opposed to stated national policy objectives. It was found that fundamantal changes are required to bring forest legislation in line with policy objectives. However, Such changes require that the views of collectors be reflected in final legislative decisions. However these are likely to take place only in the long term.

Using available data on market values of commercial NTFPs and the information on their accessibility and management, a general model for evaluating the sustainability of their utilisation was also developed. It has been argued that utilisation is generally sustainable and does not endanger any species. However, local population may diminish, and there is a need to discuss the desired and acceptable levels of sustainablity in Nepal.

PROBLEM

Forestry outputs could play an important role in the effort to sustain and improve livelihoods of rural people in Nepal. As the new "people centred" forestry paradigm is becoming more established in Nepal, increasing attention would be paid by policy makers to the use and potentials of NTFPs. The limited number of past studies on NTFPs focussed on their subsistence uses, traditional knowledge of medicinal plant use, and their botanical identification.

The only commercial NTFP to be studied in any detail was the bark of Daphne spp., used for the production of handmade paper. Today, the main focus is on commercial medicinal and aromatic plants. Nation wide research commenced only after three important publications appeared in 1993. Since then a number of workshops and seminars have been conducted and investigations are currently underway at many locations throughout the country.

Despite the increasing number of research projects and the growing number of publications, there is a general shortage of studies on NTFPs in all main areas: from subsistence uses to characterisation of overseas markets and final consumption patterns. Attempts are made to co-ordinate NTFP research at the national level. This is encouraging. However, the currently available information is generally of low quality and cannot be relied upon for generalisation. There is a severe lack of both qualitative and quantitative data to guide policy decisions.

METHODOLOGY

Field work for the study was underaken in Gorkha District in the central hills and mountain region of Nepal. Data were collected through interviews, direct observations and literature review. Mainly some 1,000 semi-structured interviews were conducted with collectors, farmers, village traders, government officials, NGOs, etc., to determine issues ranging from village types, collection areas and seasons, economic importance of vegetation types, management and utilisation systems, and marketing decision-making to legislative development. Inteviews and obsevations were made in all the seven VDCs in the northern part of the district, all six VDCs in the middle part, and in 22 of the 56 VDCs in the southern part of the district. A range of methods were used depending on the data required and the setting of the interviews: structured questionnaire; semi-structured open-ended interviews; topic-focused interviews; and informal conversational interviews.

Interviews were conducted with individuals (including key informants), focus groups and communities. Interviews were undertaken in all subsitence production type villages and all vegetation types were visited. Harvesting was studied by active participation in discrete and incidental collection trips. Specimens of commercial medicinal and aromatic plant species were collected and taxonomically identified. Regarding vegetation analysis, the Braun-Blanquet method-used in similar areas of the Nepal Himalaya - was adopted here to enable comparisons.

The collected species were followed from harvesting sites to the wholesale markets in India. But the trading links beyond the main wholesale market in Delhi, and abroad,could not be investigated. Structural and functional aspects of the NTFP trade were investigated by conducting monthly interviews with 12 local and regional traders. Prices were monitored at the three main road head towns and at the wholesale and retail markets in the Terai. During the same period prices were collected in Delhi, the main Indian wholesale market for medicinal and aromatic plants from central Nepal.

FINDINGS

Analysis of resource base related issues

A general model describing the commercial NTFP resource base in central Nepal was developed. It provides a basis for: (i) integrating commercial NTFPs into rural development

activities from the initial planning phase; (ii) making stratified sampling for village level investigations; and (iii) extrapolation of experiences and research results.

A number of species which are commercially utilised elsewhere in Nepal, are found in Gorkha District but are not presently harvested and sold. The reasons for this appear to be: (i) the lack of informaion about the valuable species of Nepal; (ii) the collectors can not recognise species in the field; and (iii) the returns on labour are perceived to be unsatisfactory.

Analysis of trade and marketing issues

Average daily income from commercial medicinal and aromatic plant (MAP) collection is competitive with other income generating activities. It constitutes from 15 to 35 % annual household income of the poor in the northern and middle parts of the district. Commercial MAP collection is generally not important in the southern part of the district. Collection is undertaken in accessible forests and pastures. The density of commercial MAPs is high and their availability so reliable that an extensive harvest has been collected annually for generations. In general, dwindling supplies are not seen as a major problem by collectors or traders.

There is a well-established market for a wide range of MAP products and the demand for these products is generally increasing as the harvested and dried MAPs move southward from the forests and pastures in the Nepal Himalaya to the main markets in Indian Gangetic plains. Approximately 98% of the products are exported unprocessed to India. The main actors in the trade are collectors, road head traders, Terai wholesalers and Indian wholesalers. An analysis of profit margins and price data indicates that MAP markets are imperfect: there is limited market information and poor market integration.

Analysis of policy and legislation issues

A review of forest and forestry related policies and legislation reveals that policies have not been translated into appropriate forest laws. The impact of the newly adopted forest legislation on rural collectors is diametrically opposed to stated national policy onbjectives, even to the extent, that the new forest legislation leaves collectors worse off than the previous forest legislation. The legislation acts to the lowering detriment of hill and mountain farmers by collector margins, reducing competition among wholesalers and encouraging corruption. Some of the main problems related to NTFP in the current legislation can be traced back to at least the 19th century.

Evaluation of the impact of trade on the resource base

The main findings of the study on the evaluation of the impact of trade on the NTFP resource base were: (i) no species are threatened with extinction because of commercial collection as botanical extinction also means economic extinction; (ii) if returns from collection of a species remain competitive over a period of time and availability decreases the species is subjected to domestication and/or cultivation; (iii) there is no pattern of massive collection before seed dispersal; and (iv) there are only some examples of local resource depletion in case of *Swertia chirayta,* and possibly *Paris polyphylla* and *Valeriana jatamansii.*

RECOMMENDATIONS

(1) To increase the collectors' net profit margins, it is necessary to increase competition in the market by increasing the number of road head traders and Terai wholesalers. The key to this is improved information.

(2) Priorities should be given to establish a system for dissemination of informaion on current market prices, research, and investment in physical infrastructure. Establishing credit facilities, encouraging and helping road head traders to establish direct export link in India and reviewing the royalty system are also important.

(3) All government bans imposed on collection, trade and export NTFP should be reviewed. All bans deemed necessary should be justified. The large Indian market and overseas markets should be investigated for future development of the NTFP trade.

(4) To bring forest legislation in line with policy objectives three fundamental changes pertinent to NTFP are required: (i) removal of legal barriers to collection and transport which would have an immediate and substantial impact on the collectors' income; (ii) changing the framework for community forestry including recognition of indigenous management systems and traditional harvest and tenure rights, and to allow communities to use their forests and pastures for income generation activitivities; and (iii) recognising the role of markets and focusing future government interventions on providing marketing information and infrastructure (as opposed to direct intervention in the NTFP markets).

(5) NTFPs must be placed higher on policy makers' agenda. This is a demanding task and entails: (i) documenting the importance and potentials of NTFPs and (ii) development of a policy making process which allows for the views of the collectors and traders as well to be presented and reflected in final decisions.

(6) Integration of the views of collectors into the policy process and legislation is possible in two ways: (i) if current policy makers be they governmental or non-governmental, start to genuinely represent the collectors, or (ii) by developing tools for community participation in the policy decision-making process.

(7) As commercial collection of NTFPs is highly unlikely to lead to extinction of the species, the relevant issues are the degrees of economic and ecological sustainability. There is a need therefore to discuss about the desired and acceptable levels of sustainability in Nepal.

(8) The present "centralised approach" to NTFP utilisation should be replaced with a "local approach".

(9) The emerging "people centred" forestry paradigm in Nepal should be expanded to include NTFP utilisation: restrictions, regulations and controls should be replaced with deregulation, decentralisation and local participation.

FURTHER RESEARCH

There is a need to study the following areas of importance to utilisation of the NTFP resource base:

(1) NTFP distribution, abundance, and levels of sustainable yields,

(2) NTFP related vegetation community structures and dynamics,

(3) Characteristics of indigenous NTFP management systems,

(4) The effect of commercial collection and non-NTFP management systems, including activities such as grazing and fire on NTFP utilsation, and

(5) Investigation of the NTFP marketing chain from the Indian wholesalers to the final consumer.

EFFECTS OF ALTITUDE ON THE GROWTH AND DEVELOPMENT OF SAPLINGS OF THE FODDER TREE *ARTOCARPUS LOKOOCHA ROXB.*

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ABSTRACT

The growth responses especially of the leaf-yielding components, of 1-year-old saplings of *Artocarpus lakoocha* to environmental conditions prevailing at 1550 m, 1200 m and 800 m alitude in Nepal were investigated under field conditions. The feeding value of leaves and the changes which occurred during the lopping season at the three different altitudes were analysed.

The first experiment studied the height, stem diameter, shoot growth and changes in leaf number over two years at the three altitudes. The plants developed faster at the lower, warmer altitudes and averaged 3.3 m in height at 800 m as compared to 1.4 m at 1550 m by November 1982. The rapid growth and leaf production in the pre-monsoon period were positively correlated with the temperature. There were significant differences in leaf number ($p<0.05$) with higher values being found at 1200 m and 800 m altitudes. The period of stem diameter increase was 5 months longer at 800 m than at 1550 m.

The second experiment consisted of pot trials lasting 8 weeks during the monsoon period. The plants were grown using soils from each of the three altitudes.The objective was to test assumptions that the soil conditions were comparable at all three altitudes and that growth of the young plants occurred also during the monsoon period. The cumulative values of the plant growth did not show significant differences ($p>0.05$) between the altitudes. Soils from 800 m tended to give higher growth rates than did soils from the other two altitudes. Growth continued during the monsoon season.

The third experiment was conducted to investigate the leaf yield of harvested trees and the feeding values of their leafs during the lopping season in winter at all three altitudes.

The leaf DM yield per tree and season varied between 34 and 40 kg. The DM (39.5 - 44.6%) and the feeding value of the tree fodder were affected by altitude but remained remarkably constant during the lopping season at each site. The CP content varied between 122 and 131 g/kg DM and seemed to remain generally low during the lopping season. The results supported the farmers' claims that the leaves of *Artocarpus lakoocha* have food value during the winter season.

PROBLEMS

The farmers of Nepal discovered long ago that the shoots, leaves and young twigs of trees in the farmlands and forests of the hills and mountain regions are the most important sources of green fodder for their ruminants during the 6-8 months dry period in winter. Many farming households have less than two trees per animal and so lack green leaf fodder for the dry period.

The popularity of fodder tree species varies from one area to another. Of over 100 different species of fodder trees, *Artocarpus lakoocha* is the one used by most farmers because its leaves are relished by cattle and buffaloes.

The farmers propagate this species *in situ* but not very intensively. Much effort is spent on its protection. Distribution of seedlings is organised by government nurseries or community. The success or failure of establishing *Artocarpus lakoocha* fodder trees within the planting programmes of the government and the communities in the varying topography of the Nepalese farmlands depends upon the knowledge one has of the environmental requirements of the species. Plants grow faster and better when planted under favourable conditions. The prevailing fodder problems would require a widespread planting in the areas where ruminants are concentrated.

Information is lacking on the optimal defoliating time in relation to the foliar nutrient composition. Very few studies have been carried out and only cytological and timber silvicultural aspects have been considered up to now. This might well be the first attempt to study the species as a fodder tree.

OBJECTIVE

The major objective of this study was to study the effect of altitude on the growth and development of the fodder tree *Artocarpus lakoocha* Roxb.

METHODOLOGY

Following methods were carried out for the following three experiments:

Experiment I: Growth and development of *Artocarpus lakoocha* saplings at three different altitudes.

Seed provenance for the nursery stock was from a single tree in Kunyel village at 900 m altitude on a southern slope. Fruits were collected on 16 July 1979. Planting took place on 2 and 3 July 1980 at all sites. The plants were about 315 days old at the time of transplanting. Measurements of the saplings were first made under dry weather conditions at the beginning of November 1980, and continued till November 1982, at intervals of 28 to 32 days.

The basal point for the measurement of height was 607 cm above the hypocotyl. During the 1980-81 growth period the numbers of shoots were counted. At the end of the experiment crown diameter were measured. The saplings were defoliated and samples of 100 leaves from each site were taken for the determination of the weight and the specific leaf area.

Multiple regression of leaf area with all the combinations of length and width, their squares, and the product of length and width were calculated for the 100 leaves. A very good fit (r^2=0.96) was obtained.

At the end of the experiment, the saplings planted in 1980 were cut at the fixed base level point. Half of the trees were cut for the sampling of the dry weight. The dry matter was determined after drying the air dried leaf samples for 4 hours at 103°C. The air-dried leaf material was also

chemically analysed according to the Weende Method for determining crude fibre and crude ash contents at the Institute of Animal Nutrition, ETH.

The data were analysed at the Computer Centre (IBM 370) of the University of Zurich using its Statistical Analysis Programme (SAS Institute Inc., Cary, N.C., USA).

Experiment II: Effect of soil the three different altiudes on he pheno-morphological changes of *Artocarpus lakoocha* spapliings

Soil was collected from each site from a depth of 0-20cm and placed in clay pots of 15 to 16 litres. The soil texture was determined by Soil Test and Civil Designs (P) Ltd, Kathmandu, according to the Jackson Method of USA. The determination of soil pH, P and K was done in the laboratory of the Institute of Crop Science, ETH, Zurich.

Uniform seeds were obtained from fruits of a tree in Bhalukhop at 1270 m collected on 15 July 1981. The seeds were sown on the same day. Significant differences ($p<0.01$) were noted only between the east plot at 1200 m and other sites. The increase in plant weight was noticeable although the differences between altitudes were not significant. Although the total number of leaves produced was not significantly different ($p>0.05$) between altitudes, slightly higher values were found at the lower altitude. The production of leaves under high temperature conditions and heavy rainfall at 1550 m and 800 m might have been less affected by the rain on the sandy loam soils at these sites.

The *Artocarpus lakoocha* saplings shed leaves during the monsoon period also. Although the plants at the highest altitude tended to loose more leaves than those at the lower altitudes, the difference between the sites were not significant. However, the plants at the highest altitude lost more leaves than they produced during the period of observation.

There was no interaction between the soil types and the altitudes during the overall growth period. The heavy rains had almost no effect despite, the wet soil. The acidic soil did not seem to be limiting to the saplings. The effect of soil on the plant growth was not significant ($p>0.05$) within a site.

Experiment III: Leaf yield and nutrient contens of the the leaves of harvested Artocarpus lakoocha fodder trees.

Trees were selected for harvesting on he basis of the following veiteria:

(a) Availability of the trees for the experiment
(b) Proximity of the trees for he experimental fields of experiment I and II
(c) All the trees in he same lopping cycle (once a year) and season, in order to obtain comparable data between the sites, and
(d) The size and age of the trees which would be representative of the trees being utilized by the farmers in the area.

Leaf samples were collected, at each sampling 5 to 10 alternating leaves being removed. The chemical analysis of the leaf samples (leaf laminae and petioles) was done in the Laboratories of the Institute of Animal Nutrition ETH. The nutrient contents were estimated according to the Weende Method.

FINDINGS

A rapid extension of growth from April to July 1981, with a peak just prior to the intensive monsoon rains, showed strong positive correlation with temperature ($r=0.89$, $p<0.01$). This trend was supported by the growth at 1550 m and 1200 m from April to August 1982. The saplings showed a constant rate of growth also during the monsoon period.

An increase in diameter occurred over a 1-month period at 800 m as opposed to 3 months at 1550 m. Growth criteria important for high leaf yield radial growth of the stem is one criterium for judging plant growth. The high growth rate of the stem diameter could suggest that the plants at lower altitudes might produce many more leaves.

The shoot development is the most important leaf yielding criterium for the assessment of a fodder trees species. The distance between the lateral branches on the main stem increased with the altitude of the site. Increment in height required to produce lateral shoot was almost constant in both years. The rate of shoot production and the number of shoots were the best criteria for assessing the growth at a particular site. The production of all categories of shoots during the 1981-82 period showed that the plants at 800 m were by far the most productive.

The saplings at 800 m produced over 71% more leaf dry weight than those at 1200 m. The almost total refoliation which occurred at the time of the monsoon rainfalls probably required ready availability of soil nutrients. However, judging by the number of leaves produced and retained, the lower altitudes (1200 m and 800 m) seemed to be more favourable for the saplings. Response of growth criteria to growth period and altitude, the extension growth of the plant and the increase in the stem diameter reached higher values at the lower warmer altitudes.

Leaf appearance was positively correlated with temperature. From April to July 1981, 79% of the variation in the rate of leaf appearance could be explained by the variation in temperature. Continuous leaf fall observed during the monsoon seemed to be due to high humidity and low radiation. However other endogenous factors could also have been responsible for this.

Leaf dry weight appeared to depend primarily upon the number and length of the shoots produced which seemed to be promoted by spring rains and higher temperatures.

Regarding the effects of environmental factors on the growth of saplings and older trees, the saplings grew faster at the lower and warmer altitudes. The decline in the rate of growth seemed to be affected by the reduced radiation during the rainy period starting in July. The pattern of growth (higher growth rate at lower altitudes) changed during the second year. The experimental results suggested that the soil at 800 m could be more fertile. The growth of the few larger trees showed much variability, probably related to different age growth history and soil conditions.

The soils down to a depth of 70 - 110 cm were very acidic (pH 5.2 - 5.7). This shows that the *Artocarpus lakoocha* species is tolerant of acidic soil. For this reason the growth at higher altitudes was slower and the production of leaves lower than at lower altitudes. Thus the planting programme be limited to sites below 1500 m.

Yield and nutrient content of the leaves

The need for more leaf fodder could be met by planting the species at lower altitudes and by harvesting the leaves of harvestable trees only. This should be done by hand since cutting is

harmful to the trees. Another possibility would be to harvest the leaves during December, when the weight of the individual leaves is high. This could be limited to areas where other sources of green fodder is available to the farmers.

There were different responses of the plants in the three experiments to the effects of altitude on leaf yield: The leaf yield was higher at the lower altitudes, both for saplings and for larger trees, depending on their size. The leaf yield could have been partly affected by the soil quality which seemed to be better at 800 m. Growth of all leaf-yielding components of the saplings was faster at lower altitudes. DM remained high (39-45%), the leaves of the young saplings being 4% higher than the leaves of the harvested trees.

Organic nutrients and mineral content

The crude protein (CP) values of the saplings were 20% higher that those of the leaves of the harvested trees. The CP content could meet the requirements of cattle heavier than those usually found in Nepal. The mean crude fibre content of leaves from older trees was about 10% higher than that of the leaves of saplings but was lower (<220 g/kg DM) than that of *Leucaena* leaves.

The mineral requirements of cattle in Nepal are probably lower than for cattle bred for commercial purposes in other countries.

The comparison of *Artocarpus lakoocha* tree fodder with herbage or grass fodder used in intensive animal husbandry systems would be of little relevance to conditions in Nepal, where the amount of tree leaves fed depends on the size and number of trees, the quantity of leaves available and the number of cattle to be fed. These leaves are sometimes the only green supplement available to the cattle and apparently enhance the intake of fibrous roughage.

The leaf fodder could be better judged within the framework of the total feeding and animal husbandry system. The values given in the table need to be applied cautiously in any wider context because of the limited number of trees per altitude considered. They may, however, suggest that this species could be an important natural resource which is not being adequately utilised.

AN INVESTIGATION OF AN INDIGENOUS KNOWLEDGE SYSTEM AND MANAGEMENT PRACTICES OF TREE FODDER RESOURCES IN THE MIDDLE HILLS OF CENTRAL NEPAL

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ABSTRACT

The main objective of this research was to investigate attributes of the indigenous knowledge system surrounding the management, cultivation and use of private tree fodder resources in one village area of one panchayat in the middle hills of central Nepal. Associated with this was the investigation of a knowledge system used by farmers in the study area to classify and evaluate animal fodder.

For the research a multi-method approach consisting of five distinet methods was used to gather different, but related, types of data and information. The methods used were: participant observation, use of a formal survey questionnaire, tree inventory, informal interviews and use of the repertory grid technique and trial test.

This research has demonstrated that there is much more to the collection, management, and use of tree fodder than may meet the eyes of outsiders. Furthermore, the research has shown that knowledgeable villagers can efficiently evaluate the relative quality of various fodders and provide good feed to their livestock by using three main tools:

1) their extensive knowledge about individual fodder species;

2) the indigenous system of classification and evaluation and

3) their skilful qualitative analysis of available tree fodder species.

The research has provided another example of how people develop and use complex cognitive systems to impress order on the apparent disorder of nature Recommendations were made based on these findings.

PROBLEM

Tree fodder is an integral component of Nepalese farming systems and can be considered a specialised use of forest and agricultural resources. Understanding the dynamics of indigenous management systems and traditional agroforestry practices of farmers in Nepal is an area of research that can potentially benefit natural resource development efforts. It is assumed that farmers themselves have such knowledge, and that gaining an awareness and understanding of this knowledge and incorporating it into programs that aim to alter land and resource use and management practices, will greatly enhance the chances of success of such programmes. Therefore, research on indigenous knowledge systems of tree fodder management and use, and

specifically those attributes of management encompassing cultivation of fodder trees on private land, is warranted.

This research arose from an intuitive belief that subsistence farmers living in the middle-hills of Nepal have developed systems of knowledge surrounding their use cultivation and general management of private and public tree fodder resources. This assumption was, and still is, grounded in the belief that people know, in culturally specific and appropriate ways, a great deal about resources they depend on for their survival. However, this intuitive belief was not supported by a search of the literature on this topic specific to Nepal, beyond anecdotal accounts and hints, concerning the existence or character of an indigenous knowledge system surrounding tree fodder resources.

Due to the high degree of uncertainty associated with this research, and a lack of supporting literature specific to tree fodder in Nepal, a flexible open framework of strategies, hypotheses and methods was initially developed. As learning about the community and their fodder tree resources progressed, gaps in this open framework were filled, and the flexible structure of the research was modified and solidified. A gradual developmental and iterative process evolved between the initial research proposal and what was learned about the community and tree fodder.

This research can be seen as involving two broad, interrelated problems. First, there was the initial problem of formulating what eventually became the research methodology. Second, there was the stated research problem of learning about the indigenous knowledge system for tree fodder resources. As such, the progressive and iterative developmental process that resulted in the final research structure is considered as one of the major personal achievements of this research.

Its primary purpose was to investigate attributes of the indigenous knowledge system surrounding the management, cultivation, and use of private tree fodder resources in one village area of one panchayat in the middle hills of Central Nepal. Associated with this was the investigation of a knowledge system used by farmers in the study area to classify and evaluate animal fodders. Additionally, socio-economic variables were investigated. The following is a list of the main questions that were addressed:

1) What do farmers know about tree fodder and the management of this resources?

2) Is there a system for the classification and/or evaluation of tree fodders and, if there is, what is the character of this system?

3) What are the stated perceptions about cultivation, use, preference and management of tree fodder resources? What actual actions are taken by people and social groups to manage fodder tree resources?

4) Who, in farming households, is primarily responsible for the various aspects of management of private fodder trees, and how are management activities distributed among household members?

5) What variables influence management activities, and what is the nature of the relationships between these variables and private fodder tree management?

METHODOLOGY

Addressing these questions and developing an understanding of indigenous knowledge systems surrounding tree fodder required the use of a multi-method research approach composed of five distinct methods. The first of these methods, participant observation, incorporated daily observations of village life with informal opportunistic discussions with residents of Salija village. This offered the principal investigator opportunities to experience the daily routine of village life. The second method involved the use of a formal survey questionnaire that measured socio-economic variables at the household level. This was closely associated with the third method, an extensive inventory of trees growing on land owned by the households that participated in the survey. The fourth method involved the use of an informal interview/discussion guide that gave structure to informal interviews with specially selected village residents. The final method made use of the repertory grid technique and trial test. This technique provided data that was used to formulate a description of a system of classification and evaluation of fodder types used by residents of Salija.

This multi-method approach facilitated the collection of different types of data and information essential to achieving the research goals, and it helped to overcome many of the problems endemic to cross-cultural research. Even though each of these methods was applied individually, they were developed and used in an integrated manner. Furthermore, the resultant data were analysed both individually and collectively.

Much research in both natural and social sciences is designed around the "received view". This rigorous process has proven successful for many research problems, especially those that emphasise scientific hypothesis testing.

Due to time and resource limitations, the study focused on only three (Worda 2, 6 and 7) of the nine wards in the panchayat.

The accuracy of this subjective judgement was validated by a reconnaissance of all nine wards of the panchayat, and through the results of the private tree inventory.

Lists of all households present in each of the three wards were prepared by each ward chairman. These lists consisted of the names of each head of household, the household head's gender, an official estimate of the amount of land owned by each household, and the household's caste composition. Potential consultants for the private tree inventory and household survey were selected randomly from each ward list. Approximately 25 % of the households from each ward were selected.

FINDINGS

The effect of land size on tree cultivation was most obvious on farms larger than 1.5 ha in size. Households with large land holdings have intensified tree planting with the aim of becoming independent of public sources of fodder and fuelwood.

Tree cultivation strategies vary between households and are influenced by people's perceptions about how best to use their land. As such, it is important to test assumptions and generalisations before using them to make planning and research decisions.

Five major species: *Ficus nemoralis* (Dudhilo) 21%; *Prunus cerasoides* (Painyu) 15%, *Neolitsea umbrosa* (Phe Phe)14%; *Buddleja asiatica* (Dhurse) 12%, and *Pinus wallichiana* (Thingre Salla) 9% constitute 70 % of all trees cultivated on private land.

Cows and buffaloes are the dominant livestock in Salija with an average of 5.6 livestock unis (LSU) per household.

Trees are not cultivated randomly on household land. Excepting fodder and fruit trees, most tree types are almost exclusively planted on marginal land, grassland, and along the sides of streams and rivers. Fodder trees are also most often cultivated on these types of land, but they are also cultivated on the terrace risers of non- irrigated agricultural land and on land surrounding household dwellings. Fruit trees are most commonly cultivated around household dwellings and along terraces of non-irrigated agricultural land.

Within the domain of tree and tree fodder knowledge, there were both unique and common elements of knowledge characteristic of men and women. Women appear to have specific interest in "domestic" fodder trees and trees that provide good quality fodder and fuelwood. Men appear to have specific interest in "forest" trees, and trees that produce winter fodder, fodders that maintains the health of livestock, and fodders that improve the production of ghiu. Alternatively, bothmen and women appear to share knowledge and perceptions about other aspects of tree fodder relatively equally.

Men appear to have greater responsibility for collecting tree fodder from public forests, while women appear to concentrate their fodder-gathering efforts from trees cultivated on private land.

There was a significant correlation between the number of fodder trees and the number of LSU per household. However this correlation was not as strong as was anticipated, and therefore, it is suggested that other variables are also important in explaining private fodder tree cultivation.

There was a significant correlation between the number of fodder trees per household and the size of land holding. This correlation is much stronger than that for fodder trees by LSU. However the correlation between the number of fodder trees and non-agricultural land is less stronger than that between fodder trees and agricultural land.

Household size is not significantly correlated to the number of fodder tees cultivated per household. This suggests that household labour is not a very important variable in terms of the number of fodder and other trees cultivated on private land. However, this same relationship probably does not exist with respect to collecting tree fodder from public lands.

Households that do not have livestock still cultivate fodder trees. One reason for this is the trading of tree fodder for dung.

It appears that the planting of fodder and other types of trees has increased over the last 12 years as compared to earlier years. This increase in planting appears to be associated with changes in the availability of forest resource, changes in household labour, presence of village-oriented nurserirs, and strong local leadership that promotes private tree planting.

There is a tradition that supports the cultivation of trees on private land. It appears that this tradition has been strengthened by environmental, social, economic and political changes

occurring in Salija and elsewhere in Nepal.

The most commonly reported reasons for planting trees on private land were: for fodder; fuelwood; and soil conservation. Contrary to other research, the planting of trees for fruit is not a very important reason.

For the study area as a whole, people interviewed reported that 86 % of the seedlings planted the previous year survived. The distribution of survival rates across the three wards suggests that environmental and biophysical variables are important for seedling survival.

Before there was a local nursery, tree seedlings were collected from the forest and/or from private land. Now, however, the nursery is the dominant supplier of tree seedlings. This is primarily due to the fact that seedlings grown by the nursery are trees requested by residents of Salija.

A total of 127 different species of trees were recorded as being cultivated on private land. The diversity of species varied between wards, with 112 species recorded in Ward 6, 61 in Ward 7 and 56 in Ward 2.

The evidence suggested that approximately 34 species have recently been added to the planting stock of trees cultivated on private land in Salija but that approximately 15 species present in the older age class were not recorded in the younger age class.

The two previous findings indicate that farmers are adapting their tree planting strategies in response to the availability of new species, to changes in supply and demand for different tree based resources, and to changes in social, economic and political environments in Salija and elsewhere in Nepal.

Residents of Salija have developed a sophisticated knowledge system for the classification and evaluation of tree fodders. This system is broader than a taxonomic system for tree species. It is used to help residents determine which fodder trees to harvest and how to formulate feed for their livestock from a changing stock of fodders to best achieve desired production goals.

Woody vines were found to be an important source of "tree" fodder for the residents of Salija. Also; the concept of "tree fodder" as commonly used both in Nepal and elsewhere was found to be much narrower and exclusive than that used by residents of Salija. The data suggested that local use of the term dale ghass ("branch grass" or tree fodder) covers all dicotyledonous fodder and bamboos while the term bhuin gass ("ground grass") covers all monocotyledonous fodders.

Field observations indicated that residents experiment with different methods of tree establishment. For example, a very effective indigenous technique for propagating *Ficus nemoralis*, an important and dominant tree fodder species in the middle hills of Nepal, is used by farmers in Salija. Because of the palatability of this species, grazing animals make it very difficult to propagate, especially on public lands. To overcome this problem, farmers in Salija use *Neolitsea umbrosa*, a small bushy tree that grazing animals ignore, as a nurse plant for *F. nemoralis*. From field observations and according to farmers who use this technique, companion planted *F. nemoralis* grows more quickly than trees grown without *N. umbrosa*.

RECOMMENDATIONS

This research, as with most other field work, led to the formulation of more questions than it answered, and there is an abundance of research "fodder" for years to come. One major area for further research is to learn more about the character of the fodder evaluation and classification model. Now that the chiso-obano construct has been identified it can be used in a repertory grid to test a greater number of tree fodder species against this attribute.

Additionally, other types of fodder could be tested against this construct to determine the extent of its "range of convenience". In a similar manner, exotic species of fodder-producing trees could be evaluated by villagers against the chiso-obano construct to see how unfamiliar species are evaluated.

Furthermore, research could be carried out to determine if this fodder evaluation model is used by other population groups across Nepal and South Asia. By testing this model across a larger population one might learn of variations, extensions, and limits of its applicability. It would also be interesting to learn if there are variations in its use across different age groups within populations. It could also be used to refine our understanding of gender-related differences in tree fodder evaluation. At a broader level, the repertory grid method could be used across a larger population sample in the hope of clarifying relationships between other verbal categories identified in this study.

It might also prove fruitful to test a set of valuable tree species using the repertory grid method with groups of forestry professionals and village farmers. From this, one might learn how these two populations differ with respect to ways that they evaluate and classify different fodder tree species. This might also indicate how different terms used to discuss trees and fodder are interpreted and used by the two groups. Results from such research could then be used to improve forestry and agricultural education programmes.

Research using this construct and the repertory grid method could also be used to evaluate changes in chiso-obano characteristics of a select number of tree fodder species across time. This research could then be matched against biochemical analysis of evaluated samples in an effort to determine any chemical or biological basis for fodder being evaluated as chiso or obano. Such research might also help identify properties of different fodders that positively and/or negatively affect milk and butter fat production and the health of livestock.

Researchers and planners around the world have shown keen interest in developing models to help explain current and changing land-use strategies and farmer decision-making systems, and then to plan development and extension efforts to alter these strategies. It appears that much of this model building effort is premature for many areas of the world. Before such macro-level models are constructed it seems appropriate for more basic research to be carried out at a more micro level. To this end, there appear to be three major interested gaps in the knowledge base needed to formulate such models: 1) many of the important variables required for model development have not yet been well defined; 2) as such, there is not a clear understanding of the data required to formulate these variables; and 3) research methods designed to efficiently and accurately gather this data are also still poorly developed.

To remedy this problem requires research to: determine what variables need to be measured; develop appropriate scales of measurement; and formulate creative methods to apply these scales.

Not all communities in the middle hills of Nepal cultivate trees on private land as intensively as households in Salija. A comparative study between two communities, one that intensively cultivates private trees and one that does not, might further our understanding of the reasons behind the presence and absence of private tree cultivation. Such a study would need to consider socio-economic, geographic, biophysical, political (local and national), historical, and cognitive variables. It is likely that an interdisciplinary research strategy would also need to be applied.

Research on indigenous knowledge systems has the potential to both help improve our understanding of the complexities of rural farming systems and improve development and extension efforts. The present research has demonstrated that the people of Salija have developed and use a complex cognitive system to help them cope with the management of tree fodder. It is likely that similar cognitive systems are used by other social groups to assist in the management of natural resources that are critical to survival. As such, this research may stimulate other research designed to refine our understanding of knowledge systems and natural resource management. Closely associated with this is the realisation that such research can also further our understanding of the social ecological nature of human kind and our interactional relationship with our environment.

VEGETATION OF STABILISING AND ERODING SLOPES IN EASTERN NEPAL

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ABSTRACT

The study, carried out in the eastern part of the middle hills of Nepal, deals with plant regeneration and succession on unstable slopes(natural or man-induced) and their possible stabilisation. Special attention is paid to the erosion problem of this region.

In order to get ideas about regeneration and development of the plantcover, 45 transects were laid through 35 landslides and slopes along a road side, at altitudes ranging from 1000 to 2600 m. The transects were divided into sections according to the different phytosociological conditions. Data were recorded after the monsoons of 1983,1984 and1985, at the end of the dry season in 1984-85 and at the start of the monsoon in 1984-1985. The post-monsoon data were usually the richest in species, so they are used for the evaluations of development and possible stabilisation in the first place. The records from the dry season and early monsoon gave additional information on the findings. Due to the wide altitudinal range and the other environmental factors, the plots were divided into four groups.

There is a positive development trend, best expressed in the strongly increasing plant frequencies, especially in the protected plots, and in the noticeable number of shrubs and trees invading the landslide and transition sections. Although it is difficult to state a succession after only three years of observation, the invasion by perennial plants can be interpreted as a sign of succession.

In order to know more about the composition of a possible climax or, at least, of a "stabilised vegetation" comparatively immune to human influences, 13 relatively stable areas were recorded too. They are related to the four groups of the landslides and slopes and helped to interpret the development trends.

Research on erosion was carried out at Dandapakhar and Bonch, the locations of two meteorological stations of the Integrated Hill Development Project (IHDP) of the region. At each site two plots were established-one bare and one covered with plants. The differences between the two plots in run-off and soil loss were evaluated. The erosion of for the uncovered plots proved to be clearly higher than that of the covered plots.

Since it is evident that erosion is reduced by plant cover, every step should be taken to protect, maintain or induce a vegetation cover onus table sites. Various measures were suggested to reduce erosion and to smooth the way for a possible stabilisation of a region.

PROBLEM

Erosion includes all processes that result in the physical wearing down of the surface of the earth. Erosion processes are complex, consisting of"natural" (geological) erosion and "accelerated" (man induced) erosion.

The problem of erosion is especially acute in Nepal for the following reasons:

- Natural erosion rates are very high becauseof the constant tectonic uplifting of the major mountain ranges and consequent downcutting of the river systems. The net result of these unrelenting forces are unstable slopes that cannot maintain their river-canyon form. Natural erosion is characterised by different forms, particularly landslides, slumps, riverbank cutting and gullying.

- Pressure on limited land resources by the steadily growing population results in increased land degradation due to forest clearing, over-grazing, fire and poor maintaining of marginal arable land. The resulting accelerated erosion is mainly characterised by the loss of topsoil through sheet and rill erosion and gully formation.

- Increasing activity in construction work, such as dam and road building, is also an important cause of land degradation. This will grow in importance with the advancing development of the country.

METHODOLOGY

To record the plants 45 fixed transects were laid through 35 slopes and landslides along the Lamosangu-Jiri road. The re-covering by plants was observed over a period of three years and the characteristics of each area were examined. From this information an attempt was made to assess the influence of the different interfering factors: meteorology, altitude, aspect, slope, soil, age of the slope/slide and influence of man and animals.

In addition, at different altitudes a series of surveys was carried out on various relatively stable but not undisturbed types of natural vegetation typical of the region. The floristic composition of the plots examined indicates the possible "climax" to be expected on the slopes in question.

At the same time, special attention was paid to run-off and soil loss in connection with amount and intensity of rainfall and plant cover on steep slopes. The experiments were carried out for one or two rainy seasons at two selected sites typical of the area. On both sites a comparison was made between an uncovered, landslide-like site and a plant-covered site and the results are discussed more generally. The data gained also gave the first information ever collected about rainfall intensity (erosivity), rainfall run-off and amount of soil loss in the project region.

FINDINGS

1) When vegetation cover is damaged or removed, the diverse climate factors affect the soil. The heavy rainfall during the monsoon, with its notable erosivity, is the strongest factor.

2) There is a positive development trend, best expressed in the strongly increasing plant frequencies, especially in the protected plots, and in the noticeable number of shrubs and

trees invading the slide and transition sections.

3) Although it is difficult to state a succession after only three years of observation, the invasion of perennial plants can be interpreted as a sign ofsuccession.

4) Research on erosion showed that the data for the uncovered plots proved to be clearly higher than those of the plots covered with plants.

5) Development of a climax or, on steep slopes rather a subclimax, can obviously take place only on mature soil.Maturing of the soil, which is a long process, is additionally slowed down by erosion.

RECOMMENDATIONS

1) To reduce the high soil loss and run-off in crucial regions, first priority should be given to protecting existing vegetation and to replanting or afforesting bare slopes.

2) So, every step should be taken to protect, maintain, or induce a vegetation cover on unstable sites. This could be achieved by:

- protection of the existing or growing vegetation by fencing or employment of watchmen.
- planting or sowing of adapted gramsses such as *Chrysopogon aciculatus,Cynodon dactylon* or *Pogonatherum* at lower altitudes and *Arundinella hookeri, Hemathria compressa* or *Pennisetum clandestinnium* (African) at higher altitudes.
- planting or sowing of unpretentious and, atleast temporary, preferably unpalatable shrubs or perennial herbs such as *Eupatorium adenophorum, Hypericum cordifolium, Osbeckia nepalensis, Phyllanthus parvifolius, Gonostegiahirta, Polygonum spp.* at lower altitudes and *Artemisia spp., Centella asiatica, Eupatorium adenophorum Lycopodium clavatum* at higher altitudes.
- planting or sowing of pioneer trees such as *Alnus nepalensis* or *Pinus roxburghii* with the aim of inducing the subclimax of forest communities via the state of grassland or shurbland.
- technical stabilisation, which promotes the resettlement by plants and in interaction with them helps shorten the unstable periods of a slope.

FOREST LAND USE DYNAMICS AND SOIL FERTILITY IN A MOUNTAIN WATERSHED IN NEPAL: A GIS EVALUATION

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ABSTRACT

The sustainability of the forest resources in Nepal has been questioned by many authors and agencies. In order to ascertain the significance of the issue, a study was carried out to: (1) document historic changes in forest area and crown cover; (2) determine relationships among soil fertility, site conditions and forest use in order to produce soil fertility maps; and (3)characterise socioeconomic information in relation to forest use. Geographic information system(GIS) techniques were used extensively in the analysis of data and the display of results.

A detailed watershed study was carried out in the densely populated Dhulikhel watershed in the Middle Hills region of central Nepal. Changes in land use were quantified between 1972 and 1990 and the GIS evaluation indicated that there has been an increase in forest area and crown cover. The increase in forest area is mostly in the form of pine (*Pinus roxburghii*) plantations. A substantial area of shrub and grassland has been converted into agricultural land.

Analysis of 136 forest soil samples indicated that the forest soil fertility is generally very poor. The two most critical nutrient problems are low total nitrogen and low phosphorus availability. Almost all of the foliage samples analysed suggest a deficiency in nitrogen and about half indicate a deficiency in phosphorus. Large amounts of foliage and litter are removed from the forests to be used as fodder and bedding for livestock, and this may be leading to soil fertility decline.

Significant relationships were found between soil fertility, site conditions and forest use. Comparisons among aspect and elevation classes show that north-facing and south-facing slopes, above and below 1200 m elevation, have significantly different soil fertility conditions. Soil carbon concentration is twice as high on north slopes at high elevation as compared to south slopes at low elevation. The GIS was used to display the spatial distribution of carbon content. Red soils were found to be very low in available phosphorus compared to non-red soils. The better protected private and government forests had better soil fertility than the less protected community forest areas which indicates that degree of protection significantly influences forest soil fertility.

The study watershed supports a large population of people and livestock which place heavy demands on the forest. These demands are further influenced by ethnic background. Tamang families own less forest land on average than Brahmin and Chhetri families and consequently have greater difficulty acquiring forest products.

GIS was found to be very effective in quantifying areas and distances, integrating biophysical and socioeconomic data and acquiring data to be used in models external to the GIS. A major advantage of using GIS is that the spatial data are stored in a format that allows integration withother databases and facilitates modelling change over time.

PROBLEM

The forests of Nepal are the major source of many vital products such as animal fodder, agricultural compost, fuelwood and timber. A rapidly expanding population is putting tremendous pressures on the forests.Questions are raised relating to soil erosion and the sustainability of soil fertility under conditions of heavy forest use. Little quantitative information is available concerning the changes in quantity and quality of the forest and the associated forest soil fertility.

In 1988, a three-year IDRC-funded research project was initiated to investigate soil erosion, sedimentation and sustainability of soil fertility in relation to different land uses in the Jhikhu Khola watershed in the Middle Hills region of Nepal. The aims of the project were to examine processes relating to soil erosion, sediment transport, soil fertility changes and land-use changes in a quantitative way, using conventional and microcomputer-based Geographic Information System (GIS) methods. As part of the watershed project, this study was carried out specifically to investigate the dynamics of the forests in a 1270 ha test area.

The aim of the study was to evaluate forest dynamics, forest soil fertility conditions and forest use in the Dhulikhel watershed, central Nepal, using GIS techniques.

METHODOLOGY

In order to quantify recent changes in land use in the study area, it was necessary to map the land use at present and at some time in the past.Changes in land use were quantified between 1972 and 1990. The main land use categories mapped are bari, khet, forest, plantation, grass, shrub and other (rocky area, business areas).

Detailed measurements relating to soil fertility, forest condition and forest utilisation were taken at 136 sample sites which were randomly located within the forest, plantation and shrub units of the study area. Over 80% of the forest, plantation and shrub units were sampled.

GIS was used intensively in the analysis of data and the display of results. Laboratory analysis also was carried out on soil, foliage and litter samples. Evaluation of socioeconomic conditions relating to forest use was carried out through household survey and structured interviews.

FINDINGS

1) There has been a significant increase in the area of agricultural land in the 1972-1990 period.

2) There has been an increase in forest area and crown cover during the 18-year period.

3) A significant amount of pine plantation has been established.

4) Soil fertility conditions for all land use types are very poor.

5) Microclimatic conditions have a significant influence on forest soil fertility levels in the study area.

6) Low phosphorus availability is a critical problem on the red soils in the study area.

7) Sal (*Shorea robusta*) stands have the poorest fertility conditions in comparison to pine (*Pinus roxburghii*) and hardwood sites.

8) Land ownership and management have a significant influence on forest soil fertility conditions.

9) There are significant differences among ethnic groups with regard to forest use in the Dhulikhel watershed.

10) There is a major deficit of both fodder and fuelwood in the study area.

11) The GIS technology was found to be very beneficial in the evaluation of forest land use dynamics and soil fertility of the Dhulikhel watershed. GIS is a very dynamic, rapidly evolving tool that offers many possibilities for the analysis and display of spatial data.

PARK-PEOPLE INTERACTIONS IN ROYAL CHITWAN NATIONAL PARK, NEPAL

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ABSTRACT

The following issues of conflict between Royal Chitwan National Park (RCNP) and its human neighbours have been addressed in this research: firewood shortage, shortage of grazing land and fodder, and crop and livestock depredation by park wildlife. In addition, previous estimates of annual grass-cutting in the park have been revised.Out of 16 village units, or 144 wards, in the study area that are within 5 km of the RCNP (total study area about 598 km^2.) 14 wards were randomly selected for detailed investigation. The investigation included interviews of 140 randomly selected heads of households, a livestock census, year-round monitoring of crop and livestock depredation by park wildlife, and monitoring of 11 patches of grassland/savanna (totalling 365 ha) in the nearby park-land to record trespass grazing. In addition, 1818 randomly selected grass-cutters were interviewed to estimate the harvest of resources in the park. Major resources left remaining after the harvest were field-assessed. Information concerning the subsistence systems and ethnicity of local people has been presented. Intensity of livestock grazing in the bordering grassland/savanna inside the Park was found to be 4.1 heads/ha. The livestock biomass was estimated to have been growing by 2.36 %, and a change in the mix of livestock ownership, including an increase in buffaloes and goats, was noticed. Rhinoceros (*Rhinoceros unicornis*) was found to be the principal crop-raiding animal, followed by wild boar (*Sus scrofa*), and chital (*Axis axis*). Tiger (*Panthera tigris*) and leopard (*Panthera pardus*) were threats to livestock. Smaller carnivores also caused substantial damage to domestic birds. Annual losses of crop and livestock sustained by the average household have been estimated. No strong correlation between distance from the Park and crop or livestock damage could be found. There were 61,614 participants in the annual 15-day grass-cutting. On the average, 3 tonnes of grasses, reeds, binding materials and firewood per household were harvested from the park. Net contribution from these harvests to the economy was estimated to be US$ 325,166. Competing theories on national park management are examined and a new concept for park management is proposed.

The RCNP is world renowned for its unique diversity of flora and fauna. The park is located in the Chitwan District of Nepal and represents a nearly pristine ecosystem of river valleys and the Siwaliks Hills.

The RCNP was officially established in 1973 and was enlarged in 1977 to include a total of 93,200 ha of land. At some places, the Park borders cultivated lands and settlements without having a river in between. Legally, no settlements exist within the boundary of the Park, but there are several villages which are enclaves almost completely surrounded by the Park.

OBJECTIVES

The study has explored some of the local conflict situations with a view to developing sound management practices to deal with the intersections of legitimate local self-interest and the

interests in preserving the international treasure of biological diversity. This research has focused on three issues that involve important conflicts between the RCNP and adjacent human communities: illegal harvest of firewood, trespassing by domestic livestock for grazing and illegal harvest of fodder, and crop and livestock damaged by wildlife. In addition, the annual harvest of thatch grass and other grass products has been assessed to revise the earlier estimates. The research objectives involved detailed examination of each specific issue.

General objectives:

1) To determine the extent and general location of conflicts between local people and the RCNP;

2) To identify and evaluate potential solutions for reducing these conflicts; and

3) To describe the subsistence economy of the local people as essential information for understanding any conflicts between Park and people.

METHODOLOGY

Out of 144 wards that are represented in the 16 village units (VUs) adjoining the Park in Chitwan District, 14 wards were randomly selected using a table of random numbers.

The distance of each ward from the Park boundary was calculated by taking the average distance from each of 10 equidistance points equally spread along the ward's perimeter to the park. The wards in the study varied from 0.20 to 3.7 km from the Park using this parameter. Nine wards were actually adjacent to the Park boundary and all were within 5 km of the Park boundary.

In each selected ward, the names of all household heads were listed by going door-to-door.The number and type of livestock owned were also recorded.

Because of the extensiveness of the study area and the fact that several kinds of data were being collected simultaneously, 14 field assistants were hired on a part time basis to assist in data collection.

The following were the research methods used in the study:

1. Interviews of household heads

From the list of household heads in each randomly selected ward, 10 households were randomly selected using a table of random numbers. In this way 140 household-heads were selected for interviews. This represents 6.66 % of the households in the sample area, or a sampling fraction of 0.65 for the entire study area.

The structured interview was divided into four major components: general issues, firewood issues,grazing and fodder issues, and crop and livestock depredation issues.

Each interview took a minimum of two visits and was conducted in an informal setting, mostly in the interviewee's courtyard and often in the presence of family members or neighbours.

2. Monitoring of livestock grazing inside the Park

Monitoring of livestock grazing inside the Park was conducted by unobtrusive counts of livestock in 11 selected grassland/savanna patches. These patches were the principal grazing areas of the wards randomly selected for detailed investigation.

Livestock counts were made on each patch once every month for a calendar year on a previously selected random date. A total of 365 ha of grassland/savanna inside the park, but close to the village, was monitored for this study, representing about 2% of total grasslands in the park.

3. Grass-cutting survey

A systematic survey was conducted during the 15-day annual grass-cutting period permitted by the RCNP, which began on 18 January, 1990. Out of 49,674 grass-cutters who entered the park from 19 designated entry points, 1814 were randomly selected to be interviewed. Every 20th person purchasing a permit was interviewed.This survey represents a sampling fraction of 3.65 %.

4. Monitoring of crop and livestock damage

The 14 sample wards were monitored for crop and livestock damage caused by park wildlife. The data were recorded on a weekly basis. The 14 field assistants were trained in making simple ocular estimates of crop damage by wild animals and birds and in recording information in a standard format.

FINDING

Conceptually, it can be argued that strict control on park resources against exploitative pressure is essential in the long-run to resolve the conflicts between national park management and local people. Only effective law enforcement against the exploitation of the park resources provides necessary conditions to motivate the people to intensify the management of their own lands rather than relying on the park for essential subsistence commodities. For the RCNP this model applies to firewood and fodder. Intensification of production of these commodities on public and private land outside the park will not happen if the park provides them freely.

RECOMMENDATIONS

1) About 600 km^2 of the land surrounding the RCNP should be designated as the "park impact zone" in the Chitwan District. Additional lands in other districts would be required to surround the entire Park. RCNP should promote intensification of sustainable land uses in this zone, both forestry and agriculture, encourage the use of adaptive technologies (biogas, improved cook-stoves etc.),create seasonal jobs for the local people, and implement other rural development programs. The active management of all non-private land in the impact zone should be the responsibility of the RCNP. The forest resources in the impact zone should be reserved primarily for local use, and export of resources to other parts of the country should be allowed only when there is a surplus.Understanding of all important spheres of economic activities that constitute the subsistence of local people is essential in designing projects best suited to the interests of local people as well as to the RCNP. These

include self-sufficiency in foods for humans, fodder and grazing needs for livestock, fuelwood, and cash income to meet other social and household needs.

2) Generally speaking, exploitation of park resources should be reduced to a minimum and the highest priority should be to conserve the unique biodiversity of the Park with little or no human influences.

3) Any departures from recommendation 2 above to allow local people to exploit critical resources in the Park should be subject to the following questions:

   i) How critical is resource to the subsistence of the local people ?

   ii) Has it been proven that the exploitation of the resource does not produce any lasting effect in the ecosystem ?

   iii) Can the resource be readily produced outside the park ?

   iv) Can the resource be replaced by manufactured goods, and if so can the park afford to subsidise their price to encourage such use ?

4) Where any resource is permitted for harve stfrom the park, exploitation methods and schedules should be designed and implemented in consultation with the local residents. For example, the management of subsistence fishing in the park rivers should be explicit concerning criteria for fishing permits, covering allowable net types, their mesh sizes, seasons, locations, restrictions on night-time use, license expiration dates, inspection mechanisms and punishments for offences.

5) The forests and open spaces near communities in the impact zone should be managed through community involvement and participation, with the RCNP being the principal co-ordinator. Forests that are remote from the villages should be managed directly by the RCNP.

6) Community forestry programmes should be designed with an emphasis on family forestry and small user groups. In addition to tree-planting,user groups should be involved in protecting and managing designated parcels of existing forest in the neighbourhood. Under the family forestry programme, the RCNP should encourage farmers to plant trees of their choice in under-utilised sections of their homesteads.

EXISTING INDIGENOUS AGROFORESTY PRACTICES IN THE MIDD-HILLS OF NEPAL AND THEIR IMPACT ON SOIL CONSERVATION

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ABSTRACT

The sustainability of the labour-intensive integrated farming system of the middle-hills is based on farmers' experience gained over many generations of combatting the harsh prevailing agroclimatic conditions. The over-population of humans and livestock in the region has resulted in a shortage of forest resources and a severe decline in soil fertility contributing to a significant loss in crop production. The farming communities have learned a lot about how to live with the prevailing conditions by permanently combining trees and shrubs on their farmland with the crops (agroforestry practices) in spite of having limited size landholding.

Among five different locations of farmland for retaining trees and shrubs, the middle of terrace riser and terrace edge were identified as the most promising with regard to fodder production and soil conservation. In addition, other locations also have some effects on production and soil conservation but to a lesser extent than the former locations. However, the terraces are least used for retaining trees because of their importance for crop production.The findings also suggest that farmers have been increasing the density of trees and shrubs on southern aspects as the altitude decreases, whereas the reverse was found for northern aspects. Apart from location and aspect, they have an ample amount management knowledge on various species for fodder, fuelwood and soil conservation along with different propagation methods of the species. But very few changes were found to be made in cropping patterns and crop variety.

Therefore it is high time to look at the existing indigenous knowledge of the middle-hills farmers in different aspects of the farming systems. In addition, new technologies developed on the basis of the indigenous knowledge would be easily adopted by the farmers, since they do not demand much modification to existing methods. Thus, programmes aimed at the sustainability of the middle-hills farming system can not be continued successfully unless a proper documentation of the existing knowledge of the farming communities on various aspects of the agroforestry practices is carried out. This must be conducted before carrying out any research on the agroforestry system in the region.

PROBLEM

The middle-hills occupy the largest part of Nepal and are considered to be the original lands of the Nepalese population. The people are still practising traditional systems of labour intensive and complex farming.

The systems are based on integrated farming, where three distinct components-forestry, livestock husbandry and arable cropping are combined. Over the years the farmers have developed effective methods to alleviate the prevailing condition of declining soil fertility due to the shortage of forest resources by permanently retaining trees and shrubs with the crops on their farm lands despite having limited land holdings. In other words they have relied on their own resources and knowledge and have demonstrated keen understanding of the principles of sustainability by having a farming system which is referred to as agroforestry (AF).

Various practices of the AF system prevail in the region. However, there has been no research on the value of different management practices of the trees or on the various species retained by farmers on their farmlands. According to farmers, the location of trees and shrubs on various areas of the farmland has both direct and indirect impacts on various functions attributable to trees in the farming systems. Therefore, acquiring an awareness and understanding of the rural knowledge and programmes which aim to improve land, resources use and management practices should greatly enhance the chances of developing technologies that could be readily adopted by the farming communities, rather than introducing totally new technologies. In addition, scientific verification of some indigenous knowledge may be required where there are indications of conflicts between knowledge of different farmers and farming communities. Furthermore, the ecological understanding developed by one farming community may be relevant to addressing the problems encountered by other communities, so investigation of local practices would be a powerful and efficient means of extending the scientific understanding of AF for both Nepal and other parts of the world with similar problems.

METHODOLOGY

The study was conducted in four villages situated at four different agroecological zones in the middle-hills. Most of the information was collected direct observations of villages to visualise some of the prominent features of practices in the fields, and groups discussions on various aspects of the practices. Indirect information were also collected through individual farmer interviews, inquiring into the different practices of AF practised in their different farmlands and their impacts on soil erosion, fodder and fuelwood production. So, the main techniques used to collect the information were:

1) direct observation in the field;
2) participatory rural appraisal; and
3) formal individual questionnaires

FINDINGS

Most of the practices adopted by farmers have their own functions in supporting and sustaining the existing farming systems of the middle-hills without adversely affected arable crop production. Besides metting a considerable proportion of their fodder and fuelwood needs they have also been able to conserve soil from different farmlands. Similarly density of trees/shrubs increases with decrease in altitude on south facing aspects whereas it is the reverse in the north. However, the results of the findings may not be conclusive for the whole region due to the erratic differences in locality factors, such as microclimate, agroecology, within small areas which may require modification of the findings for them to be compatible according to the prevailing conditions. In addition, some of the findings may need verification. It can therefore be said that the middle-hills farming system is itself one of the agroforestry system. Adequate

knowledge still exists within the farming communities on different aspects of AF practices and their management systems which they modify according to their needs and demands through their available limite dresources. Much of the knowledge has great potential for improving livestock forage production along with protection of the soil and water of the region.

RECOMMENDATIONS

To improve the AF in the region detailed studies on the existing indigenous knowledge should be documented systematically so as to indicate a distinct line of action for future research and development activities. Many of the research and development activities have been confined to eastern, central to western regions of the country with the mid-western and far-western regions rarely being explored for their potential in the system. These are the most neglected regions of the middle-hills but their great diversity of social and ecological aspects should provide a large amount of additional knowledge to other parts of the country as well as to other similar parts of the world.

THE STATUS OF THE TIGER (*PANTHERA TIGRIS TIGRIS*) AND ITS IMPACT ON PRINCIPAL PREY POPULATIONS IN THE ROYAL CHITWAN NATIONAL PARK NEPAL

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ABSTRACT

This study carried out in he Chitwan Nationaal Park, Nepal attemted to gather the basic ecological information, both on the tiger and its principal prey species, which is necessary for the conservation and management of the tiger in the wild. During the entire study period nine tigers 17 times, seven leopards 9 times, twenty different hoofed animals (ungulates), and one sloth beer were captured. The animals were immobilised, fitted with radio-transmitter collars and released on their home grounds. Their movements and activities were monitored with radio-receivers.

The size of the tiger population was fairely stable during the study period. The reproductive rate of the population was high. Mortality occurred in cubs. Poisoning of tiger-decimated livestock carcasses by villagers in areas adjacent to park boundaries killed some adults. Intra-specific competition, including combats between individuals, seems to be the factor limiting tiger density.

Grassland and riverine forest in the park was the most productive habitat with 5612 kg/km^2 biomass as compared to 1846 kg/km^2 for sal forest. The overall crude biomass estimate for the entire park was 2581 kg/km^2. Both in terms of number and biomass weight, chital was the most abundant species of all large mammals in the park as a whole. In the order of total biomass consumed sambar, chital, hog deer, wild boar and barking deer were the principal prey. In the order of tigers' preference however, sambar, hog deer, wild boar, barking deer and chital was the principal prey. Various recommendations were made based on these findings of the study. Buffer area habitat adjoining the Park was also recommended. Controlled burning of grasslands, controlled harvesing of thatch grass by local villagers and planned harvesting of nature sal forests could be carried out in the interest of local villagers ass well as Park and good wild life habitats.

PROBLEM

Historically, Nepal was renowned for both the variety and abundance of large wild animals, and the unique royal big game hunting of tigers (Panthera tigris tigris) and rhinos (Rhinoceros unicornis). Rapid destruction of habitats however resulted in a drastic decline in the numbers and distribution of many important wildlife species.

The tiger is considered to be the king of the jungle in Nepal,. It has a unique place in the culture, religion and history of the Nepalese people. The tiger is feared, admired, and respected by the human population for its ruthlessness beauty, grace, strength, and other natural and supernatural attributes. But the tiger has an uncertain future, not only in Nepal but throughout its range of existence, as several tiger subspecies are already extinct and the remaining are listed as endangered.

The hunting of tigers was prohibited in Nepal in 1972, and the long term survival of this magificant species has been recognised as a major concern since then. The precarious status of tigers was formally recognised at the 1969 meeting of the general assembly of the International Union for the Conservation of Nature and Natural Resources (IUCN) in Delhi, India. Since then national and international efforts have been focused on the conservation and protection of this spectacular species. For making the proper management decisions to maintain viable tiger population in the wild, basic background information on its ecology and behaviour is vital. Such data, however, are either scarce or lacking.

METHODOLOGY

Initially one each of adult male and female tigers, a female tiger cub and two adult female leopards were immobilized. For immobilization, the Parke Davis drug CI-744, which is chemically a 1:1 combination of tiletamine hydrochloride and zolazepam HC1 was used.

During the entire study period nine tigers 17 times, seven leopards 9 times, twenty different hoofed animals (ungulates) and one sloth bear were captured. The animals were immobilized, fitted with radio-transmitter collars and released on their home grounds. Their movements and activities were monitored with radio-receivers. Some individuals lost their collars or needed replacement and these animals were darted more than once. All specimens were darted as free ranging individuals, except one female leopard which was box trapped two times and immobilized for handling.

Systematic observations of both marked and unmarked ungulates were carried out from elephants back, on foot and vehicles, and machans (platforms built on trees). Line transects were used to estimate animal densities in all vegetation types. Further information on tiger population and behavior were collected from natural kills and from bait animals killed by tigers and leopards.

FINDINGS

1) The tiger's color and stripes, while sitting motionless or during stealthy approach, help in achieving concealment and avoiding detection. The black markings overlaid on the white hair area of the cheeks and above each eye are different and distinct between animals. They seem to provide reliable identification marks for individual tigers.

2) Sexual dimorphism is quite pronounced in tigers. Males are significantly heavier and longer than females and the male has a thick ruff of hair around its neck. Fully adult males are much fewer in number than females.

3) The size of the tiger population was fairly stable during the study period. The reproductive rate of the population was high. Mortality occurred in cubs, and the poisoning of tiger-decimated livestock carcasses by villagers in areas adjacent to park boundaries killed some adults. Intra-specific competition, including combats between individuals, seems to be the factor limiting tiger density.

4) Grassland and riverine forest was the most productive habitat with 5612 kg/km^2 biomass versus 1846 kg/km^2 for sal forest. The overall crude biomass estimate for the entire park was 2581 kg/km^2.

5) Both in terms of number and biomass weight, chital was the most abundant species of all large mammals in the park as a whole. In sal forests, chital represented over 50 % of ungulate number and biomass. Hog deer accounted for over half of all animals present and more than one-third of the biomass in the grassland/riverine forest vegetation type.

6) Although only 2 to 3 individuals occurred per km^2., sambar ranked high in terms of biomass weight among ungulates in all vegetation types. Largely because of their individual size, however, rhinoceroses yielded an estimated one-half of the total biomass in the grassland and riverine forest, and nearly a fourth in the entire area.

7) In the study area, tigers were most active when their prey also were actively feeding in late afternoon, night and early morning, They usually rested close to water during the hot part of the day from mid-morning to mid-afternoon,.

8) In the order of total biomass consumed sambar, chital, hog deer, wild boar and barking deer were the principal prey. In the order of tigers prefererence however, sambar, hog deer, wild boar, barking deer and chital were the princilal prey.

9) Among the wild ungulates killed by tigers, a comparison of kills by sex indicated males of sambar, chital and wild boars were sought for tiger predation in preference to females.

10) The amounts of meat consumed per tiger were calculated in the field from the weights of buffalo baits and natural kills. These varied from 11 kg to a maximum of 34 kg in a day. These amounts varied according to the number of tigers associated with the kills, and whether cubs were present.

RECOMMENDATIONS

1) Tiger habitats must be sufficiently large to support the number of animals which provides for an adequate genetic diversity. "Buffer area" habitats adjoining park must also be maintained to provide for an adequate and diverse gene pool.

2) If the historic, cultural, scientific, recreational and economic benefits of national parks as living museums are to be preserved for future generations, it would be advisable to strengthen the provisions in the national park act against further human encroachments on the domains of tigers, and the associated fauna and flora with which they are inextricably linked.

3) As tigers can not live overcrowded and remain at low density, there was no reasonable possibility of large increases in tiger number in any reserve where natural densities prevail.

4) The controlled burning of grasslands and other areas, and the controlled harvesting of thatch grass and reeds by local villagers should also be beneficially carried out in order to maintain early stages of vegetation which are some of the best wildlife habitats.

5) Properly-planned harvesting of mature and overmature sal forests in selected areas, under the supervision of Forest Department and park authorities, would benefit wildlife by returning such areas to early stages of vegetative and faunal succession.

FARMERS' ECOLOGICAL KNOWLEDGE ABOUT THE MANAGEMENT AND USE OF FARMLAND TREE FODDER RESOURCE IN THE MID-HILLS OF EASTERN NEPAL

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ABSTRACT

This thesis presents an investigation into indigenous ecological knowledge about the management and use of farmland tree fodder resources in a rural village setting in the middle-hills of eastern Nepal. The study focused upon a collection of hamlets spread over an attitudinal range of 500 m to 200 m with a population of 3500 people comprising a village development committee. The study focused on the indigenous ecological knowledge associated with decision-making criteria used by farmers in managing their farmland tree fodder resources. Information relating to how farmers perceived the value of particular fodder species, the knowledge used by them in fodder evaluation, how they perceived the interactions occurring in their tree-crop-based farming systems, and the underlying ecological knowledge used by farmers inmanaging the interaction was colleced from key informants and was evaluated in terms of its respresentativeness, the extent to which it was used by farmers and the extent to which it was complementary and/or contradictory to professional knowledge held by research workers operating in the study area.

The research relied upon concepts and approaches to knowledge elicitation developed in the fields of anthropology and ethnography combined with a novel methodology for collecting, recording, assessing and evaluating indigenous ecological knowledge using knowledge based systems techniques. The defining feature of the approach adopted was the explicit representation of knowledge and in cremental knowledge acquisition based on an iterative and rigorous evaluation of the usefulness of the knowledge already acquired. The practical utility of the approach was that once created, knowledge bases could be maintained and updated current knowledge on the topic in question. A comprehensive knowledge base on tree fodder resources was created through interviews with key informants.

The research demonstrated that farmers possess a detailed ecological knowledge of tree and crop interactions, tree fodder quality and tree fodder management techniques which they use in formulating fodder management and feeding strategies. It was also revealed that the farmers' ecological knowledge was explanatory, predictive and of technical relevance. Indigenous ecological knowledge research in general and farmers' ecological knowledge in particular was demonstrated to have the potential to improve the understanding that researchers have of the complex interdisciplinary field of tree fodder resources and to be used to improve the design of research and development programmes to make them more responsive to the needs of the target community. The study has identified several key issues having direct implications for designing future tree fodder research and development programmes in Nepal. These, along with some policy issues raised by the study and how the tree fodder knowledge base created during the course of this study may be further improved and used in a research and development context are discussed. Key areas for further research are indicated.

PROBLEM

The farmers in the middle-hills of Nepal generally pursue a mixed farming system comprising three closely and inseparably integrated components: crop production, animal husbandry and forestry. The farmers who cultivate land also raise livestock and depend on tree resources for the support of both these components.

In recent years, the importance of farmland trees and particularly tree fodder in maintaining farming systems has been widely recognised. More recently the tree fodder component has emerged as a primary focus of rural development efforts in Nepal.

Currently, several government institutions, bilateral aid projects and non-government organisations are involved in promoting tree planting on farmland and providing seedings to farmers. However, attempts to promote tree planting have frequently been unsuccessful. Evaluation of such programmes has shown that more than decade of experience with private tree planting has failed to produce the desired results on a sustainable basis. Several factors have been identified as impediments to the successful implementation of private tree-planting programmes, but failure to take adequate note of local needs and aspirations and, therefore, local knowledge and practices has been the major contributing factor.

In many cases private tree-planting programmes seem to have been developed on the assumption that it was necessary to provide villagers with seedlings. Most of these programmes are "top down" in their approach,based on the simple assumption that if farmers were to plant trees they would need seedlings and therefore seedlings should be provided. So it is clear that the private tree-planting programmes have often been designed with little or no consultation with the participating farmers. Fundamentally, programmes were advocated in the absence of information about villagers' views and knowledge on the subject. Therefore, appropriate strategies for planting private tree-planting programmes responsive to local needs were lacking.

Until recently, little attention has been paid to the indigenous knowledge research in Nepal. However, recent thinking relating to resource-poor farming communities has highlighted the importance of indigenous knowledge in rural development programmes and this topic is gaining more importance in recent development literature.

OBJECTIVES

The main aim of this study was to learn from Nepali farmers about their knowledge of cultivation, management and use of tree fodder resources. The main motivation behind the research lay in the belief that understanding local knowledge can help researchers and development professionals in designing appropriate research and development strategies that are responsive to local needs.

More specifically the study aimed to document farmers' ecological knowledge associated with decision-making criteria used by them in managing their farmland tree fodder resources by examining:

- how farmers perceive the value of a particular fodder species and the underlying knowledge systems used by them in fodder evaluation; and

- how farmers perceive interactions occurring in their tree-crop-based farming systems and the underlying knowledge systems used by farmers in managing them.

METHODOLOGY

A progressive and iterative process was adopted in developing research methods appropriate to what is, in effect, a novel area of research. Examples from literature were used to guide the selection of appropriate research techniques. The fieldwork approach and strategy used by various authors researching other topics in Nepal also provided useful examples. Since interaction with the local community formed the primary element of the fieldwork, interviewing was a central component of the research.

In order to structure the information gathering process, initially the following broad research questions were posed:

- What are the farmers perceptions and what do they know about cultivation, management and use of farmland tree fodder resources?
- What trees are most valued by villagers for fodder and why? Is there a local system of classification and evaluation of fodder trees, and if so what are the attributes of the trees that are recognised and used?
- Are fodder trees planted randomly on farmland?
- Are there any associations between fodder tree species and agricultural crops? What factors influence villagers' interest in where to plant a particular fodder tree species on their farmland ?

To address the above questions a multi-method research approach was adopted. This included: house hold level survey; inventory of trees grown on farmland; and the use of knowledge-based systems techniques.

FINDINGS

The present research has demonstrated that farmers possess a detailed ecological knowledge of tree fodder quality, tree and crop interactions and tree fodder management techniques, which they use to assist them in formulating fodder management and feeding strategies. The study has shown that farmers' ecological knowledge is explanatory, predictive and of technical relevance. It has been shown that indigenous ecological knowledge research in general and farmers' ecological knowledge in particular has the potential to improve the researchers' understanding of the complex interdisciplinary field of tree fodder resources and so improve the design of research and development programmes, making them more responsive to the needs of the target community.

The study has demonstrated the value of using a knowledge-based systems approach to indigenous ecological knowledge research. It may be concluded that researchers and development professionals can gain from an explicit account the knowledge which exists in farming communities. Research and development strategies aimed at improving the management and use of natural resources by local communities and devised on the basis of an

evaluation of their knowledge and needs are likely to be more appropriate than those that are not, and can be expected to enjoy higher adoption rates. It is a sad reflection that indigenous knowledge research has received so little serious attention from Nepali researchers.

RECOMMENDATIONS

One important area for further research is to gather more information about the indigenous systems of tree fodder classification and evaluation used by farmers. Now that the posilo-kam posilo, chiso-obano and rukho-malilo classification systems have been identified, further research to determine if similar fodder classification and evaluation systems are used more widely by other people across the hills of Nepal would be useful.

The study has indicated that while farmers, development professionals and researchers often use different terminologies in describing and rationalising aspects of tree fodder production and management practices, some of the terms used by farmers and others may be similar.Further research along these lines, including knowledge of farmers, researchers and extension workers and preferably involving both junior and senior staff working on tree fodder improvement programmes in Nepal might be useful in understanding how different terms are used to describe tree fodder resources and how they are interpreted and used by different groups of people. The identification of similarities and differences in terms used by various groups of people may have a significant impact on planning future tree fodder research and extension programmes.

It appears that farmer knowledge about the management and use of farmland trees has probably been under estimated and the need to promote tree planting on farmland has probably been overestimated.

SOLVING COMMON-PROPERTY RESOURCE PROBLEMS: DEFORESTATION IN NEPAL

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ABSTRACT

This dissertation describes the problem of deforestation in Nepal and analyzes policy alternatives for dealing with this problem. Deforestation is an example of a larger class of common-property renewable resource problems which occur in both developed and under-developed countries, in all geographic contexts, and in all climates. Analyzing this problem leads to a number of general insights which can be applied in a variety of situations.

Many renewable natural resources are being subjected to the increasing demands of an ever-growing human population. As the population increases, the consumption of these resources exceeds their yield, and stocks of these resources decline. Because they often play vital roles in maintaining local or global ecological balances, the environment is altered as these resources decline, often with adverse consequences for mankind. Unfortunately they are often common property,so people over-use them, no individual has more than a minimal incentive to invest in replenishing them, and markets which might act to alleviate these problems are often imperfect or non-existent.

An economic model of deforestation was developed to help structure the analysis. Deforestation is shown to be a result of common ownership of the forest, coupled with an inelastic and increasing demand for forest products. The consequences of the common-propertyproblem are compounded by the external effects-notably erosion-which accompany over-use of the forest.

Analysis of the economic model concentrates on the common-property character of the forest. Differences between the costs to society and the costs considered by individual common owners result in many types of inefficient use. On the demand side, over-consumption is a combination of over-use relative to other goods and over-use in one year relative to the next. Common owners are also likely to consume the wrong mix of resources even if their total consumption level is efficient. Finally, common owners may use inefficient methods to harvest resources.

On the supply side, common-property resources are much like public goods.Divergences between private and social costs and benefits lead to under-investment in replenishing the supplies of renewable resources, misallocation of inputs, and under-investmentin in formation about these resources.

External environmental costs and benefits also compound common-property resource problems. Unfortunately, the reasons for which resources are common property are often related to external effects, so externality problems frequently aggravate common-property problems.

This analysis indicates that an economic model is a powerful tool for understanding the problem of deforestation in Nepal.Extending the results of this analysis to other situations shows that common-property renewable resource problems have important similarities as well as individual differences, and indicates the widespread applicability of solutions to specific problems.

PROBLEM

Common-property renewable resource problems occur all over the world; depletion of fishing grounds and he over-harvesting of seals and whales are well-known examples of the abuse of commonly-owned resources.

In most developing countries, forests are property, available to anyone the force behind most of he deforestation in Africa and the Indian subcontaintinent is the survival instinct: the forest in these parts of the world are being cut to provide fuelwood and farmland for impoverished people. Clearing forests may be a short-term solution o food shortages, But it only compounds what has been called the poor man's energy crisis.

This thesis was about deforestation in Nepal. Solving the problem was important in its own right, but the analysis assumes more importance because deforestation is a worldwide phenomenon. From the analysis of deforestation in Nepal, policy maker in other countries could be learn about the complexity of the practical problems be solved in an actual situation.

This dissertation attempts to the following questions: Why is Nepal's forest deteriorating? What is the solution to this problem? How does analyzing deforestation in Nepal help solve other common property renewable resource problems?

The Problem in Nepal.

Nepal's forest is disappearing. Villagers are cutting fuelwood for cooking and heating, farmers are clearing forest land for agriculture, an grazing animal are preventing new trees from growing.

Fuelwood is main source of energy in Nepal, so deforestation affects everyone.

As fuelwood becomes scarcer and more expensive, people are taking drastic measures. When firewood is unavailable, villagers burn dung for fuel. In both rural and urban area, agriculture is suffering from the loss of nutrients previously provided by manure.

As forest cover decreases, erosion, increases, and hills absorb less and less of the heavy summer monsoon. showers. Rivulets become gullies and streams become torrents.

Deforestation is combination of several related problems. The demand for fuelwood exceeds the growth of fuelwood, so the stock of forest resources is depleted o meet the demand.

Deforestation in Nepal deserves attention by itself, and it is linked with other important problems such as food production, policy-makers must tackle his problem because there are no available substitutes for the forest as a source of energy and for protection against erosion. When the forest disappears, there will be no way to cook food even if enough is produced, and erosion will guarantee that enough food is produced.

Economic theory indicates that individuals over-consume common-property resources, and under-invest in the provision of public goods, Are these the main problems of deforestation in Nepal? Government intervention, especially quotas on use and taxes o support public investment, are standard theoretical prescription for solving these problems. Are these practical solutions fro Nepal?

METHODOLOGY

An economic model which can be applied to the problem of deforestation in Nepal and analyzes the key characteristics has been used. Models of deforestation could also be derived from anthropology, climatology, or theology, but there are compelling reasons for choosing the economic model. First, the collection and use of forest products, especially fuelwood, is primarily an economic problem: it is question of the cost of labour and the benefits of cooking and heating, not a question of territorial rights, a changing climate, or religious beliefs. Second, a relatively simple economic model captures the main features of deforestation. Third, the economic model describes the problem of deforestation in terms which can be affected by public policies, so analyzing this model provides clues for devising solutions to this problem. The economic model of deforestation is thus likely to be more fruitful for policy-makers than models based on other disciplines.

Much of the economic analysis used in this model of deforestation has its origin in village customs and physical phenomena.

Graphs are used to illustrate the main features of the model of deforestation in Nepal. These graphs are based on an algebraic formulation of the model.

FINDINGS

Common owners over-consume a resource in two different ways: they over-use the resource relative to other goods, and they over-use the resource in the year relative to the next year. Common owners consume too much wood too quickly. Both kinds of misuse occur because the cost of the resource to each individual is less than the cost to society.

With two substitutable common-property resources, common owners may consume too much of one and too little of the other, even if total use is efficient. This wrong consumption mix also results from the difference between individual costs and social costs. In Nepal, villagers probably cut too much hardwood relative to softwood.

Common owners may use inefficient methods to harvest a resource. This is probably not a big problem for forest use in Nepal, but it is important for other common-property resources.

If investment in increasing the supply of the resource is possible, common owners will generally invest too little. In fact they are not likely to invest in the resource at all, because other common owners will reap most of the benefits of any investment. Very little reforestation will be done by common owners, because trees planted in the commonly-owned forest by one villager will probably be harvested by another villager. In the absence of a collective agreement under which everyone plants trees or the government pays people to plant trees, nobody is motivated to plant any trees.

If a resource can be left as common property or converted into private property, common owners will convert it into private property. They will do this even if the resource's value in use as private property is much lower than its value in use as common property, because individuals reap all the benefits of private property for themselves, but they share the benefits of common property with all other owners. Nepali villagers leave too little land in forests and convert too much to farmland because each owner captures the full benefits of private farmland but only part

of the benefits of common forest land.

Common owners under-invest in information about the resource and common owners have no incentive to acquire knowledge about planting methods growth rates or optimal cutting techniques because no individual common owner can reap the benefits of improved information.

From a policy viewpoint, the most interesting finding is that supply is a bigger problem than demand. The examination of Nepal's forests shows that under-investment in the supply of a common-property resource is likely to be a much greater problem than over-use. External environmental costs and benefits further aggravate the problem of deforestation. As a result of these costs and benefits, villagers over-use the forest resource and under-invest in replenishing its supply. Again, under-investment is a bigger problem than over-use.

What should be done

Describing solutions on a conceptual basis is the first step in solving the problem of deforestation in Nepal. The economic model of deforestation indicates three inefficient outcomes: there are welfare losses through common-property ownership, welfare losses through external effects, and welfare losses through inefficient use. The problems of external effects can also be solved with unified management. Unfortunately, whereas solving common-property problems requires only local unified management, solving external effects problems requires overall unified management of the resource as well as other resources affected by it. For example, solving the problems of the external effects of deforestation in Nepal would require international cooperation with India and Bangladesh as well as coordinated management within Nepal, because these problems affect all three countries.

Problems of external costs may also be solved through taxes or quotas on resource use, or through subsidies for substitutes for the resource. Problems of external benefits may be solved through subsidies or through direct government investment.

Inefficient use can be reduced by subsidizing efficient use. More efficient use of fuelwood could be promoted by subsidizing the construction of improved stoves, by providing information about these stoves, or by providing demonstration stoves to a few families in each community, to promote efficient use of fuelwood.

If property rights cannot be changed, solving the problem of deforestation becomes a question of choosing among regulatory instruments and targets.

In general, any policy that raises the cost of anything affecting consumption of forest products or lowers the cost of anything affecting investments in replenishing the forest is a possible policy option. The hard task is to determine which instruments such as taxes, subsidies, quotas and government investment and which targets such as fuelwood, fodder, kerosene, bio-gas plants, improved stoves and livestock best meet the efficiency conditions and are thus most promising for solving the problem.

What can be done

The main objective of forest policy in Nepal should be reduce the welfare losses of inefficient use of the forest resource.

Forest policies should be evaluated for economic efficiency, political acceptance and administrative feasibility.

Solutions to the problem of deforestation fall into two categories: those that decrease the demand for forest products, and those that increase the supply of forest products.

RECOMMENDATION

The government should emphasize the establishment of Panchyat Protected Forests and use of more efficient stoves. These are the most efficient ways to combat deforestation in Nepal.

The Government should take advantage of the private demand, provide seedlings to villagers, and rely on private incentives to care for these trees. Villagers' general preference for fodder and fruit tree seedlings indicates that private plantings can be expected to provide much more fodder than fuelwood. By promoting fuelwood production and more efficient fuelwood use, the government can complement private initiatives.

Policy-makers should consciously use the first years of community forestry to acquire more information about this policy and about Nepal's forest in general. As more data become available, policy-makers should re-evaluate the problem of deforestation, and re-assess the costs and benefits of alternative strategies for solving this problem. The factors leading to success or failure for the different strategies within the community forestry policy should be identified, and the emphasis of this policy should be changed if necessary.

Compendiums of
Master Degree Theses (M.Sc. etc.)

A GEOSTATISTICAL APPROACH FOR BIODIVERSITY STUDY IN NEPAL

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ABSTRACT

The aim of this research was to apply and evaluate geostatistical techniques which might contribute to the development of a methodology for determining the spatial distribution of endangered tree species, a primary pre-requisite for future planning for conservation of biodiversity. Most of studies on biodiversity in the past were qualitative, and in some cases subjective. The growing concern over loss of biodiversity has increased interest in conservation-oriented projects and programmes, but the basic information is still lacking. The thesis stesses that so far neither the spatial distribution of species nor the use of such knowledge for the conservation of the species has been fully investigaed.

The study focuse on three endangered tree species in Chudi (Tanahu district) and Batter (Nuwakot district) in the middle hills of Nepal. Finding where and how much of these species remain was the core of the research.

Spatial data about the species were collected in the field over a regular grid using geostatistical procedures, and analysis has revealed that this technique works well, at least in the study area, in determining their spatial distribution, where the variation of the distribution of the species is systematic. The research showed that simple choropleth maps delineated by sharp boundaries as traditionally used in forestry, do not represent the distribution of some species in the study areas which are due to various natural and human factors in fact more gradual then abrupt. As evident from kriging and simulation, geostatistical techniques appear to offer a way of describing spatial continuity of the distribution of species that is an essential feature for biodiversity mapping. A geostatistical approach is able to quantify the magnitude and location of the distribution of endangered tree species in the study area. It has been found that there is a possibility to integrate the spatial knowledge of species approach to have potential to give the direction for the conservation of endangered tree species by facilitating spatial and temporal monitoring.

Methodology development is a complex and long-term process to solve the problem of spatial distribution of endangered tree species. Geostatistical techniques as applied in this research are likely to be useful for the development of a methodology which can be used in the standard practices. This research recommends refinement of the present methodology and strongly recommends further research on the spatial distribution problems of the tree species.

PROBLEMS

Nepal's forest resources are being rapidly depleted and pressure on forestland is increasing. Forests are being harvested for fuelwood, fodder, timber and other products. The main causes of forest degradation are over-cutting of wood for fuel and timber and heavy lopping of trees

for fodder. In Nepal, 75% of the total energy and 42% of the livestock feed is obtained from the forest. Forest fires and illicit felling of timber are also major causes of forest degradation.

At present, deforestation is greater than afforestation in Nepal and it is thought that the existing forest resource is no longer adequate to meet the demand for forest products.

In spite of many national efforts, data and estimates on forest resources are still lacking, or, if available, are not reliable or up-to-date. The development and institutionalisation of a suitable system and up-dating of existing data is a top priority in Nepal.

With an ever-increasing population in a shrinking forest resource base, the necessity of monitoring major and minor changes of Nepal's forest resource, particularly biodiversity is vital. Information on resource change and determination of current status of, at least, the principal tree species is the primary prerequisite for future planning in the forestry sector. Answers to the questions- What species do we have ? How much do we have ?, What is the condition ?, How are they distributed? and What is the value ? - are the most important information needs for planning and management of forest resources. A complete understanding of current status and monitoring of change from the past is fundamental to future analysis. From the rapid deforestation process in Nepal, questions have emerged concerning the dynamics of the forests: How have they changed ? Why have they changed ? How will they change in future ? Regional and national assessments which are directed at the information needs of policy and programme formulators are also concerned with the current status of the forest resources and, equally important is how the forest resource is changing over several years.

Only a few studies on biodiversity have been conducted in different parts of the country. There is a scarcity of quantitative and systematic data on the geographic distribution, location within the geographic range, status, ecological characteristic of the species and their possible vulnerabilities to environmental change. Many areas in the country are still under-explored in Nepal. Because of complexity of interwoven factors, biodiversity research outside the protected area is rearely done.

OBJECTIVES

- To develop a methodology to determine the spatial distribution of endangered tree species.

The general objective of the research was:

- To apply and analyse selected geostatistical techniques which might contribute to the development of a methodology to determine the spatial distribution of endangered tree species.

Specific objectives

To accomplish the general objective, the following specific objectives were identified:

1) To investigate the existence of spatial variation of the distribution of a selected number of endangered tree species (in terms of basal area per unit area) in the principal study area and compare that spatial variation with the spatial variation in another (protected) area (with similar environmental conditions).

2) To estimate the spatial variation of the distribution of those species in the principal study area and map them by using kriging interpolation.

For the present research, two types of study area were chosen: a principal study area and a subsidiary study area.

METHODOLOGY

The study was carried out in three stages:

- pre-fieldwork
- fieldwork
- post-fieldwork

Activities carried out during pre-fieldwork included: studying geostatistics, gathering secondary data and reviewing relevant documents.

The field work was a household survey for which a stratified random sampling technique was used based on the caste/ethnic group. The households which were to be interviewed were selected from each stratum in equal proportion from the population of the study.

FINDINGS

There exists a well defined spatial variation of the distribution of endangered tree species (in terms of basal area and number per unit area) perpendicular to the settlement in the principal study area. The spatial variation parallel to the settlement is comparatively weak.

From the comparison of spatial variation of the distribution of basal area values in the principal study area with the protected area, it has been found that the variograms are likely to show similar behaviour in the similar areas with respect to the same under-lying casual factor causing spatial variation of the variable of interest.

Estimation and mapping of the spaial variation of the distribution of the endangered tree species can be done by kriging interpolation. Contours are used to display the special variation of species distribution.

Besides kriging interpolation, spatial variation of the distribution of endangered tree species can also be mapped by means of geostatistical simulation. Spatial uncertainty of the values of interest at unsampled locations can be assessed by comparing a number of realisations with each other and can be interpreted visually.

The procedure and output between kriging and simulation is quite different. In comparison to simulation, kriging is easy to perform. kriging and simulation have their own importance kriging is considered twice as good (or as reliable) estimate as simulation. To retain histogram, variogram, and conditioning data simulation is preferred. In the noisy data set kriging might be useful.

RECOMMENDATIONS

The study concerned geostatistical techniques which might contribute to the development of a methodology to determine the spatial distribution of some endangered tree species and it has made an important contribution to a general methodology for biodiversity research. Since, methodology development is a long-term process, it is recommended refinement of the present approach, particularly on steps to be carried out during field sampling, if similar outputs are expected; and proposes the sequence of activities.

The selection of areas for pilot surveys should be representative and therefore should be done by carefully applying geostatistical sampling design.

Adaptive sampling techniques might be helpful in gaining information about rare species, once local concentrations of the species have finally been identified.

A REVIEW OF SOCIO-ECONOMIC ASPECTS OF AGROFORESTRY WITH SPECIAL REFERENCE TO THE TERAI REGION OF NEPAL

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ABSTRACT

This dissertation investigates socio-economic and cultural factors affecting the adoption of agroforestry technologies and also examines the techniques of valuing inputs and outputs of agroforestry for cost-benefit analysis purposes, with special reference to the Terai region of Nepal.

The present forestry situation, existing traditional agroforestry systems, and the socio-economic environment of the region are discussed as are the factors which should be considered in large scale adoption of agroforestry systems, apart from technical and financial factors. The socio-economic and cultural variables affecting agroforestry development in the region are identified on the basis of available literature and personal experience of the area. How the tradition, culture, behaviour and social milieu of an area affect the adoption of a system have been highlighted.

Agroforestry systems may enable more effective use of land and yield a higher net economic rate of return. However it is difficult to present agroforestry information in a form suited for rational decision-making because valuation of the wide range of both environmental and non-environmental costs/benefits involved is very difficult. The possible costs/benefits of agroforestry systems in the Terai have been identified, and some meaningful method of valuation of them in cost-benefit analysis of agroforestry systems are reviewed.

It is concluded that: (a) the social issues of the production methods and resource strategies of involved agroforestry systems have to be given due respect and are also to be viewed from the socio-cultural viewpoint; (b) for the valuation of inputs/outputs, the data sources need to be improved in order to get appropriate results; (c) the discount rate needs to be considered in greater detail as agroforestry systems are very sensitive to it; and (d) no specific correct decision criterion for choice of agroforestry system exists and, therefore, combined use of Net Profit Value (NPV) and Internal Rate of Reurn (IRR) has been suggested.

PROBLEMS

While the existing forest is the most important natural resource of Nepal in meeting the basic needs of the rural people for fuelwood, fodder, timber, poles, leaf litter etc. it also plays an important role in protecting the fragile ecosystem of the Himalayan region. Due to the close interrelationship of human and forest, it can be regarded as a part of the human ecosystem and is deeply rooted in the culture and traditions of the rural people.

In the last few years the forest resource of the country reached a critical point as demands on it have become so high that there is always a short supply and the growth on a sustainable basis is not possible. As a result, the existing poorly stocked forest is degrading very fast. To cope with the situation several forestry development projects are being implemented and new

approaches to agroforestry are also being sought so as to reduce the further deterioration of the existing natural forest.

The devastation of forest is more severe in the Terai region than in other regions of the country. Large areas of forest have been converted to agriculture and there is still tremendous pressure to convert existing degraded natural forest to agriculture and for forest produce. Several forestry projects implemented in the region are looking for faster growing species in order to replace the slow growing indigenous species. Efforts are being made to innovate the appropriate agroforestry system that may at least alleviate the problem.

It is being increasingly realised that technical soundness and financial attractiveness are not the only criteria to be considered in the development of appropriate agroforestry system and that socio-economic and cultural environment of an area can become an obstacle for effective implementation of these systems. Thus, consideration of these factors is equally important when devising a new agroforestry technology. Falling to consider these factors will not only reduce the adoption rate of a particular agroforesry system but can also exclude the people and hence affect implementation of similar programmes in the future.

OBJECTIVES

The main objectives were to:

1) investigate the socio-economic variables affecting the adoption of agroforestry technologies in the Terai region and take these variables into account in designing and analysing the agroforestry intervention.

2) examine the techniques of valuation of inputs and outputs, and the applicability of the principles of cost-benefit analysis, in evaluating agroforestry innovation in the context of the Terai region of Nepal.

METHODOLOGY

Cost-benefit analysis (CBA) is one approach widely used for determining the economic attractiveness of a programme. Although the approach is widely used for commercial forestry programmes, due to various non-marketed costs and benefits involved in forestry related programmes the CBA approach will always have to pass through a difficult valuation process. The approach is also used by many analysts for agroforestry projects and may be applicable in determining the economic validity of a proposed agroforestry system.

FINDINGS

It has been recognised that the involvement of people in tree planting is the only solution to alleviate the problem. Appropriate new agroforestry systems could be devised and the traditional agroforestry that has been in existence since time immemorial could also be improved to increase social welfare. The most difficult task that always arises in tree planting, is the involvement of the people in the plantation scheme. The introduction of trees in a farming system is not only affected by climatic and edaphic factors but also by the socio-cultural environment. Existing land use practices have close linkages with people's tradition,

culture and socio-economic factors. Any change in farming practice, therefore, may have a linkages upon these factors of a society. In general the positive impacts may not be noticed whereas a minor negative impact may strongly affect the implementation of a programme.

In order to obtain large-scale adoption of an agroforestry system due respect must be given to the social issues of the system. Overlooking these issues on the one hand affects the implementation a wrong course may be taken or the target group missed On the other hand it can have a serious effect upon the future participation of the people in the similar programmes.

The production methods and resource allocation strategies of innovated agroforestry systems must also be viewed from a socio-economic and cultural viewpoint. The socio-cultural variables are very much site specific. The different areas may have a different set of factors affecting the adoption differently. The actual implication of tradition, culture, and socio-economic factors upon the agroforestry development have not been much studied in the past. The investigation of the influence of these factors upon acceptability of a system is of utmost importance during the designing phase.

There is no general consensus in the use of techniques of valuing the costs and benefits of agroforestry system in cost-benefit analysis. The cost-benefit analysis approach has been much used during recent years to compare the economic attractiveness of different programmes. Agroforestry systems involve many environmental and non-environmental inputs and outputs. The valuation of these inputs/outputs are very difficult. The conscientiousness of an analyst has therefore, much influence in the analytical process.

There is no consensus in the estimation of calorific value of wood, kerosene, charcoal and cattle dung. For example, there is a 100% variation in the estimation in kerosene equivalent of fuelwood.

The replacement source of fuelwood in its absence varies from place to place. The entire fuelwood, in is absence, is never replaced by one substitute. There would be a proportionate increase in use of other fuels. This fact often seems to be eschewed when estimating the replacement value.

The valuation of fuelwood in terms of opportunity cost of the labour many also not give a real value especially in the Terai. This approach depends upon the assumption that the labour for collection would be diverted from the production process and it would reduce the production.

In valuing environmental cost/benefits, the surrogate market/productivity/replacement cost approach may not give appropriate results The improvement in productivity or aesthetic value due to agroforestry may not have much impact upon the perception of land value. The productivity approach and the replacement cost approach and involve detailed study in productivity improvement, and increase in quality of nutrients on the soil and its effect upon the production. There is a lack of information in this aspect, in the Terai, so it poses a difficult problem in estimating the value.

The qualitative description of some benefits is also necessary. The non-environmental benefits such as time saved in forest product collection, foreign currency saving, and increase in production through reduction in cattle dung burning etc. are also important from the national viewpoint Although some proxy values can be assigned to these benefits, the

qualitative description could also provide some basis for decision making.

RECOMMENDATIONS

Discount rate needs to be considered in much greater detail. There is a long time gap between the initial investment and return in agroforestry. This is because trees take several years to give any return. This makes an agroforestry project more sensitive to the discount rates as compared to agriculture or other quick paying projects. A discount rate of about 12% has been suggested for agricultural projects in developing countries like Nepal. But this discount rate may not be appropriate for the analysis of agroforestry systems. Moreover, the discount rate fixed during planting may no longer be valid during harvesting. Thus, a separate discount rate may have to be determined by considering the importance of agroforesty to the 'rural poor'.

There is no general agreement in choosing the decision criterion for choice of agroforestry project. Agroforestry projects are, in general, mutually exclusive projects. The use of benefit/cost (B/C) ratio or net benefit-investment ration (N/K) ratio for mutually exclusive projects can lead to erroneous investment choices. Thus, the combined use of NPV and IRR and calculation of cross-over discount rate may be appropriate for the analysis of agroforestry in the context of the Terai.

THE MANAGEMENT OF COMMON FOREST RESOURCE: AN EVALUATION OF BHARKHORE FOREST USER GROUP

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ABSTRACT

Although the practice of forest protection and conservation by rural people in Nepal has a long established history, the active management of such forests is a relatively new concept. The mechanism of community forestry (CF) has been developed since 1978 to stimulate active involvement of local people in forest management activities as a means of improving the livelihoods of these people by providing more forest products. Under the CF framework, it is the local people organised as a forest user group (FUG) who make decision regarding the forest management, utilisation and distribution of benifit from a forest. Some believe however the management of community forests in the hills of Nepal by FUG is passive and proection oriented, resulting in fewer benefis than might otherwise be gained.

The aim of the study was to describe the active management of communit forest by the Bharkhore FUG. The thesis analyses the forest management and institutional development activities of this FUG from Western Nepal, in relation to modern innovative forest management principles and the robustness of a local level forest management institution based on common property.

PROBLEM

In Nepal, particularly in the middle hills, forests are an integral part of the farming system. During the 1970's there was a growing recognition that the Department of Forests (DoF) alone could not manage the forests. A partnership between Government and villagers was seen as being essential to ensure that the forests were managed sustainably and that people had guaranteed access to forest products. In order to implement these ideas, His Majesty's Government of Nepal (HMG) moved towards the adoption of Community Forestry (CF). The essence of CF in Nepal is the development of a partnership between the local communities DoF. The social unit representing the local communities of a particular forest in this partnership is the FUG.

It is frequently reported that FUGs are reluctant to manage the forest effectively that the main forest management activities are little more than the removal dead and dying trees and leaf litter.

Many studies claim that hill farmers neither misuse the forest nor consume it inefficiently, and that they remained very conservative in harvesting the resources.

More attention is paid to the membership of FUGs than to the forest to be managed, more attention to developing confidence among users and promoting decision-making, than o technical innovation. This attitude creates a challenge for foresters, villagers and project staff to ensure the appropriate application of silvicultural regimes to achieve management

objectives. There is an urgent need o more away from conservation and protection to more production-oriented management approaches in CF.

the philosophy of CF has bee explored by many writers in he past. these studies have focused on the social, organisational and institutional relationships in CF. However, there is a gap between studies focusing on the working unit of CF, and the resource and its management practices. The FUG is the working unit of CF. Therefore, this research aimed to study within he theoretical framework of the new principles of people-centred forest management and common property focusing specifically on one FUG.

OBJECTIVE

The study aims to demonstrate FUG involvement in active forest management. The objective of the research is to understand the dynamic functioning process of a FUG.

METHODOLOGY

The existing body of relevant literature on CF, common property and FUG information from Bharkhore is the basis of this dissertation. A case study is presented from western Nepal.

FINDING

The case study presented in this dissertation indicates that Bharkhore FUG is managing the forest actively, in contrast to the passive management which was previously thought to be the norm. Such active forest management by a FUG can lead to an increased supply of forest products without damaging the forest resource. In addition, the increased supply of forest products to the users appears to lead to the overall strengthening of the FUG as an effective institution, able to solve problems and manage the forest without the need for continued recourse to outside support. In other words, FUG involvement in more active community forest management seems to lead to increased self-reliance. It appears that the adoption of an effective 'learning process' plays to key role in determining to what extent the FUG is active in managing the community forest on an equitable and sustainable basis. However, this needs to be verified in the future through more studies covering FUGs which vary in location, ethnicity, history of forest management and different socio-economic profiles.

An analysis of the characteristics of Bharkhore FUG against the robustness criteria for a local level forest management institution has shown that there is a need for the careful application of these criteria because they do not address 'the resource aspect' adequately and are focused towards the 'institutional aspect' only. In other words, the theory of common property provides sufficient framework to analyse 'the people aspect' and its institutional arrangements, it does not provide adequate framework for 'the resource aspect' and technical management. This is important because FUGs, meeting all the robustness criteria are not necesserily involved in active forest management. In future there is a need to evaluate the robustness of the FUGs of Nepal with wider research covering FUGs with varying shapes, sizes, ethnicity, socio-economic characteristics and different forest management histories. This study should be helpful in solving the problems related to the question what are the reasons for the FUGs not being involved in an effective institutional and social development process?

An analysis of the forest management practice of Bharkhore FUG indicates that this FUG is heading towards the achievement of most of the principles of people-centred forest management and that the users not only have some skills in matching silvicultural operations to forest type and product needs but they have been also involved in designing, implementing and monitoring demonstration plots without outside support. However, this has not been developed sufficiently to obtain a sustained yield from the forest or to fully utilise the available growing space. In addition, the contents of the constitution and the operation plan (OP) are not free of ambiguity. These are the areas where there is room for innovative technical intervention from professional staff.

RECOMMENDATIONS

Research in necessary to determine the appropriate silvicultural options to restore the community forests to full productivity to meet the full range of local demands at the earliest possible time. The demonstration plots managed jointly by the FUG and the DOF are necessary to encourage more intensive harvesting in community forest to achieve a sustainable offtake of defined products. The ambiguity in the OP and the constitution can be eliminated through training and extension and more careful execution of the CF field planning process.

It is unwise to draw general conclusions regarding the indicators for a successful FUG from a case study based on one FUG. The findings from this FUG need to confirmed by broader studies covering FUG with different histories shapes, sizes, ethnicity, socio-economic conditions and geographic locations. such studies should be helpful in identifying the characteristics of successful and unsuccessful FUGs and in solving the problems for FUGs which are not involved in active forest management. They should also identify the key areas where there is a need for state intervention for the successful management of the community forests.

Finally, it is worth mentioning a few words about the implications of this research. Dispite the dangers of drawing general conclusions from a case study based on one FUG, the study neverthless proides evidence against what is generally thought to be the passive management of forest by user groups. The development of a FUG like Bharkhore as a technology and information transfer centre can create 'chain effects' among the neighbouring FUGs. It is expected that this research will motivate others to conduct more research exploring the existing active forest management practices of FUGs in the hills of Nepal.

FOREST USER GROUP AS A VIABLE GRASSROOT LEVEL ORGANIZATION FOR EFFECTIVE LOCAL FOREST RESOURCE MANAGEMENT

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ABSTRACT

In Nepal community forestry (CF), is becoming the favoured philosophy for developing and managing forests at the local level. It emerged during 1970s as a result of change in development approaches from economic growth to basic needs. Because of the failure of past forest policies to address forest degradation, the government then decided to change from it conventional forest policy of conserving the environment of the hills to improving the socio-economic condition of the rural people. In this context Nepal has adopted a progressive policy for the forestry sector, which emphasises CF. The main principle of CF is to involve rural people in the management of local forests. Group involvement in natural resource management as practiced in Nepal through people's organisations called Forest User Groups (FUG) is perhaps a new approach in the world.

The aim of this study was to assess whether the FUG would be a suitable organisation to manage local forest resources, It looked into sustainable forest management, empowerment of local people, changes in planning processes and the changing role of the Forest Department. The thesis analyses institutional and organisational aspects of the FUG concept and then discusses its implications for policy. It also discusses some of the problem areas in this concept, and the support needed to improve future activities.

The two main ingredients of CF-people's participation and benefit sharing-are becoming realities in Nepal. In this regard, the thesis reviews CF policy and its evolution in Nepal.

It provides some recommendations for future policy and of strategies. The most important recommendations concern the need for co-operation between different line agencies and for more staff in the field. It further argues that a federation of FUGs would be helpful in institutionalising the empowerment process.

PROBLEM

The concept of CF gathered great strength after the FAO published Forestry for Local Community Development in 1978. However, in Nepal, it emerged in 1976, after realisation that traditional forestry efforts were inadequate to halt forest degradation without the active involvement of local people.

In many countries the terms '**social forestry**' and '**community forestry**' are used interchangeably, but in reality they are practised differently. Social forestry is a mechanism for sharing benefits between the government and local people, whereas, in Nepal, all the benefits go to the local people under CF programs.

The involvement of local groups and organisations in agriculture and community development has been studied quite extensively, but studies on their involvement in natural resource management are very rare because it is such a recent development. At this stage FGUs are also involved in community development but the concept of their involvement in local resources management in Nepal is in its infancy. Hence, it is essential to study the nature and activities of FUGs for the future.

OBJECTIVES

The study aimed to explore different aspects of FUGs and to assess them as grassroots level organisations for local forest resource management. The specific broad objectives of the dissertation were:

1) to review the present CF policies
2) to review the working strategies for CF,
3) to analyse organisational and institutional aspects of FUGs,
4) to analyse the implications of the FUGs concept for community forest management.

METHODOLOGY

This study was based on a literature review related to common property resource, management, local institutions and organisations and forest policies and the author's own experience in community forestry for some 10 years.

FINDINGS

The study found that forest management by local communities through their organisations is a key element of government policy in Nepal and is an appropriate policy for the developing countries like Nepal, where the physiography of the country and limited government staff make it impossible for the Government to manage alone. This policy recognises the importance of local communities in forest management. However, policy itself is not everything. There is a need to improve the present situation for effective implementation of it in practice.

Emergence of New Policy

There were both external and internal factors affecting the emergence of this policy. The main external factor was the changed preception of developmnt in the world; the main internal actor was the failure of past policies which could not halt the degradation of the forests in the country.

The focal point of this policy is the FUGs, which have been taking over authority as the new manager of their forest resources from the old manager (the Government). Critical to this process is how the FUGs are formed and how the forests are handed over by the Forest Department or taken over by the FUG and how forest resources are managed and are distributed.

FUGs Success

It is clear that the FUGs are meeting certain prerequisites for functioning effectively and sustainably and balancing the needs of their members with those of the nation. Internal action and behaviour, institutional capacity and the concerted planning of activities which are seen to meet the needs of he members within the dynamics of environment and society are some of these pre-requisites.

Others are: participation in decision-making, feedback from the members about action and recognised leadership. Diversification of activities under taken by the FUGs is a further response to the need to expand in order to survive economically and strategically. Solidarity, self-consciousness and confidence developed in rural people through the FUGs are both ends in themselves and means to develop their communities as well as their local resources.

The organisational and institutional aspects of FUGs showed that rural people, who are illiterate and poor can have the ability to protect, manage and regenerate their forests without any assistance from outside.

However, many FUGs have inadequate administrative, book-keeping and managerial skills and experiences. Poor communications within the groups, politicisation, nepotism, inadequate consultation with opressed groups and lack of good leadership are areas where the FUGs still need external support to enhance their capabilities.

RECOMMENDATIONS

Collaborative Work with various Agencies

There is a need for collaboration between local government agencies and NGOs for implementation of CF policies.

Staff in the field

The success of CF depends on the ability of Forest Department "to work with, encourage, teach, persuade, empower and support the FUGs"

Training Needs

The training institutes need to adopt new curriculum according to the needs of the staff as well as the FUGs. Forestry institutes need to change their curricula according to the current world thinking concerning the forestry sector.

Federations of FUGs'

The organisation of rural people could be strengthened and empowered by the formation of

federations of FUGs at each level from the local to the national level. Such federation would be helpful to articulating and processing their demands and claims to the government agencies.

Further study

There is a need for further study in some of the most important areas. Since the findings show that FUGs are involved in community development work, there is scope for in-depth study in this area, such as how and at what level their work is compatible with government activities. Secondly, there is a need is to obtain empirical data on the impact of FUGs on local forests and the level of improvement of forest condition. Thirdly study on the degree of domination of elites in the decision-making processes of FUGs will be essential.

A REVIEW OF COMMUNITY FORESTRY POLICY IMPLEMENTATION IN THE HILLS OF NEPAL

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ABSTRACT

Owing to the failure of nationalisation to improe he country's fores resource and realisation of the need for people's participation in forest resource management, he Government of Nepal has introduced a community forestry (CF) policy. Under this policy, all accessible forests of the hills of Nepal will be handed over to organisations of the actual users of the forests which are generally referred to as Forest Users Groups (FUGs), provided that these users are ready to take forest management responsibilities. FUGs, with the assistance of forestry staff, prepare operational (management) plans of the forests handed over to them and are responsible to implement the plans accordingly.

Since 1978, the Government has as been promoting CV program, mainly in the hill region. Hundreds of thousands of hectares of forests lands have now been handed over to various FUGs. However, there is little information on the effectiveness of this policy.

This dissertations makes an attempt to analyse the government community forestry policy and then assess the process of how this policy is translated into practice. It is based on the review and analysis of the literature and author's own experience of planning and implementing community forestry in the field.

The study shows that although the current policy is very progressive in nature, the old established structure, procedure and functioning of the DOF as an institution have not changed according to the spirit of the policy. There has been the tendency to view community forestry as just another government programme and is planned and implemented as fixed targets to the extent that the formation of FUGs is being superimposed over the indigenous management systems rather than building on them, although they have been functioning for a long time.

As already noted, community forestry policy is an expression of the shift to a community based participatory approach in development thinking. It is also a response to the deforestation crisis in Nepal. Government forest policy has rightly been described as going through a paradigm shift from forest-centred to people-centred forestry, where policies are progressive and dynamic in nature.

OBJECTIVES

The overall aim of the study is to broaden the understanding of community forestry management practice in Nepal and the difficulties experienced in association with the implementation of the country's community forestry policy. The specific objectives are as follows:

- To examine main salient features of community forestry policy in Nepal,

- To explore the working relationship between the Department of Forest and rural communities in general, and between District Forest Office and Forest User Groups at the local levels in particular.
- To identify the strengths and weaknesses of the collaborative working relationship between Forest Department staff and Forest User Groups.
- To discuss the policy implications.

FINDINGS

The most important finding was that the formulation of good policy, though extremely important, simply does not make things happen automatically on the ground. There is a gap between rhetoric and reality in implementing CF policy. Policy change must be accompanied by change in the DOF itself as an organisation and in the role of foresters, the agents who implement the policy. As community forestry is still at a very early stage and evolving, the approach to the implementation of the policy, therefore, needs to be flexible.

There is a need to reorient the Ministry of Forest and Soil-conservaion staff in CF and for, the course curriculum needs to be revised to incorporate such subjects as rural sociology and psychology while still not undermining the technical subjects.

There is no direct linkage between the Forest Research and Survey Centre, DOF and the District Forest Office at the field level. Most research programmes of the centre are related to technical forestry and they are planned and conducted in isolation. It is important that forestry research programmes are based on the needs and problems of the users and they are carried out together with the users.

CF is less about teaching to the people about forests by foresters, rather foresters learning from people by interacting with them. Therefore, foresters as implementing agents of CF should develop a willingness to learn from the community. For that, the community should be given their forests. The local FUGs should be viewed as local institutions and their capacity should be strengthened.

Finally, there has been tendency of setting uniform targets throughout the country (e.g. formation of FUGs). Donor agencies also want progress in number. Such an approach has, to some extent, affected community forestry programmes. On the other hand, several studies have demonstrated that rural communities know the importance of forests and trees and are capable of managing them. Many communities have developed their own rules, regulations and sanctions to protect and use forest and tree resources. It is therefore, important that such local initiatives are identified, recognised and fully supported.

DETERMINATIONS OF FODDER TREE ADOPTION IN THE MID HILLS OF NEPAL

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ABSTRACT

Assessing the low acceptance of private plantation programs launched by government and non-government agencies to alleviate the shortage of fodder in the mid, hills of Nepal was the major concern of the study. The main objectives of the researchwere: to describe adoption of fodder trees, to evaluate the performance of adoption and to analyse the factors influencing adoption.

Employing a multi-stage sampling technique, four Village Development Committees (VDCs) of Kavre district were selected on the basis of availability or non-availability of nurseries and markets. Survey data of the year 1993 was collected from 216 sampled households; 90 of these were identified as adopters and 126 as non-adopters.

Adopters' fodder trees got 78.5% of the demand of the farm households for tree fodder. Increment in milk production ranges form 46% to 146 % and saving over 56% time for fodder collection were the positive effects of adoption. Peduction in crop yield only less than 5% was reported in two Village Development Committees (VDCs).

A Logit Model with Maximum Likelihood Technique was employed in the investigation of the determinants of tree fodder adoptions. Farmers' knowledge (e.g. about the purpose of fodder trees growing, skill in production, opinions about tree fodder in livestock feed, awareness in terms of scarcity problems, environment, market prices, sources of availability and agencies) was shown to be the most important determinant. Social participation, distances to nursery and market and supply of fodder per livestock unit were other significant determinants in adoption of fodder trees on farm land, but gross income, education, land per ruminant, family size and distance to forest were found to be insignificant.

Ranking and scoring techniques were used for understanding farmers' opinions and perceptions on fodder trees and distribution programs. The results indicated that high biomass fodder trees are preferred by most of sampled households. Unknown about the importance of fodder trees followed by land constraints were investigated as the main reasons of non-adoption while mortality of seedlings was found as the barrier for the further adoption. Hence, the thesis urges the immediate establishment of a regular monitoring program through effective extension to improve farmers' understanding of the importance of growing fodder trees and to create awareness regarding sources, agencies and market prices. A comprehensive government program for distribution of resistant and desirable species and establishment of nurseries should be included in future plans for overcoming the problems discovered.

PROBLEMS

The major efforts of most of the agriculture-based countries are aimed at increasing agricultural productivity and improving the economic condition of farmers through the introduction of improved agricultural technology. Planting of fodder trees on private land is one agricultural technology that has been receiving a considerable attention for the sustenance of the farming system.

The middle hills economy of Nepal, is characterised by mixed farming systems in which, trees, crop and livestock are the cornerstones.

According to this survey of the hills, lack of fodder trees, inadequate pasture and grazing are responsible for the low production of dairy animals as well as other factors such as disease and breed.

Planting of fodder trees (dale ghans) on private land in this context has the potential the problems of fodder scarcity and soil erosion and to provide energy inputs, thus aoding the survival of hill farming systems.

Realising the fact, Government and non-government concerned with research and development have formulated a fodder improvement programs under their livestock development policy.

But, still the problem of fodder scarcity has not been overcome. Various studies have revealed that production and distribution of seedling did not match with the plantation on the farm land, even though planting has been increased.

This evidence of farmers' use of fodder tree seedlings from sources other than nurseries might be the problems of adoption of such saplings. Since just introduction of any kind of technology (farming practice) is not enough, it should be socially acceptable to help overcome meet the shortage fodder, to improve the farmers' income and consequently to strengthen the overall economy of the country. Therefore it is essential to identify and analyse the factors that may be responsible for adoption or non adoption of fodder trees on farm land in order to design and implement proper policy measures so as to overcome the current problems of the fodder shortage.

OBJECTIVES

This study sought to clarify the fodder situation and the key determinants of fodder tree adoption in the hills of Nepal. Specifically, the objective of the study were:

- to describe the farming system and socio-economic conditions in the area, with reference to fodder tree and livestock situation.
- to measure the adoption of fodder trees in farm families.
- to investigate and analyse the relationship between socio-economic factors and farmers' adoption of fodder trees in order to identify the farmers' characteristics associated with fodder trees adoption.

- to assess farmers' perception about fodder tree distribution programme carried out by government and private agencies.

- to identify constraints and possibilities to increase fodder production.

METHODOLOGY

The following combination of methods was applied to gather necessary and relevant information:

1) primary data collection;
2) secondary data collection; and
3) participatory surveys.

Commensurate with the objectives, a sample size of 216 households with equal number (54) from each of the 4 Village Development Committees (VDCs) were selected. A multistage purposive sampling procedure was used and both informal and formal survey were conducted.

The formal survey was carried out by questionnaire, the questions covering mainly socio-economic profiles, adoption, farm production and income on the concerned subject matter were asked to the sampled households. The questionnaires were prepared after discussion with experts so as to obtain only the required informaiton. Skilled experienced persons of the relevant field were hired as enumerators for reliability.

FINDINGS

In view of the fodder scarcity and requirements of the exising animals in the research sites, fodder tree plantation seems to be a promising program. However, the deficit of green fodder throughout the VDCs even where tree/ livestock unit was large, reflects the need of selection of the most suitable species.

Generally in the case of technology adoption, the adaptability is greatly enhanced when a farmers' attitude towards adoption is affected by his/her perception of need for and economic resource. However, here the innovation promoted is not simply a reflection of perceived need and access to resources, but also a question of socio-economic and institutional arrangements within and between the households.

The impact of such programs can be seen from the several changes that have occurred in household farming system. The major changes seem to have been through adoption performance. It can be concluded that the areas having both nursery and market should beer adoption performance in terms of demands and supply. High bio-mass, dominance of exotic species and consciousness about the fodder shortage and impact to the environment are the other significant contributions.

The adoption of fodder trees on the farm is largely a matter of the size of holdings and socio-economic characteristics of the household. Particularly in a given socio-economic environment, the perception is dependent upon the knowledge of an individual. The formal and informal participation could widen the horizons of the farmers rather than the formal education.

RECOMMENDATION

Since the present analysis is based on a limited number of observations from only four VDCs, this makes generalisation difficult. Nevertheless, it may be indicative of the forces at work in the process of adoption of farm practices in Nepal. Additionally, adoption is defined on a conceptual basis, which may not show the actual adopters' characteristics. Hence, there is need of further study with clear concept in adoption.

EUCALYPTUS SPECIES FOR ENERGY PRODUCTION

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ABSTRACT

The emergence and subsequent development of civilisation has been clearly associated with an increase in the per capita consumption of energy. In Nepal, out of 269 kg coal equivalent (CE) of per capita energy consumption per annum, which is the lowest figure among the developing countries, the forest energy provide 248 kg CE or about 95.8% of the total energy requirement of the country.

In the absence of adequate alternative source of energy, the traditional source of fuelwood (primarily firewood) much meet the demand of fuelwood. Trees are lopped of all their branches except for the top crown. The highly populated middle hills and valleys of Nepal are devoid of the vegetation. Uncontroll grazing, indiscriminate liquidation of forests and cultivation steep slopes and marginal lands have led to a situation which threatens an alarming unpredictable disaster. Gathering firewood is now whole day's tasks in some mountains villages of Nepal. The fuelwood storage promises to become a national catastrophe. Sign of the crises are obvious throughout Nepal. The economy of Nepal is agrarian and electricity is likely to be only complementary to fuelwood. Because of infrastructural and distribution problems and limited generating capacity, this form of energy will be at the disposal of roughly 3% of Nepal's population.

In view of these, facts, it is fortunate that trees, when properly managed, are renewable resources, and that an immediate logical response to the firewood shortage that will have many incidental and ecological benefits, is to plant more trees on farms, as shelterbelts along road sides, and uncultivable lands throughout the rural areas. To meet the future demands for energy one promising approach is to develop rural fuelwood programs to ensure that ultimately each village has well-established wood lots to cover its needs for fuelwood.

Fast growing species of trees are available that can be harvested as firewood in less than 10 years and some of these species also regenerate without replanting.

Another is a wide choice of *Eucalyptus* species with these properties and also desirable growth characteristics and relatively high calorific value. Some of these were selected for early trials conducted by the Nepal-Australia Forestry Project and the Forestry Resources Survey Office (Department of Forest) Nepal, and proved to be relatively fast growing and tolerant of prevailing site conditions.

Trials of various *Eucalyptus* in the Adhabar area of Bhabar Zones showed that *Eucalyptus camaldulensis* (Potford provenance) was he best and planting *Eucalyptus* spp. for firewood crops is finally sound.

PROBLEM

The highly populated middle hills of Nepal are in a process of devastation and deterioration because of the intensive use and abuse of land. The energy problem in Nepal is twofold. Rural areas rely almost entirely on fuelwood for energy and growing population has placed the forest under heavy pressure.

In Nepal, the fuelwood requirement is met almost entirely by Shorea robusta, a tree locally named sal or sakhuwa, a species of Dipterocarpacease family. The botanical name of this species is *Shorea robusta*, which is naturally occurring in Terai and Bhabar areas at altitudes upto 2000 ft. It is an extremely slow growing species with a natural rotation estimated at about 120 years. To meet the increasing demand no one can rely on so long rotation and it is imperative to switch on to a fast growing species suitable to the prevailing site conditions.

Early experiments have shown that various species of *Eucalyptus* viz. *E. camaldulensis, E. teriticornis, E. alba, E. citriodorus* and *E. grandis* are very suitable for the fuel wood, having relatively high calorific value and good coppicing power.

In view of the fast growing nature of the *Eucalyptus* species and the growing demand for fuelwood this study aimed a small goal of reviewing the past studies and their applications under Nepalese condition. However, the strategy of planting fast growing species involves a network of techniques and a tremendous amount of work is required to cover all the aspects of energy production. This paper covers only one aspect of the whole net-work which aims for fuelwood production.

OBJECTIVES

1□ To assess the fuelwood requirements of the population,

2□ To compare the survival and growth of different fuelwood species grown at Adhabar and adjoining areas,

3□ To identify the suitability of *Eucalyptus* species as source of fuelwood production.

METHODOLOGY

Data for analysis and interpolation were collected mainly from three sources.

(a) Formal/informal speeches delivered by the officials of the Nepal, UK, Australian, Indian Forest Services,

(b) The necessary informaion from the various forestry agencies in Nepal,

(c) Measurement of height and diameter of *Eucalyptus* species planted in recent trails,

A simple statistical method of analysing the data is presented in the present thesis.

FINDINGS

The early stages of trails in Adhabar and Trishuli have shown that Australian species of *Eucalyptus* viz. *E. camaldulensis*, *E. tereticornsis*, and *E. alba* are most promising for fuelwood plantations having relatively high calorific value and good coppicing power.

VARIATION OF FICUS SEMICORDATA BUCH. HAM. EX SMITH SENSU LATO, ITS TAXONOMY, DISTRIBUTION AND USE AS A FODDER TREE IN NEPAL

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ABSTRACT

The people of Nepal have a long tradition of farming, with tree fodder and agriculture being interdependent components. Tree fodder provides about 40% of all animal feed but, is in short supply in the dry season. *Ficus semicordata* (Moraceae) known in the vernacular language as the khanyu provides an important fodder. Farmers distinguish two types, khasro khanyu and rai khanyu based on differences in the vegetative parts. Two further sub types are recognised within khasro khanyu depending on the edibility of the fruit (figs). Field surveys were conducted to:

(1) investigate by stratified random sampling the types of *Ficus semicordata* recognised and preferred by farmers and their uses in Nepal .
(2) examine the distribution of the types of khanyu in Central Nepal through an altidudinal transect from 200 to 2600 m and assess their size, form, degree of lopping and associated vegetation.
(3) establish whether botanical differences really exist in Nepal from a random stratified sample of khanyu trees.

It was found that two main types of Khanyu i.e. khasro khanyu and rai khanyu are identified by the farmers, except in the Far Western Region where rai khanyu is absent. The majority (72%) of those identifying the two types prefer rai khanyu as fodder for a variety of reasons. The distribution of the two types along an altitudinal transect in Central Nepal showed that khasro khanyu occurs from 200-2000 m. and rai khanyu from 1400-2000 m.

It was found after examining 312 herbarium samples that two varieties of Ficus semicordata (var. semicordata and var. montana) exist and their descriptions are given. These two varieties agree with the Nepalese classification of Khasro and Rai Khanyu.

PROBLEM

The people of Nepal have a long tradition of mixed farming with animal husbandry and agriculture being interdependent components. Livestock is also an integral part of the cultural life in Nepal. Animals are primarily kept for milk, meat, draught power, manure, and for religious purposes.

Farmers in Nepal have used fodder from trees to feed their animals since time immemorial. Although, they know little about their chemical composition, they have considerable knowledge of their empirical nutritional qualities.

The preference of these fodder trees varies form one ecological zone to another in relation to their availability within the zone and their feed value. Among the species used in Nepal for fodder, the khanyu tree, *F. semicordata* is one of the most important. It is a common tree belonging to family Moraceae. In Nepal certain ethnic groups such as Magars and Tamang call this plant by a different name (Kosing) but in the Nepalese vernacular language it is always known as Khanyu or Khanayo.

Nepali farmers distinguish two broad catagories of Khanyu trees -- Khasro and Rai Khanyu on the basis of leaf size and texture, quality of fodder and edibility of the fruit by human beings. In the Western and Far western regions of Nepal, farmers differentiate Khasro Khanyu trees into two further types which they call Packche Khanyu or Khaje Khanyu (meaning the Khanyu where the fruits ripen and are edible) and Wackche Khanyu or Akhaje Khanyu (literally the Khanyu where figs tend to cause vomiting if eaten by human beings).

Whereas both Khasro and Rai Khanyu have a high potential for fodder production during the long dry period (January to May) over a broad ecological range, farmers tend to prefer Rai Khanyu. They believe that livestock fed with rai khanyu give higher milk yields while khasro khanyu has an adverse on milk production and tends o reduce it. Only in the Nepali language are these two kinds of *F. semicordata* clearly differentiated

OBJECTIVES

Since *F. semicordate* is such an important tree resource in the economy of Nepal, particularly as fodder and food crop, it was decided to make an in depth study of its distribution over a range of ecological and altitudinal conditions. An attempt was also made to ascertain its frequency in different habitats such as forest and farm land and to learn more about the phenology of leaf flushing. As at least two different kinds of Khanyu are recognized by farmers it was decided to try to discover whether there is actually a botanical distinction between the two types or not. It was also considered necessary to investigate certain aspects of fig biology in an attempt to understand possible reasons for the edibility or toxic properties of some Khanyu fruit.

METHODOLOGY

A random selection of ten farmers, within altitudinal range of 200 to 2200m, were interviewed from 12 random wards, in the Eastern and Western regions of Nepal to test the questionnaire. The main survey was carried out in a total of 36 wards selected at random stratified in the three regions (East, West and Far West) of Nepal. A wards, a total of 564 farmers were selected at random using the voters list.

FINDINGS

Results of the survey show that *F. Semicordata* (khanyu) occurs both in forests and on farmland. The natural occurrence limit of the two kinds of khanyu is different, khasro khanyu occurs between

200 and 1400 m and rai kahnyu is 1450 to 1950 m but there is a considerable overlap. Khasro khanyu occurs in tree forest types from broad-leaved tropical forest to sutropical deciduous hill forest. Rai Khanyu is restricted in its distribution and occurs only in semi-evergreen hill forest.

The types could be distinguished by leaf morphology and latex color. Soil analyses revealed that both kinds of *F. Semicordata* grow in the soil of various texture classes. Temperature seems to limit the distribution of rai khanyu. The analysis showed that real botanical differences exist between khasro khanyu and rai khanyu, but these chiefly concern the vegetative parts of the plant, especially the leaves.

RECOMMENDATION

Rai khanyu is such an important fodder tree in Nepal, but has a rather restricted range, attempts should be made to introduce this trees to other part of the country. This could be done through the Department of Forest either by collecting seeds from fig or by transplanting young wild saplings.

FLORISTIC COMPOSITION OF SUMMER HABITATS AND IDETARY RELATIONSHIPS BEWTWEEN TIBETAN ARGALI (OVIS AMMON HODGSONII), NAUR (PSEUDOIS NAYAUR) AND DIMESTIC GOAT (CAPRA HIRCUS) IN THE DAMODAR KUNDA REGION OF UPPER MUSTANG IN NEPAL HIMALAYA

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ABSTRACT

During the summer of 1996 (July and August), the potential for food competition between Tibetan argali (*Ovis ammon hodgsonii*), naur (*Pseudois nayaur*) and domestic goat (*Capra hircus*) was studied on the basis of available forage and their diets in a 177 km^2 area in the Damodar Kunda region, upper Mustang. Tibetan argali, naur and domestic goat are non-randomly distributed in three different zones in the study area, with approximate ecological densities of 1.3, 5.5 and 30.1 per km^2, respectively. The study confirmed the occurrence of Tibetan argali in Nepal.

Stratified quadrat sampling was used to describe the floristic composition and forage availability in the three zones. A microhistological technique of faecal analysis was adjusted for inherent biases by comparing with bite-count data obtained for domestic goats and was used to study the ungulate diets.

A total of five different vegetation types were identified in the study area. Dry grassland was distributed in all three zones. Wet meadow and Lonicera community were found in both the naur and the domestic goat zones, and desert steppe and dry meadow were restricted to the Tibetan argali zone.

In the Tibetan argali zone, both species richness and forage availability were lowest. Graminoids were more abundant than forbs; among the latter *Saussurea graminifolia* was the most abundant species. The naur zone was richest both in species and in forage availability. Here, the most abundant forage category as the graminoids, but the shrub *Potentilla fruticosa* was the most abundant species. The goat zone was moderately rich in both species and forage availability the most abundant forage category here being shrubs, particularly the species *Lonicera rupicola*. In terms of floristic composition, the naur and goat zones were the most and the Tibetan argali and goat zones the least similar.

Tibetan argali had very a high selection for forbs, particularly *Saussurea graminifolia* and *Sedum* spp. Naur had highest selection for graminoids, but at the species level naur strongly selected the shrub *Potentilla fruticosa* and the forb *Chesneya* sp. Domesic goat had the highest selection for shrubs, particularly *Lonicera rupicola* and *Potentilla fruticosa*.

The proportions of various food items in the diets were significantly different both at the species (X^2 = 574.8, P<0.001 df=4) and at the forage category level (x^2=242, P<0.001, df=4). The three ungulates shared three common plant species, viz. *Agrostis* sp., *Stipa* sp. and *Potentilla fruticosa* in their diet, but diet overlap at the species level was generally low. At the forage category level, naur and domesic goat had the highest diet overlap among the ungulate pairs compared.

Due to spatial separation and little dietary overlap, there is no apparent food competition during the summer between the three ungulaes at present. However, if densities should increase and cause more overlap in habitat use, naur would bee expected to compete with both goat and argali for food because of their similar foraging regimes, than between goat and argali.

PROBLEM

The Himalayan region, 'the greatest physical feature of the earth', covers approximately 23% of Nepal along its northern border with Tibet. These mountains provide a mosaic of vegetation communities along their altitudinal gradient. This, together with a myriad of topographical features, places the mountains at a comparative ecological advantage over the plains by providing habitats for a unique assemblage of large wild ungulates. Although numbers have diminished in many areas, the Himalaya still support a wide variety of large ungulates including naur (*Pseudois nayaur)* (also known as blue sheep or bharal) and argali (*Ovis ammmon hodgsonn*) (also known as Tibetan argali, nayan or nyan)

A knowledge of the food ecology, paricularly a dietary relationships between sympatric wild and domestic ungulates, is one of the major pre-requisites for address the issue of livestock/wildlife conflicts and to assess the possibility of the multiple-use range resource management.

In Nepal, studies on naur have so far mainly been limited to behavioral and population aspects. Most knowledge on argali has been based on indirect observations like field signs and interviews. A few studies on argali have been carried out elsewhere, such as in Ladakh, India but are limited to general comments. Thus, the current status of argali is obscure and deserves urgent atention in order to carry out long-term conservation activities. The comparative food habits of argali, naur and domestic stock in Tibet have also been studied. The results so far are in agreement with the generalisation that *Pseudois* and *Ovis* are grazers and that the domestic goats are "the black sheep" among livestsock which consume everything edible.

These closely related, similar-sized species of Caprinae, inhabiting the same region, may compete for resources and co-exist either by geographical partitioning of ranges (by factors like altitude, types of terrain, vegetation cover) or by different food preferences, or both. Ecological separation between argali and naur has been reported, as naur prefers precipitous habitats and argali undulating terrain, but nothing has been published about the way the animals partition the habitat. However, there are instances where the two species have been seen near each other in Tibet and in Ladakh, where argali has been reported to colonize typical naur habitat, the possibility of interspecific food competition has been raised.

Therefore, whether these ungulate species are competitors is a question which is still unanswered. This study addresses this issues.

METHODOLOGY

Detailed vegetation analyses were carried out to describe and map floristic composition and other habitat features. Stratified quadrat sampling was employed, placing the transects in an east-west direction in homogenous areas of plant communities. A total of 474 quadrats were laid in different vegetation types. Quadrat size was 2 x 2 m in Lonicera (shrub) communities and 1 x 1 m in the other four vegetaion types. The distance between two parallel transects was maintained at 10 m and the first transect was placed after a random number of steps.

In addition to the vegetation survey, presence of pellets and tracks, altitude, aspect, slope and percent bare ground/scree were recorded to assess general habitat characteristics along the vegetation transects in each quadrat. A herbarium of all the plant species encountered in the field was prepared as a reference collection. Unidentified specimens were later identified at the National Herbarium in Kathmandu. To roughly assess the total number of wild ungulates and map their distributiion, the ungulate habitats were searched out with 8 x 30 binoculars from suitable vantage points. When a herd was observed, a 15-40 variable spotting scope was used to count and classify the individuals unit.

Diet composition was studied by microhistological analyses of faces of all three ungulate species. Direct observation using the bite-count method was employed for goats in order to compare and adjust the faecal analysis data. In addition, feeding site examinations were carried out for the naur and argali so as to supplement the results of the faecal analysis. However, due to low sample sizes and the unreliability pertaining to information on consumed plant species, data from the feeding site examinations are not incorporated in the thesis.

FINDINGS

The Damodar Kunda region provides a mosaic of habitats with a unique aggregation of rare and endangered wild animal species. Apparently it supports carnivores such as the brown bear, grey wolf, snow leopard and possibly lynx, and their prey species such as marmot, pika, naur and argali. The occurrence in Nepal of the latter was first confirmed in this study.

Damodar Kunda is also a good-quality pasture with relatively abundant palatable forage resources such as *Kobresia, Stipa Lonicera*, *Elymus*, *Agrostis*, and *Saussurea* species for both livestock (such as sheep, goat, yak, dzopa and horse) and wild herbivores (argali and naur). The good condition of the pastures is also indicated by the presence of breeding populations of argali and naur and relatively few and low coverage of increaser species.

There is little food competition between argali, naur and goat during summer with current approximate ecological densities of 1.3, 5.5 and 30.1, respectively.

During the winter season, the argali might migrate towards the north-east into Tibet, because the topography of the western side is more rugged and therefore not suitable for argali. Moreover, the villagers inhabiting the western side reported that they had never seen argali in and around their villages. Naur, on the other hand, are likely to move towards the west during winter because of suitable topography. If this is the case, food competition between argali and naur during winter should not occur.

There is little potential for food competition between the wild and domestic ungulates. Thus, animal husbandry and wildlife conservation in the study area during summer seem to be compatible with current traditional herding practice, provided that the wild ungulates are not harassed.

RECOMMENDATIONS

In the future, any increases in the populations of argali or naur or both will probably broaden the dietary overlap between them, thereby raising the potential for interspecific competition for food. In that case, argali being the more selective feeder, it could become the weakest part. Likewise, if stock numbers of goat should increase, it will probably compete for food more with naur than with argali. In addition, excessive grazing by domestic stock during summer may also limit forage availability during winter for the wild ungulates if they do not move out of the area. Therefore, studies of the pasture condition, particularly focusing on the impact of summer grazing by livestock on forage availability during winter and on the carrying capacity of the pasture to determine the optimum stocking level are required to assess the possibility for promoting animal husbandary in the region.

Future studies of naur and argali to determine seasonal patterns of habitat use, winter movements and interspecific competition are needed to draw firmer conclusions.

DEVELOPING A SCHEME FOR APPLICATION OF THE USLE IN NEPAL

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ABSTRACT

In order to select the best land treatment methods for soil and water conservation, it is necessary to assess soil erosion from fields under different land use types. The Universal Soil Loss Equation (USLE) was chosen to estimate soil loss to the base of the slope from the field. Parameter estimations for this equation require fairly long-term rainfall data from a recording rain gauge, soil tests, measurement of slope length and gradient, and estimation of crop and management factors and support practice factors from site-specific experiments. Use of this equation in developing countries is limited because of lack of data. All the available data and information from the literature and field observations were used to estimate the factor parameters of this equation for the Phewa Tal watershed. The soil loss over the watershed was then computed to be 134965.9 tonnes per year. For conservation planning the tolerable soil loss needs to be established using the USLE. Approaches to maintaining soil loss below the tolerable level must then be made by choosing the appropriate cropping management conservation practices.

PROBLEM

Soil is one of the principal natural resources of the earth, being essential for the production of food, fibre, fuel wood and other necessities of life. The International Soil Science Society defines soil as follows:

The soil is a limited and irreplaceable resource, and the growing degradation and loss of soil means that the expanding population in many parts of the world is pressing this resource to its limits. In its absence the biosphere environments of man will collapse with devastating results for humanity.

Such a vital resource is mismanaged and abused in many parts of the world,, and the damage is leading to soil erosion on a vast scale. Soil erosion is the removal of soil from its original location. It is a process of detachment and transportation of soil materials by erosive agents. The factors which influence the rate of erosion are grouped under the headings of energy, resistance and protection. The energy group includes the erosive agents of rainfall, run-off and wind. The remaining factors directly affect the power of the erosive agents. The resistance group is responsible for the erosibility of the soil. Potential erosion of the soil decreases with increasing infiltration of water into the soil. The protective group focuses on factors related to the plant cover. This group is responsible for protecting the soil by intercepting rainfall and reducing run-off and wind velocities.

Man's struggle with soil erosion must have started with the start of crop cultivation. Soil erosion is a national problem in most of the countries in the world. But, in the past,insufficient attention has been given to soil erosion control in most of the developing countries. Rapidly increasing populations of humans and livestock had resulted in over-exploitation of natural resources to meet the ever-increasing demand for food, fibre and fuel. Thus, humans depending upon the natural resources may affect their own environment in a negative way. This poses a great threat to scientific land management and optimum productivity.

METHODOLOGY

This study was based mainly on a literatures review and field observations.

FINDINGS

There are limitations and problems in using the USLE that lead to inaccuracy of results obtained by using the limited data available for estimating the factor values of the equation. Some of the limitations and problems of using the USLE in Phewa Tal watershed area are: (a) short-duration high-intensity rainfall data are not available over a long period of time; (b) USLE was designed to predict sheet and rill erosion from cultivated fields in the USA; results based on US experience cannot be easily applied in this mountainous region where cultivation is carried out on terraced fields on steep slopes; (c) the monsoonal rainfall with its assessnable thunderstorms and hailstorms does not follow US rainfall patterns and (d) the equation does not take into account gully erosion and streambank erosion.

RECOMMENDATIONS

Despite these problems and limitations, soil loss for various combinations of factor values were computed using the USLE. These results should prove beneficial in planning conservation programmes that lead to minimum soil loss from a particular field. At the same time, soil loss computed using the USLE should be evaluated by comparing run-off and erosion data from plots in the area. At present, there are only limited data available from the plot studies. Also, there is a need to develop a new data base over several years to compute the factor values. Soil loss estimated by using the new data base should be verified and supported by the run-off erosion plot measurements. The new data base is needed to modify the USLE for mountainous regions of recent origin, where gully and channel erosion are serious problems. These first steps provide the means of estimation of soil loss and ways for erosion control practices to be applied and a programme started to save Nepal's valuable soil resources.

GENDER ROLES IN AN AGROFORESTRY SYSTEM IN THE EASTERN HILLS OF NEPAL: A CASE STUDY OF SALLE VILLAGE

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ABSTRACT

This thesis describes agrofrestry systems practised in the eastern hills of Nepal. Salle village represents an example of low productivity agriculture in the midst of rapid environmental degradation as a result of deforestation.

The research identified the uses and components of agroforestry systems and their interrelationships, gender division in agroforestry activities, and the impact on women of the existing tree-planting program conducted by PAC (Pakhribas Agricultural Centre).

Results indicated strong interaction among the components (i.e. crops, trees and livestock). Crops are the main components followed by livestock and trees. In the last five years, the number of small ruminants (goats and sheep) was found to have decreased by about 48%. This is related to the prohibition of using grassland (now under three plantations) for grazing animals. On the other hand, new tree species such as *Pinus wallichiana, Quercus glauca, Castanopsis hystrix* and *Juglans regia* have been introduced. However, these species are not suitable to fulfil the village fodder requirement.

The substantial roles of women in agroforestry systems of middle hills are highlighted. The study showed that women make important decisions and contribute their labour in household, farm, livestock and forestry activities. The degree of their involvement, however, varies among scocio-economic groups. It was found that, on average, women worked in various activities for 12 house 49 minutes in a day while men worked for 8 hours 5 minutes. The working times of both were observed to be longer in the monsoon than in winter.

Women have a significant roles in the management of tree species. Although most of the tree management activities such as fodder and fuelwood collection and planting of samplings were reported to be generally performed by both (56%), it was noted that 38% of respondents reported exclusive involvement of women in these activities. The analysis of labour-use patterns also indicated significant differences in the involvement of women as compared to men. Prefernce criteria for tree species were also different according to gender. However, some tree species, e.g. *Saurauia napaulensis*, *Ficus roxburghii, Ficus nerifolia* and *Alnus nepalensis* were preferred by both men and women.

Over-all, women as compared with men, involve themselves more in agroforestry production and management activities. The tree plantation program conducted by PAC has brought some changes and consequences to Salle village. These included changes in livestock population, livestock management, availability of bedding material and some fodders and the division of labour. As the household changes from a free-grazing livestock system to stall feeding, the women find themselves with more work, as children who once took care of the grazing livestock are sent to school. In this context, the improvement of agroforestry systems in eastern hills of Nepal cannot be achieved without the contribution of women.

PROBLEM

Approximately three-fourths of Nepal's land area falls into the middle hills and high mountain categories with elevations ranging from 300 m to 8000 m in the Himalayas. The hill farming systems are based on strategies to manage forest, pasture and arable lands simultaneously and in an integrated fashion to obtain essential items of food, shelter and clothing.

In the past, traditional forestry practices were maintained under low population pressure, but at present they cannot meet the needs of current population. The hills area is geologically unstable, and every year landslides destroy fragile hill-slopes. Landslides are mainly due to deforestation. The increasing needs of more fuelwood and more agricultural land feed humans and livestock, and the felling of tress for short-term gain have all contributed to a rapid rate of deforestation. Over 95% of cooking energy is met by fuelwood. The current livestock stocking rate in the hills is none times larger than the carrying capacity. Some estimates suggest that in just over ten years, from late 1960s to the early 1980s, up to half of the forests in some hill regions have been cut down, with the area under forests reduced from nearly 60% to about 30% of the total area. Because of heavy landslides and soil erosion in agricultural fields, a serious food deficit is developing. Agroforestry is one of the proposed technological solutions to these problems.

Daily activities performed by men and women in Nepalese agroforestry systems reflect the prevailing sexual division of labour, skills, responsibility, and control within the larger society. The success or failure of research efforts depends on the ability of researchers to recognise the social objectives of diverse groups of rural producers and to reconcile or accommodate the conflicts between men and women and between classes of rural clients. In the Neplalese context generally, participation of the people in the public welfare activities is a sort of tradition in the society, where people are courteous and respectful in nature. They possess their own views of life, have natural dignity and respect that can bring community-based developmental activities into effect. Those cover use of natural resources, education and some primary health-care services. However, the problems and opportunities inherent in the gender division of access and control in agroforestry activities, present a special challenge which must deal with women's relationship to the community as well as between groups of women based on caste, ethnicity and source of livelihood.

OBJECTIVES

This study had the following objectives:

1) to describe the various components and their interrelationships in the existing agroforestry systems;
2) To identify and compare the participation of male and female farmers in the existing agroforestry and household activities;
3) To evaluate the constraints, opportunities and impact of the PAC's private tree planting program toward a sustainable agroforestry system using gender-based analysis.

METHODOLOGY

Data collection was done using a combination of different methods as follows:

1) Pre-diagnostic Description

Selection of the study area and an initial understanding of agroforestry systems of the area followed a review of existing sources of information. Available literature and other sources of information on secondary data such as climate, soil types and topography were collected, examined and consolidated for the study.

2) Participatory Rural Appraisal (PRA)

PRA was conducted for one week, as PRA is increasingly being recognised as a data-collection method which increases farmers' participation and focuses more on the farmers' decision-making processes than conventional methods do.

The following data and data collection methods were employed with the PRA:

i) wealth ranking,
ii) agro-ecosystem mapping (resource mapping),
iii) matrix scoring,
iv) activity profiles and daily routines,
v) participant observation,
vi) semistructured interviews of key informant groups, and
vii) group interviews

1) Formal Survey

Preliminary testing of questionnaires was conducted in ten households, and any improvements or changes needed were incorporated. The number of households to be interviewed was decided on the basis of analytical results of the PRA, considering ethnic groups and economic status. Tow-way stratified sampling method was applied to select 103 households.

The formal questionnaire was used to obtain quantitative and statistically more precise information on farm size, family structure, land ownership, farmers' preferences etc. the interviews were conducted with both female and male farmers of the same household so as to remove gender bias and to get reliable results. Information was collected to identify women's status in the family, including age, marital status, family size etc. This also included their farming knowledge with respect to agroforestry, access to and control of resources skill and interests, and problem in their participation in training activities.

FINDINGS

1) There exists strong interaction among the components i.e. crops, trees and livestock, in which crops are the main component followed by livestock and trees.

2) In the last five years, the number of small ruminants like goat and sheep was found to have decreased by about 48%, mainly because of the ban on using grassland for grazing if

it is under tree plantation whereas newly introduced tree species like *Pinus wallichiana, Quercus glauca, Castanopsis hystricx* and *Juglans regia* are not suitable to village fodder requirement.

3) Women make important decisions and contribute their labour to household, farm, livestock and forestry activities. The degree of their involvement, however, varies among socio-economic groups. It was found that, on average, women worked in various activities for 12 hours 49 minutes per day while men worked 8 hours 5 minutes. The working time of both was observed to be longer in the monsoon than in winter.

4) Women play a significant role in the management of tree species as there was found their exclusive involvement in the tree management activities like fodder and fuelwood collection and planting of saplings.

5) Preference criteria for tree species were different between the genders. However, some tree species like *Saurauia napaulensis, Ficus roxburghii, F. nerifolia* and *Alnsu nepalnesis* were preferred by both men and women.

6) The tree plantation program conducted by PAC at Salle village has brought some changes and consequences which include changes in livestock population, livestock management, availability of bedding material and some fodder and the division of labour.

7) As the household changes from a free-grazing livestock system to stall feeding, the women find themselves with more work as children who once took care of the livestock are sent to school.

8) Over-all, women, as compared with men are involved more in agroforestry production and management activities. The improvement of agroforestry systems in the eastern hills of Nepal cannot be achieved without the contribution of women.

RECOMMENDATIONS

1) Development of an upland maize and potato based cropping system in order to make the village development sustainable should be the policy level approach in the area. This should bring further interactive changes in the relationship between crop, livestock and tree components which should be addressed simultaneously to lessen the complexity of the system.

2) The findings should help in formulating policies which strengthen women's participation in improving crop production activities.

3) The management of fodder and fuelwood tress may be more efficient if women are provided with the necessary technical support, training and encouragement to participate in meetings etc.

4) Through the analysis of time allocation of women, it can be suggested that the training should held in winter rather than in monsoon.

5) Women's concerns should also be integrated and analysed before launching further agroforestry and livestock oriented research and programs in Salle village.

6) Species selection, site management and further training related to agroforestry activities should reflect the needs and aspirations of local people to make any program successful.

7) Since the long-term success of any development program depends to a large extent on the participation of local people, this aspect should be adequately addressed when initiating rural development programs in general and forestry development programs in particular.

FURTHER RESEARCH

Research is needed to identify the best fodder tree species for combination with maize, potato, millet, soybean and wheat. Shading effects were described as the main disadvantage of agroforestry, hence, threes giving less shade to above mentioned crops should be experimented with.

A CRITIQUE OF LAND RESOURCE MAPS OF NEPAL (1980-1985)

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ABSTRACT

Resource information has special significance in Nepal, where the diversity in biophysical conditions is extreme. Poor resource information may lead to wrong decisions with regard to irrigation development, agricultural credit and input supply, agriculture and forestry research activities, infrastructural development and land settlement plans. Wrong decisions result in the inefficient use of available resources, in loss of production, and in the accentuation of the provery of country.

In the past, several government departments have collected resource information to meet their interim requirements, but comprehensive information covering the entire country is lacking. The Land Resource Mapping Project (LRMP) 1980-1985 was initiated to fill this gap and create a basis for rational development at various levels. This project produced various sets of maps and accompanying reports but these maps have limitations which may restrict their use. This study found various limitations, which are mentioned not because the survey is considered in any way deficient, but so that its inherent weakness and underlying principles should be understood by its users. Various recommendations are made based on the findings of the study.

PROBLEM

The diversity within and between regions is a result of the complex interactions between topography, climate, geology and land use. Even places within one small catchment show marked contrasts in terms of opportunities and constraints for development. However the general land use pattern that can be seen at present may be quite different from what the land can offer. Vulnerable land may be being used beyond its carrying capacity, while other land may be left unused or used below its potential. In the former case, erosion and other forms of soil degradation associated with a decrease in production will be the ultimate result, while in the latter case potential productivity is foregone. Amongst other errors which may result from poor resource information are wrong decisions with regard to irrigation development, agricultural credit and input supply, agriculture and forestry research activities, infrastructural development and land settlement plans. Wrong decisions result in the inefficient use of available resources, in loss of production, and in the accentuation of the proverty of the country.

Certainly physical resource information alone cannot give complete answers to the questions resource planners and managers would like to ask. For instance, the pattern of land use that farmers are adopting or would like to adopt is controlled not only by biophysical land factors but also by their own socio-economic conditions and cultural attitudes. However land resource maps, if interpreted carefully by taking cultural and socio-economic factors into account, could be a very useful tool for the purpose of sound land-use planning, management and policy making.

These resource information has special significance in Nepal, where the diversity in biophysical conditions is extreme. In the past, several government departments have collected resource information to meet their interim requirements. Comprehensive information covering the entire country was largely missing. The Land Resource Mapping Project (LRMP) 1980-1985 was initiated to fill this gap and create a basis for rational development at various levels. The project has produced the different sets of maps and accompanying reports. However these maps have some limitations which may restrict their use.

METHODOLOGY

The study was based on a literature review.

FINDINGS

For the following maps produced under the LRMP, the limitations discovered by this study are as follows:

Land Capability Maps

1) The capability classification relies on land systems maps supplemented by climatic factors (temperature and moisture) recorded at only a limited number of stations.The interpretations of the land systems maps for land capability discriminates only on slope with soil depth inferred and ignores all other soil characteristics. Such an approach can be judged against that used in Malawi, where the conversion table makes use of nine limiting factors including soil texture, permeability and surface hindrances. This gives an indication of the nature of future work in Nepal.

2) The scale of mapping, 1:50,000, means 1 cm^2 on the map represents 0.25 km^2 on the ground. Consequently, sites less then 25 ha are not shown. This means, obviously, that impurities within map units of as much as 25 ha may have been included in each delineation.

3) Class III land (slope ranging from 5° to 30°) is considered suitable for arable agriculture as long as terracing is done. But the forestry requirement of the country (43% of its total area) will have to be met at least in part from this class of lands. With this need it would have been reasonable to divide Class III land on the basis of suitability for forestry and agriculture.

4) The irrigation classification is restricted to Class I (nearly level) and Class II (slope ranging from 1° to 5°) lands. Class III, where the population density per cultivated hectare is greatest, is completely left out. The irrigation classification deals with the nature of deficiences: topographic, drainage and soil, and hence is applicable for both irrigated and rainfed farming. The maps could have wider application if the irrigation classification was carried out on all cultivatable areas.

5) The irrigation classification, though it gives the nature of deficiences, does not give an idea of their magnitude. Similarly, the availability of water for irrigation has not been considered. This means that the feasibility for irrigation development cannot be precisely

assessed.

6) The capability maps, by their nature, do not consider remoteness, soil fertility status, water availability, marketing facility and socio-political factors in the determination of the classes.

Land Systems Maps

1) The scale of these maps is 1:50,000, hence areas smaller than 25 ha cannot be delineated. In practice the delineation are probably even more generalised than this.

2) In mountainous terrain and on recent alluvial terrain, the variability of soil characteristics is extreme, even over short distances. Since the maps are based on aerial photo interpretation, soil variability is not specifically surveyed. The land system legend indicates only "dominant soils" and "dominant textures". Besides, soils have been described only at Great Soil Group Level, which is of little practical value and not comprehensible except to pedologists familiar with soil taxonomy.

3) The practical value of aerial photographs for base maps is not recognised.

LAND UTILISATION MAPS

1) Here again, because of scale, the minimum area that can be represented is 25 hectares. This means that many significant patches of agricultural land use in the rural economy cannot be seen on the maps.

2) Land in the hills has been divided into only two units - Level Terrace and Sloping Terrace. In practice, depending on the extent of the slope, soil quality and climate, there can be many more types of land use which might have been taken into account in the land units. The classification system masks such variability.

3) The maps do not show the occurrence of cash crops other than the most common agricultural ones. For these other cash crops, knowledge transfer thus becomes a separate and completely new exercise.

4) Grazing lands have been classed on the basis of climatic conditions and not on carrying capacity, which would be of much more value to planners.

RECOMMENDATIONS

The Land Resource Maps of Nepal (1980-1985) should not be regarded as serving every purpose and their limiations should be clearly understood.They are of reconnaisance nature and suit the purposes of broad land use planning and decision making. They provide also some valid basis for further survey. The 1: 50,000 scale is probably the limit of usefulness of the land systems approach and more detailed information on, for example, soils would be better gathered on the basis of soil series or soil/landform mapping. Likewise, grazing needs a special purpose assessment of carrying capacity. With such information the matching of land utilisation type requirements to land qualities, the essence of land evaluation, would be possible.

However, the LRMP survey does provide, for the first time, up-to-date information of a consistent quality for the whole of Nepal, to be used as a basis for broad land-use planning, policy making and more detailed survey. The limitations have been pointed out not because the survey is considered is any way deficient but so that its inherent weaknesses and underlying principles should be understood by its users.

SOIL NUTRIENTS UNDER DIFFERENT FOREST TREE TYPES OF PHULCHOKI HILL

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ABSTRACT

Physico-chemical analyses for pH and for six elements (N,P,K, Ca, Mg and Fe) were done on soils in various forest trees of Phulchoki hill forest near Kathmandu, during winter, spring and rainy seasons. Soil samples were collected from fifteen stands (20 m x 40 m) on the northern slope and eight on the southern slope, the altitudinal difference from one stand to the next being 50 m. The north slope of the hill was found to contain more soil nutrients than the south. Nutrients were generally higher at lower elevations on both the slopes, but Mg and Fe did not exhibit this pattern. Soils under a dense stratum of trees were rich in every analysed element. Seasons and altitude were found to play a significant role in the variation of nutrients on both the slopes.

Species such as *Acer oblongum, Myrsene* sp. and *Pyrus pashia* present at lower altitudes and *Quercus semecarpifolia* and *Rhododendron arboreum* at higher altitudes occurred frequently in nutrient rich soils. *Dodocadonia grandifloria* and *Ilex fragilis* were generally common in soils rich in Mg and Fe.

PROBLEMS

Natural forests are being destroyed for various reasons, and the obvious problem is ecological imbalance. Since the mid 1950s, heavy destruction and encroachment of forest in the hills and Terai of Nepal, have posed a great problem of the loss of top soil each year. Forest and soils being complementary to each other, the present work aims to find out the nutrient status in the soils of nearby hills covered by forests.

OBJECTIVES

1) to establish the seasonal and altitudinal variations in soil nutrients.
2) to study the nutrient status of various forest types.
3) to find relationships between soil nutrients and tree species.
4) to find plants suitable as indicators of particular nutrients.

METHODOLOGY:

The study area was demarcated and a transect slopes was drawn from the foot of the hill to top (2790 m). The south-facing slope started from a base line at an altitude of 2090 m, and the north-west facing slope starting from 1620 m. A systematic method of sampling was adopted and a 20 m x 40 m stand size was found appropriate to represent all vegetation present. Soils were collected under the canopies of particular trees present within the stands.

Prior to collection, any debris, leaf litter, or root mats present on the forest floor were removed. A pit was excavated to the base of the soil profile and generally a depth of 100 cm was set for the sampling sequence. Altogether, 89 soil samples-69 from the north-west facing slope and 20 from the south slope were collected in each season. Soils under 26 different tree species were analysed for PH and the macroelements N, P, K, Ca, Mg and the micronutrient Fe by prescribed techniques.

FINDINGS

Topography and aspect along with parental material have played a key role in the differentiation of forest types on Phulchoki. Aspect has caused the northern slop to become more dense and with more canopy by providing less exposure to both wind and sun light and thus facilitating retention of moisture and nutrients. The southern slope is steeper and highly exposed to light and wind resulting in high temperature and high run-off due to which the area is sparsely covered with ground vegetation; these factors lead to less litter in the substrate and ultimately to decrease the nutrient status of the soil.

The presence of more soil nutrients (except Mg and Fe) in the lower part of the forest on the north-west slope and the south facing slope shows a distinct variation in soil nutrients according to aspect, but in each case it has revealed a simple conclusion that more dense the forest more will be the soil nutrients. The higher amounts of Mg and Fe at higher altitudes on both slopes seem due to heavy deposition of these elements in and around that portion of the hill, and the high density of *Quercus semecarpifolia* and *Rhododendron arboreum* in such sites indicates that these species prefer these elements.

Various types of broad-leaved deciduous tree species seem to provide more soil nutrients, as revealed from the higher nutrient levels at lower altitudes.

SOME MANAGEMENT DETERMINANTS FOR SUCCESS OR FAILURE OF THE COMMUNITY FORESTRY PROGRAM IN KASKI DISTRICT, WESTERN NEPAL

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ABSTRACT

This study was conducted to identify traditional forestry practices that influence Nepal's community forestry activities; to compare the program staffs and community's expectations and perceptions of, and attitudes toward Nepal's community forestry program; and to determine the relationship between people's participation in community forest management and success of community forestry programs.

Data were collected through semi-structured questionnaires from 143 household heads of two panchayats, Kalika and Rakhee, in Kaski district, Western Nepal, and from 30 staff members involved with community forestry programs. These were analysed using means, standard deviations, frequencies, percentages, Chi-square test, and Wilcoxon-Mann-Whitney test for large samples.

Among the major findings of the study were:

1) The success or failure of community forestry program is not affected by the program's similarly to or disparity with traditional forestry practices except in terms of ownership and protection and conservation practices.

2) The success or failure of community forestry program is not significantly related to the congruency or disparity in the expectations, perceptions and attitudes of the people and the staff.

3) Nationalisation, which is widely blamed for Nepal's deforestation, was not responsible for deforestation, at least in the two panchayats studied.

4) People's participation in community forestry programmes is low and not related to their success or failure.

5) An influential forest committee and a supportive panchayat leadership are major factors that contribute to the success of a community forestry programme.

6) There is nevertheless a generally low membership of forest committees, even through such committees facilitate people's participation in the programmes.

7) The protection and conservation of the community forest solely depend on forest watchers, who are badly underpaid and are only supported by community forestry programme as long as the project is there.

8) Legal authority of ownership of community forests is not given to the forest users' group but to the panchayat, even thruogh the forest users' boundary does not generally coincide with that of the panchayat's political boundary.

9) The people's ideas, traditional practices and inclinations are not actively and consciously incorporated in the community forestry programmes.

10) Community forestry programs focus on the planting of trees and have no apparent concern with agroforestry or the intercropping of the panchayat forest with agricultural plants.

11) Community forestry program staff lack the necessary facilities and equipment to improve their working environment and their implementation capabilities.

12) Community forestry programmes are hindered by the presence of other forestry projects with similar activities but with higher funding and rates of payment.

PROBLEMS

Various studies conducted in Nepal have indicated that several ecosystems have reached or are reaching their carrying capacity and that deforestation, erosion and changes in rainfall patterns are caused by use of resources beyond their carrying capacities.

Since 1978, establishment of community forests has been a major policy of the Ministry of Forest and Soil Conservation and has appeared to be a good solution to Nepal's deforestation problem.

This study tried to investigate the role of management in the success or failure of community forestry programmes in Nepal. For this purpose the perspectives of program managers (staff) and of communities (programme participants) were investigated. Biophysical and socio-economic factors were controlled so that the management determinants could be more fully understood. Efforts were made to identify the disparities between staff and communities in their expectations and perceptions of, and attitudes towards community forestry programs and to show what impact these expectations, perceptions and attitudes have on the success of the programmes.

METHODOLOGY

The study was conducted in two village panchayats with almost the same biophysical and socio-economic conditions and located in Kaski District near Pokhara in Western Nepal. One of the study areas, Kalika Panchayat, has a relatively more successful community forestry programme than the other.

The analysis was carried out at two levels: the household and the programme levels. The household level's unit of analysis was represented by the household head (household refers to a group of persons living together and sharing the same housekeeping, kitchen and eating arrangements). The programme level's units of analysis were represented by panchayat forest foreman, panchayat forest watcher, forest guards, the community forestry assistant, forest

ranger, and the forest officials at the district level and at the central level (CFDP chief, unit chief and other officers of the units).

Two panchayats were selected randomly to serve as the study areas. The two Panchayats were Kalika Village Panchayat and Rakhee Village Panchayat, both within the hill district of Kaski.

The population was stratified according to major caste/ethnic groups so as to represent each group proportionately. Sample size was decide to be 10 percent base on the availability of time and resource.

The following methods were applied for data collection:

1) group discussion
2) interviews
3) sample survey
4) observation

The sample survey was conducted through a pre-tested semi-structured questionnaire. The interviews consisted of both open and closed questions. The survey of household respondents was carried out with the help of trained research assistants.

FINDINGS AND RECOMMENDATIONS

There is no significant relationship between the congruency or disparity between programme staff's and the people's expectations and perception of and attitude towards the community forestry programme with the success or failure of the program. Higher level or people's participation is related to a community forestry programme's success even if such participation does not cover all programme activities.

Community forestry programmes should not be expressed in the annual work plan as mere numerical entries.This practice leads to purely physical or quantitative records of achievements at the field level whereas community forestry should have a strong qualitative aspect. It has a slow pace in the beginning but should soon accelerate when people see how it benefits them socio-economically and environmentally. The people used to have a traditional practice of tapping every household for forest protection and conservation on a rotational basis. This tradition should be revived in the programs, at least as supplementary to the hiring of watchers.

The programmes seem to focus only on the planting of trees. Intercropping of the forest with some agricultural crops should be strongly considered as this should increase the economic returns and at the same time decrease the tending cost and watchers' costs. Besides, intercropping will also help boost the income of the villagers.

The forest committee and the people's support of the committee are vital to the success of a community forestry programme. The committee should be legally recognised. For even though the present decentralisation act recognises user groups as legal institutions, it only recognises the political boundary of the panchayat; the forest and its users do not follow that boundary. Sometimes the people reside in one panchayat but use the forest of another panchayat especially if that forest is within their vicinity. In some cases, therefore, people of

two or more panchayats might be using the same forest, and sometimes conflicts arise. Legalisation of the forest committee plus careful selection of its members would enable the committee to settle disputes that the programme officers, especially those at ranger level, lack the necessary facilities and equipment to improve their working environment as well as their capabilities. These officers also appear to lack such training and orientation to make them competent and confident enough to work with the people as extension agents of the Department of Forest.

The presence of other forestry projects with similar activities but with different economic norms/rates hinders the progress of such projects with lower budgets or lower rates as the community forestry programme. Community forestry generally expects and seeks people's participation and thus it has lower rates of payment than high paying projects in the neighbourhood. As far as possible, therefore, common or more equitable norms and rates should be adopted for all the projects. It would help too if the duplication of activities in the same areas by different projects should be avoided as far as possible.

BEGINNING WITH BUFFER ZONE MANAGEMENT: A CASE STUDY FROM ROYAL BARDIA NATIONAL PARK, NEPAL

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ABSTRACT

In order to share the benefits of protected areas among neighbouring communities and to manage forest resources outside protected areas for their sustainable use, recent amendments have been made in the National Parks and Wildlife Conservation Act of Nepal, 1992. The Act has made provision for establishing a buffer zones around the protected areas.

This study was conducted along the southern boundary of Royal Bardia National Park to survey people's perception and natural resource use, with a view to developing a general proposal and appropriate approaches for a buffer zone management programme. A general household survey (n=210) was conducted in twelve Village Development Committees (VDC) of which five were selected for a more intensive study.

Crop damage and daily needs such as fuelwood and fodder were perceived as major problems by the local people. Illegal use of the National Park for fuelwood and grazing by wards bordering the Park but not any other forest was significantly higher than that by wards bordering a forest. Supply and demand for fuelwood, timber and fodder were estimated for five VDCs. Timber was found to be in deficit for one VDC, fuelwood for two VDCs, and fodder for all five VDCs.

Crop damage by wild animals was reported to occur by all VDCs, but the extent of crop damage varied locally. Crop damage in wards away from the Park but with a corridor to it was significantly higher than in those without a corridor. Chital and wild boar were found to be the main crop raiders in the study area. In the western sector of the Park rhinoceros and wild elephants also contributed significantly to crop damage in specific locations.

Local people's, expectations from the buffer zones providied under the Act were identified. Lack of irrigation facility and unemployment were the major priorities for economic development of this area. The potentials of different forests outside the National Park were assessed and general recommendations for buffer zone management were made. A buffer zone for five VDCs west of the Babai River was proposed, with site-specific recommendations regarding fuelwood, grazing, crop damage and local community development.

PROBLEM

Royal Bardia National Park (RBNP) was formerly used by local people for grazing livestock, firewood collection, hunting, fishing and collection of minor forest products. Because of the low human density, there was probably a balance between the needs of local people and the forest resources, particularly for the indigenous Tharu communities which formed the dominant ethnic group of the area. Now the internal population growth and immigrations of the hill people have increased the pressure on natural resources.

Before the Parks was declared a protected area some parts of it (the Babai valley and Bagaura Phanta) were being used for agricultural production as well. Hence, conflicts started right from the establishment of the protected area.

Now it has become widely accepted that the success of conservation is highly dependent on the dedication and support of the local people, and that to develop appropriate solutions for a particular area it is essential to understand localised constraints and possibilities. Before creating and managing buffer zones around the RBNP, it becomes essential to understand the problems of local people, the resources needed by them and the availability of the resources. The forest pockets extending from the boundaries of the park may not be sufficient to meet local needs. Hence there is a need to look at specific locations to determine management options which could be helpful to optimize the effect of the buffer zones on neighboring communities and to minimize impacts on the park. As community development is one of the objectives of buffer zone management (BZM), to know the expectations of the local people from the NPWC Act is important.

METHODOLOGY

A preliminary survey was conducted in 108 wards of 12 VDCs in the study area to locate the wards which border the National Park boundary (stratum 1) and which do not (stratum 2).

The following steps were then taken:

a) Out of the 108 wards in the study area, 15 (13.8%) were selected as sample wards. Five wards from stratum 1 and ten wards from stratum 2 were then randomly selected, according to the proporions of the two strata in the total.

b) A total of 210 households (13.2% of the 1585 in the sample wards) were selected for a household questionnaire survey. From each sample ward 14 households were then randomly selected. The questionnaire covered various issues related to fuelwood grazing, crop damage and buffer zone management.

c) To look at policy issues at the ward level, 23 randomly seleced ward leaders were interviewed with a prepared set of questions.

d) Interviews with the park warden, former warden Army commander, and King Mahendra Trust for Nature Conservaion (KMTNC) manager were conducted to gather information about potential buffer areas and different aspects of their management. Rangers and senior game scouts were also asked about the use of park resources by the local people and their perceptions regarding the buffer zones.

e) Two group discussions with local people and ward leaders were held, primarily to brief them on the aim of the study and to get a general picture of the area.

FINDINGS

Crop damage and meeting daily needs such as fuelwood and fodder were perceived as major problems by the local people.

Illegal use of the National Park for fuelwood and grazing by wards bordering the Park was significantly higher than by those which do not.

The proposed buffer zone in the five VDCs west of the Babai River includes all land inside the boundaries of these VDCs except part of Baganaha forests.

The supply and demand estimate for fuelwood, fodder and timber in the five selected VDCs, showed that one VDC (Shivapur) has a timber deficit, two VDCs (Shivapur and Neulapur) with fuelwood deficit, while all the VDCs have he fodder deficit.

Crop damage was particularly important and was perceived as the highest priority problem by all VDCs.

People wanted government involvement mainly to control the harvesting of the resources and to ensure a fair sharing of the benefits.

Local people showed a keen interest in hunting of wild animals other than endangered species within the buffer zones.

RECOMMENDATIONS

Before implementing a buffer zone management programme in RBNP, it is essential to conduct a complete inventory of all resources available within the buffer zone. This inventory would not only disclose the resource situation in the area but would also be a basis for evaluating the effect of buffer zone management in the future.

The National Parks and Wild Life Conservation Act, 1992 allows the use only of fallen and dead trees for fuel and fodder. It does not clarify the position of other forest products which are quite important for local people (timber, vegetables, rattan, fish, snails etc.). Hence these resources should also be taken into consideration.

Management of the buffer forests should be with the active support of local communities. Army movement in the buffer zone is not recommended

There is provision for the formation of user groups to manage resources in the buffer zones. The buffer zone of the southern boundary of RBNP should be managed by a steering committee consisting of:

- leaders of the 12 VDCs,
- a Park representative, and
- a representative from the District Forest Office.

Under the umbrella of this committee there should be a user group in each VDC. The buffer zone management committee should aim to increase fuelwood supply by providing seedlings and technical assistance to farmers to plant trees on private lands, by establishing community plantations and by better management of buffer zone forests. Establishment of nurseries to provide seedlings is therefore a high priority.

Farmers should be encouraged to stall-feed their livestock particularly through subsidies to establish bio-gas plants,whith would not only reduce the firewood demand but also enable farmers to get more dung required for the bio-gas plant.

Collection of thatch grass is essential for the local community and so should be continued.

Irrigation was a key issue raised by the respondents. Hence needs to be involved in this sector also as it is the basis for the economic development of the local farmers.

A fund for assisting private initiatives such as cottage industries should be established.

Small farmers working on alienable land should be given secure title so as to encourage them to improve such land.

Agroforestry may be a suitable option in some buffer forests. In some buffer zone areas elsewhere, this has been extremely successful.

Rural services such as health posts, drinking water and school support are good tools for encouraging local participation. Although such services were not of highest priority according to local respondents, BZM could still assist with them by providing initial technical and financial support. However the responsibilities for management and maintenance should be transferred to the local villagers.

Despite improved management activities, the high population growth may still exceed the resource supply. Family planning programmes are therefore urgent at the village level to keep a balance between human needs and available resources in the future.

Grass cutting along roadsides should be allowed. as this would relieve some of the local grazing problems and is essential to prevent wildfires from throwing cigarettes by passengers.

Hotels and resorts should not be permitted inside the Park and contracts with existing operators should be terminated in due course. Instead, the buffer zone should be opened for such purposes.

The following specific recommendations were made regarding the buffer zone west of the Babai:

1) Provide timber and thatch needs to build machans easily.

2) To avoid sleepless nights for many farmers, some stations with improved sound making devices (sound making devices in different areas could be connected by ropes and controlled by a station) are essential like between Hattisar and Park Headquarter, between Park office and Chitkaya, and between Chitkaya and Motipur.

3) Local people should be helped to improve their fences and in areas where crop damage by rhinoceros and elephants is serious, such as in Shivapur ward of Thakurdwara and Kailashi ward of Suryapatuwa, trenches are recommended. Electric fencing powered by solar panels could also be explored as an option for preventing crop damage by these large mammals.

4) Despite providing fences there should be some entry points for the local people.

Otherwise the fencing might be ineffective, as has happened in the Koshi Tappu Wildlife Reserve.

5) Certain crop species that are useful to local people but are not palatable to wild animals should be encouraged, for example bamboo, eucalyptus, pine, teak and rattan may be practical for planting along the Park boundaries in the buffer zones.

6) In the long run the fuelwood and grazing needs of two VDCs (Shivapur and Neulapur) need to be met by encouraging private plantations. However, the following should be considered as short-term solutions:

   a) Grass cutting for stall feeding should be allowed inside the National Park and fuelwood depots should be established in Shivapur and Neulapur.

   b) The National Park could demarcate some Park land in these areas as buffer zones to allow people use of resources. Possible areas for this are the Shivapur Phanta forest and bordering areas of the some wards of Neulapur VDC.

   c) Fuelwood depots could be established in Suryapatuwa, Thakurdwara, Neulapur and Bangnaha, so that excess from some areas could be supplied to deficit areas. Such depots could be supplied by collecting wood from buffer zone forests. The BZM committee and user groups should manage the fuelwood depots and charge nominal fees to generate income.

   d) The unpalatable bush encroachment in Bathanapur forest, Bhansariya forest and Kaligaudi plantation could be dealt wih.

   e) As the south-west sector of the Park has great wildlife potential, tourism in this area could be promoted, provided is carefully monitored. Besides revenue generation, tourism is a good way to solve unemployment problems and provide a market for local agricultural products.

   f) There is a legal provision for killing wild boars entering private farmlands. However, this is not practised since the use of firearms is prohibited. Hunting of wild boar and chital should be permitted in buffer zones by issuing hunting licences. Such hunting licences would generate added revenue for BZM.

SYSTEMATIC ADAPTIVE CLUSTER SAMPLING FOR ASSESSING RARE TREE SPECIES IN SHIVAPURI WATERSHED AND WILDLIFE RESERVE, NEPAL

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ABSTRACT

The need for biodiversity conservation in Nepal has become prominent because of deforestation and degradation of forest. One of the problems in this respect is selective removal of preferred tree species, which give rise to rarity of these species. Estimates of the density and distribution of rare species are often approximate and of the limited use in biodiversity conservation and management. This situation demands an effective sampling design that yields precise data.

In this study the Systematic Adaptive Cluster Sampling (SACS) method with spatial information was used for the estimation of density and spatial distribution of three rare tree species in Shivapuri Watershed and Wildlife Reserve, Nepal. In this method an initial probability sample is selected and whenever the species of interest satisfies the condition (at least one tree of the seleced species should be encounered in a sampling unit), units in the neighbourhood of that observation are added to the sample. Using the partial selection and inclusion probabilities of the sampling units to be included in the sample, population densities are calculated.

Spatial distribution maps were produced using GEOEAS (a geostatistical tool), and the sample variances obatined for different species were compared with those from conventional designs for efficiency.

This study showed that the SACS design gives better estimates of populations and smaller sample variances. The estimates were found to be influenced by level of rarity, cluster sizes and within-network variances. The three rare tree species selected were found sparsely distributed in very few and small clusters. *Michelia kisopa* was found to be the rarest of the three species.

OBJECTIVES

1) to apply SACS and assess its potential in determining the spatial distribution and density of three rare tree species in the Shivapuri Watershed and Wildlife Reserve, Nepal, viz:

   Schima wallichii (chilaune)
   Daphniphyllum himalense (raktachandan)
   Michelia kisopa (champ)

2. To spatially analyse the distributions of the selected rare tree species and prepare spatial distribution maps.

METHODOLOGY

The spatial distribution maps were produced using the Geostatistical Environmental Assessment Software. To determine the efficiency, the sample variances for different species by adaptive procedure were compared with the sample variances from the conventional sampling design.

Sampling points located on the maps were identified in the field using aerial photographs, protractor, compass, altimeter and measuring tape. Square-shaped sampling units were adopted and the south-west corner of the sampling unit was considered as the starting point of the unit. To determine he boundary of the units, the breaking-tape method was used.

In this study, stems larger than 12 cm DBH (diameter at breast height overbark i.e. 1.3 m. above ground level) were classified as trees. Stems having DBH between 5 cm and 12 cm were dassified as saplings, and stems smaller than 5 cm as regeneration. Plot sizes for regeneration and saplings were as taken 50 m^2 and 200 m^2 respectively. In all sampling units, three types of plots were started from a common point (south-west corner of sampling unit).

Simplicity to implement:

The SACS is simple to implement. The selection of initial sampling units can be done easily. Adding more units adaptively can be done easily by visiting units systematically in the field.

This method requires simple instruments like compass, hypsometer, altimeter, measuring tape and diameter tape. These are easily available in the organisations related to forestry in Nepal. Moreover, it only requires a basic knowledge of statistics and inventory skills, which most of the foresters in Nepal already have.

FINDINGS

The study showed that the SACS design gives better estimates of population with smaller sample variances and that the estimates are influenced by the level of rarity, cluster sizes and within-network variances.

The three selected tree species were found to be sparsely distributed in very few and small clusters. *Michelia kisopa* was found to be the rarest, followed by *Daphniphyllum himalense* and then *Schima wallichii*.

No significant correlation between the selected tree species (trees, saplings and regeneration) and environmental factors (altitude, aspect and average plot slope) have been found.

RECOMMENDATIONS:

To protect *Michelia kisopa*, a special conservation plan should be prepared and immediately implemented.

Since it is not possible to assess all rare species by sampling, priorities for further work should be determined according to rarity.

It appears important to combine the SACS data with a general forest inventory plan. The reason for this is that the assessing of rare species only might be costly. The ways of incoperating SACS data into general forest inventory plans have to be researched further. The cost-effectiveness of the SACS method should also be investigeted.

Although all the tree species found in Nepal have not been studied, most of the commercial tree species of Nepal are becoming rarer and endangered. To conserve the species for balanced ecosystem and sustainable use, conservation plans and their implementation are required. For this purpose, effective estimate of the density and distribution of the rare tree species is very urgent.

If the statistical and practical conditions required for the SACS mehod can be met, this method should be useful to assess the rare tree species in Nepal.

GROWTH AND ECTOMYCORRHIZAL DEVELOPMENT OF PINE SEEDLINGS INOCULATED WITH THE FUNGAL SYMBIONT *PISOLITHUS TINCTORIUS*

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ABSTRACT

The use of the fungal symbiont *Pisolithus tinctorius* has potential application in afforestation and reforestation programs. It is one of the few species of ectomycorrhizal fungi ecologically adopted to adverse sites. Pine seedlings with "tailormade" *Pisolithus* root systems survive and grow dramatically better on adverse sites.

A negative correlation was found between the percentage of short roots that developed *Pisolithus* ectomycorrhizae and the growth of *Pinus kesiya* and *P. roxburghii* seedlings.These with significantly less *Pisolithus* ectomycorrhizae development attended maximum growth. *Pinus patula* seedlings with significantly more *Pisolithus* ectomycorrhizae exhibited a lower growth. The growth of *P. wallichiana* with significantly more ectomycorrhizae formed by a naturally occurring fungus was severely inhibited. *Pinus patula* developed the highest amount of *Pisolithus* ectomycorrhizae short roots.

Higher fertility levels produced lower ectomycorrhizal short root development and higher biomass of seedlings.

The most important indigenous pines of Nepal, *P. roxburghii* and *P. wallichiana* are ectomycorrhizal with *Pisolithus tinctorius,* which had not been recorded previously. *Pisolithus tinctorius* may inhibit seedling growth at the early stage of inoculation. More research is necessary to reach any major conclusions.

PROBLEM

Nepal is in the midst of an environmental crisis. The green forest, once considered the treasure of Nepal, is rapidly declining. The natural erosion process in the hills is very high. In order to maintain the ecological balance and meet the increasing demands for fuelwood and fodder, Nepal will require about 1.88 million ha of plantation forest by the turn of the century. Pines are the primary species which can be grown successfully in those left-over degraded areas, where other no forms of land use can be practised. Mycorrhizal association is one of the important factors in the survival and growth of forest trees. This is true especially in the case of pine.

The use of fungal symbiont *Pisolithus tinctorius* has potential application in afforestation and reforestation programmes. It is one of the few species of ectomycorrhizal fungi ecologically adopted to adverse sites. Pine seedlings with "tailormade" *Pisolithus* root systems survive and grow dramatically better on adverse sites.

OBJECTIVES

1) to determine the effects of the fungal symbiont *Pisolithus tinctorius* on the growth and ectomycorrhizal development of five species of pine, *Pinus kesiya*, *P. patula*, *P. roxburghii*, *P. wallichiana,* and *P. virginiana.*

2) to correlate the fertility status with the ectomycorrhizal short root formation, and the growth of pine seedlings.

METHODOLOGY

Pine seeds were obtained from the Forestry Department, Kathmandu, Nepal and F. W. Schumacher Co. Massachusetts. Inoculum of the ectomycorrhizal fungus, *Pisolithus tinctorius* (isolate 298) was provided by the Institute for Mycorrhizal Research and Development, Athens, Georgia.

The mycelial inoculum of *Pisolithus tinctorius* was developed according to standard procedures. Mycorrhizal inoculum was uniformly incorporated into growing medium at the rates of 1:6 v/v. Stratified pine seeds were sown in Spencer-Lemaire rootrainers. Peter's Professional Fertiliser (20N, 20P, 20K) was applied weekly at the rates of 50, 100, 150 and 200 ppm of nitrogen. Seedlings were grown for about eight months in the green house.

The experiment was a split-plot design with a factorial arrangement of mycorrhiza and fertility levels as main plot treatments and the species as the split-plot treatment. Six replications were used with four seedlings per species within 336 experimental units.

FINDINGS

The effect of mycorrhizal inoculation on the height growth was highly significant and it accounted for 16 % of total variation. Uninoculated seedlings were larger than inoculated seedlings. The development of root system was greater in inoculated seedlings. The effect of fertilizer on the seedling growth characteristics was in all cases highly significant. The fertility treatments accounted for 64, 8, 18, 49 and 25% of total variation for seedling height, root-collar diameter, volume, dry weight of shoots and root dry weight respectively. In all cases, seedlings grew more with increasing fertility levels. All growth characteristics, differed very significantly among species. *Pinus kesiya* exhibited the largest height of growth. The maximum root-collar diameter was attained by *P. roxburghii.* Among the species, *P. wallichiana* produced the least growth.

The seedlings were found to be ectomycorrhizal with *Pisolithus tinctorius* and an unidentified naturally occurring black fungus. Inoculated seedlings had significantly more ectomycorrhizal development than uninoculated seedlings. The highest fertility levels of 150 and 200 ppm suppressed the development of *Pisolithus* ectomycorrhizae. The difference in ability of the different species of pine to develop ectomycorrhizae was highly significant. The amount of ectomycorrhizae formed by *P. patula* was almost double that formed by *P. virginiana.* The percentage of ectomycorrhizae formed by the naturally occurring fungus was significantly higher in *P. wallichiana.*

A negative correlation was found between the percentage of short root that developed *Pisolithus* ectomycorrhizae and the growth of pine seedlings. *Pinus kesiya* and *P. roxburghii* seedlings with significantly less *Pisolithus* ectomycorrhizae development attained maximum growth, whereas *P. patula* seedlings with significantly more *Pisolithus* ectomycorrhizae exhibited lower growth. The growth of *P. wallichiana* with significantly more ectomycorrhizae formed by naturally occurring fungus was severely inhibited. *P. patula* developed the highest amount of *Pisolithus* ectomycorrhizae short roots.

Higher fertilizer levels produced lower ectomycorrhizal short root development and higher biomass of seedlings. The most important indigenous pines of Nepal, *P. roxburghii* and *P. wallichiana* are ectomycorrhizal with *Pisolithus tinctorius* which had not been recorded previously. *Pisolithus tinctorius* may inhibit seedling growth at the early stage of inoculation. More research is necessary to reach any major conclusions.

TERRACING AS AN EFFECTIVE LAND USE PRACTICE TO MINIMISE EROSION IN NEPALESE HILLS

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ABSTRACT

Improper land use practices have caused and are still causing a progressively more serious problem in Nepal. Research in minimising the loss of soil and nutrients from agricultural lands, due to erosion, is relatively lacking compared to overall agricultural research.

Though terracing is a highly evolved art in Nepalese hills, most of the upland terraces are unmanaged and need improvement and maintenance. Unmanaged terraces are, at present, accelerating erosion in the hills.

This study concentrated on the economics of terrace improvement and maintenance in order to get maximum benefits from the land with minimum erosion.

The causes and magnitude of erosion problems as well as examples of past attempts to solve them are briefly described.

The importance of terracing has been elucidated by examples from some countries with similar problems. Application of the soil loss equation points to the importance of properly maintained terraces in minimising erosion. Although terrace construction and improvement is not profitable in the short term, it is however, important as a social investment for long-term survival.

PROBLEM

The removal of natural vegetation in order to bring land under cultivation has interfered with the natural factors of soil stabilisation and has resulted in a condition that favours soil erosion and floods. The loss of top soil in the mountains which is raising the bed level of many rivers in the plains by 15 to 30 cm every year, is not only increasing the incidence of floods in the plains but also challenging many irrigation, power and drinking water storage structures. This way the mountainous region is losing cultivable land every year and the pressure on agricultural land is ever increasing.

The population pressure in the hills region is excessive, and results in over-utilisation of agricultural lands, deforestation and overgrazing of forest areas, causing erosion, landslides and floods in the country. This encourages the hills people to migrate to the fertile and thinly populated plains for better farming and living. The average rate of migration into the forested land of the plains has been estimated to be about 50000 people per year for the last 10 years. According to government estimates, the proportion of Nepal's land area covered in forest has declined from 45 % in 1964 to 34 % in 1974 and is now only 29%. At this rate there could be no forest cover left in another 20 years.

The total reliance on agriculture and the lack of occupational diversity of the people in the mountains is one of the main reasons for the rapid loss of forest land.

The most detrimental and widespread form of erosion is sheet erosion on cultivated land. Much of this form of erosion occurs during the early monsoon before crops have grown high enough to protect the soil.

Lack of education and information to the people in the hills cause and are still causing erosion. Unscientific methods of agriculture and unregulated drainage channels from irrigated farmlands are accelerating erosion problems.

OBJECTIVES

1) to demonstrate that terracing is an effective land-use practice for crop production by reducing soil erosion to tolerable limits, in Nepalese hills.

2) to provide necessary guidelines for planners and decision-makers in determining whether terrace improvement in the hills is economically feasible and effective in increasing crop yields with minimum soil loss.

METHODOLOGY

This study was mainly based on a review of the literature.

FINDINGS

The best way to lower the slope-angle, control soil erosion, and conserve, distribute and control water is to construct terraces. The art and knowledge of terrace construction in Nepal is considerably advanced, even without access to expert scientific advice or modern technology, because of the continuous research applied by local people with prevailing conditions (ecological and environmental) over many centuries.

Research in minimising the loss of soil and nutrients from agricultural lands, due to erosion, is still in its infancy compared with other agriculture research. Examples of highly successful terraces are those which are now maintained best; the irrigated bench terraces come to this category.

Although no data are available to compare crop yields, an application of Wischmeir's Universal Soil Loss Equation indicates that properly maintained terraces minimise the loss of soil and nutrients, thereby creating favourable conditions for crops.

The presently accepted scheme for economic analysis of investment in land-use development is the benefit-cost analysis. Benefit-cost analysis is used in this report to evaluate the terrace improvements, as a guide for decision-making. Western economists are inclined to emphasise short-run market objectives, where land, labour and any other inputs are valued in monetary terms. This rationale does not make much sense in countries faced with resource shortages. Benefit-cost analysis using today's interest rates may not be profitable, but we build terraces as a social investment because we know that our long-term survival may depend on this type

of conservational measure.

RECOMMENDATIONS

All land in the hills is not suitable for arable use even if terraces are made. There may be better alternative uses rather than to ignore the limitations. Decisions could be made on the basis of (a) matching the land-use with physical and ecological conditions, and (b) by socio-economic analysis. But, if steep slopes have to be utilised for growing agricultural crops, terracing is the only way of protecting land.

Terracing needs to be researched more thoroughly in all respects, to retain this unique physical and cultural landscape.

Active participation of the people together with continued government help in the restoration and improvement of terraces would minimise soil erosion and maximise food production. To attain these goals, a combination of research and education is needed to guide the efforts of individual farmer.

Research into farming techniques and land uses would further determine the economic feasibility of improving terraces.

Along with good terrace management, cropping techniques should be improved so as to give maximum cover to exposed terraces and at the same time greater yields to the farmer.

CONSERVATION STRATEGIES OF NEPAL, 1951-1985

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ABSTRACT

The purpose of this study was to describe and analyse conservation strategies advocated by the Nepal Government in national development plans during the period 1951 to 1985. The objectives, priorities, budgets, organisations, technical areas for emphasis, people's participation, and legislation, enclodied in these strategies are reviewed and compared chronologically.

Conservation was one of the ascepts of all plans surveyed. During the 1950s and 1960s the plans were inclined towards government control and people's participation in implementation. During the 1970s, the strategies were modified, with a greater appreciation of conservation through preventive technical measures and mutual cooperation between government and the people.

By the 1980s, conservation was upgraded to the top priority national program supported with appropriate legislation so that people could participate at all levels.

Conservation should be regarded as an integral part of all developmental works, along with support through organisation, legislation, and people's participation.

PROBLEM

From time immemorial the Nepalese people have depended on the country's natural resources such as soil, water and forests for their livelihood. At present, they face a serious problem regarding these resources. The natural environment of the country has been degraded at an alarming rate in the last three decades because of deforestation that has greatly aggravated soil erosion. Deforestation has also created a scarcity of firewood and fodder, has indirectly affected natural springs, causing them to dry up in the dry season, and has caused mountain slopes to slide down in the rainy season. Soil erosion is the result of deforestation, heavy grazing and unscientific cultivation in the already fragile mountain ecosystem. The consequences are decreases in the carrying capacity of the grazing lands, decreases in productivity of soil, and increases in siltation of the waterbodies, both natural and man-made.

Since the beginning of the new era in 1951, Nepal has adopted six national development plans, all of which have included conservation programs, and the Government has enacted much legislation pertaining to the conservation of natural resources. Aerial photography, satellite imagery and computers also have been introduced.

Several donor agencies, e.g. FAO, UNDP, and USAID and SATA have also supported the conservation efforts in Nepal. But still the natural environment of the country has deterioraed at an alarming rate from 1951 to 1984.

Why has the environment deteriorated in spite of the earnest efforts made in conservation ? To this question, there may be many answers. One answer would include the conservation strategies which govern the conservation programmes.

METHODOLOGY

The study comprised a review of six national development plan periods from 1956 to 1985, and one pre-plan period of 1951 to 1956. For each of the seven periods, the study included a description of conservation strategies on the following pattern: 1. objective, 2. priority, 3. budget, 4. organisation, 5. technical areas for emphasis, 6. people's participation and 7. legislation.

FINDINGS

1) The national development plans have incorporated conservation among the main objectives since 1980.

2) The agricultural sector, which includes conservation, has received first priority since 1975.

3) A specific priority for conservation was not clear in the plans.

4) The budgetary allocations for conservation programmes in the various plans increased over the years.

5) The proportion of the conservation budget to the total plan budget has remained about constant at between 2 and 3%.

6) Frequent changes to major organisational structures were conspicuous throughout the period surveyed.

7) During the 1970s and 1980s organisational expansion took place more rapidly than during the preceding decades.

8) The technical measures taken before 1980 were not effective in keeping pace with the population explosion and in competing with other land-use developments, e.g. resettlement, agriculture and roads.

9) Preventive technical measures, e.g. reforestation, soil conservation and wildlife management began to be emphasised during the 1970s.

10) Sporadic efforts in extension were initiated in the 1950s and 1960s, but were institutionalised only after the late 1970s.

11) Adoption of modern technology included aerial photography in the early 1960s and satellite imagery interpretation in the 1970s.

12) Throughout the period surveyed, research was given less attention than other technical efforts.

13) Before 1980 the in-country training institutions did not supply sufficient middle and lower-level technicians. The expansion of training facilities including graduate level study of conservation in the early 1980s, may serve to reduce the shortages in future.

14) Overseas training of graduate and post-graduate technicians abroad was made available.

15) In-service training was institutionalised in the early 1980s.

16) The indigenous conservation efforts of many local people, e.g. the Shingo Naua, disappeared in the 1950s.

17) During the 1960s people's participation was sought only at the implementation level of conservation projects.

18) During the 1970s people's participation at all levels, imncluding decision-making, and benefit-sharing was realised to be needed in conservation.

19) People's participation at all levels was instititutionally recognised in the 1980s.

20) Until 1976 the legislation empowered the government agencies to have an authoritative control over natural resources and thus greatly increased their responsibility.

21) Since 1977 a radical change in government policy has resulted in the enactment and amendment of legislation to authorise the local institutions to have more control over the conservation programmes.

22) In the early 1980s an act pertaining to land-use was enacted for the first time.

23) Conservation was treated as an individual development programme in all the national development programs.

RECOMMENDATIONS

1) If conservation of natural resources is to contribute significantly towards the sustainable development of the country, conservation strategies should be incorporated in all developmental programs, rather than being provided as separate individual programs. Findings of this study indicated that wrhile individual conservation programs might be technically appropriate and timely, they were ineffective in restoring the deteriorating environment as they were in competition with other land-use developments, e.g. resettlement and agriculture.

2) If conservation is a continuous process, especially in a mountainous country like Nepal, the deparment of soil conservation and watershed management (DSCWM) should be expanded by establishing permanent offices at the village, district and regional levels. The

study showed that the DSCWM had project offices only at the village or district levels and only during the periods of individual projects.

3) If one of the strategies of the present conservation efforts is to develop scientific land-use throughout the country, the legislation pertaining to land reform should cover land-use policy as well. The study showed that the conservation-oriented legislation did not cover all the agricultural and resettled lands in the country.

FURTHER STUDIES

Further detailed studies are suggested in the following areas:

a) qualitative and evaluative assessment of the present technical areas for emphasis.

b) strategies to be advocated by the Government in developing other activities which affect the natural environment e.g. agriculture, road building, resettlement and tourism.

c) methods of people's participation when the present plantation crops start to provide benefits in the near future.

d) effectiveness of present organisational structures.

A SIMULATION MODEL TO ASSESS THE HYDROLOGIC PERFORMANCE OF THE TINAU WATERSHED, NEPAL

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ABSTRACT

A physical event-based computer methodology is presented for evaluating the hydrologic performance of the Tinau watershed in Nepal.

A stochastic model of the seasonal precipitation was developed and used to generate long-term daily synthetic rainfall data. Storm systems in the monsoon months of June to September are treated as frontal systems, and the storms of the remaining months of the years as independent thunderstorm events. A fitted-parameter conceptual model, called a Generalised Streamflow Simulation System (GSSS), is used to simulate long baseflow recessions. The GSSS model transforms the synthetic rainfall data into daily streamflow using a soil moisture accounting process in a physically consistent manner.

The computer output from the model consists of statistics and cumulative density functions for monthly, seasonal and annual discharges, maximum daily high and low flows and consecutive days of low baseflow. The model output can be used by decision makers to meet the objectives of proper land use and development.

PROBLEM

The Himalayan mountain range is considered to be the largest, highest and youngest in the world. The annual south-east monsoon produces heavy rainfall on the southern aspects of the range, which results in the washing off of productive fertile soil from the hill slopes. Nepal lies on this ecological range. Over 90% of the population of Nepal are engaged in agriculture, mainly subsistence agriculture. Over 350000 people are added to the population of farmers each year. Unfortunately agricultural production has not been able to keep pace with population growth. Cultivation and animal husbandry have been expanded to unsuitable terrain and steeper slopes to meet the growing needs. The human activities place extreme pressure on forests and hill slopes already in delicate balance with the natural environment. In addition to accelerated soil loss, landslides commonly occur every year and destroy human lives, livestock and crops. The depletion of soil from the hill lands produces sediments choked streams and rivers in the valleys and flood plains and causes floods during the rainy season and droughts during the dry season.

It is estimated that on the average over 240 million cubic meters of soil is lost every year from the Nepalese hills. The principal areas of this erosion are on public lands; e.g. forest, shrub and brush, and pasture lands. Land management is an urgent need in these areas, but decision-makers and planners have difficulties due to the lack of accurate and up-to-date assessment of the water resources in the region.

Land-use management and environmental protection are key issues of development strategies for the Tinau watershed. An accurate and comprehensive assessment of the present natural resource base and its potential for development would help to optimise the benefits from agricultural land use as well as reduce the damage to the natural environment. Because an adequate data base for making decisions in water resources development is not available, a land-use management plan and policy has not yet been developed for the Tinau watershed. In planning for the water resource, there is a need for a methodology that takes account of the variability of rainfall, run-off and erosion from the watershed with time.

METHODOLOGY

The approach of the Tinau Watershed model was to: (1) simulate a time series of daily rainfall using stochastic methods; (2) route the rainfall into a series of cascading soil moisture storage compartments; (3) drain the soil water to generate interflow and baseflow and (4) evaluate the statistics of hydrologic performance in terms of monthly, seasonal and annual streamflows, maximum and minimum daily discharges and consecutive days of low flows. A simulation technique was used because of the short historical flow records available for the Tinau river, and because the most severe drought period and the greatest flow of the historical records are unlikely to be the maximum possible.

The following steps were taken in determining the model:

1) to develop a physical event-based stochastic precipitation model to simulate a long-term series of daily rainfall data;

2) to develop a fitted parameter, soil moisture accounting hydrologic model to transform the synthetic rainfall data into a sequence of daily streamflow events;

3) to produce statistical summaries and plot cumulative frequencies on monthly, seasonal and annual flows, daily maximum minimum discharges and consecutive days of low baseflow recessions; and

4) to evaluate the results.

A separate submodel was also developed and operated for each of steps 1 and 2 described above and was linked into the overall model.

FINDINGS

The simulated mean annual run-off was 1090.6 mm, with a mean maximum daily discharge of 1010.4 m^3/s. High pre-monsoon rainfall produced an early commencement of baseflow in some years. Late monsoon rainfall caused long baseflow recessions throughout the summer months of March, April and May. The mean for consecutive days of low flow during this period was 24.42 days. Periods of low flow days extended as long as 157 days. April and May were the driest months, with low flows falling as low as 0.10 mm. Winter flows were satisfactory with mean flow of 0.9 mm. August and September were the wettest months with an average flow of 11.6 mm.

Some limitations were observed in the watershed model. In the stochastic precipitation model, daily rainfall amount was evaluated by distributing total rainfall amount per group among the number of days in a group. So extreme rainfall events could not be considered in the assessment of peak flows. However, the actual highest daily flow recorded was 3500 m^3/s in 1981. The simulated result showed a highest daily flow of 4440 m^3/s. Another limitation of the model was low base-flow production. The actual baseflow was 0.95 m^3/s in 1981, but the simulated base-flow was as low as 0.253 m^3/s.

The model was calibrated with only 8 years of historical data. The model could be recalibrated, tested and validated with additional rainfall and run-off data when it becomes available. Even so, the output of the precipitation model developed closely matched the quantity and variability of the actual rainfall measured in the critical period of the monsoon season. A more realiable output would be expected if a longer historical record were available. The use of the output of the model will depend upon the objective of the user. The model may be used as a part of a comprehensive watershed model in decision-making processes. The model has the advantage of allowing decisions to be based upon the risks the user is willing to take.

DEFORESTATION IN NEPAL - CAUSES AND CONSEQUENCES

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ABSTRACT

The destruction and deterioration of the forests of Nepal is severe, and the consequences of deforestation are leading the country to both ecological and socio-economic crises.

Detailed study suggests that in Nepal it is deforestation which is rampant in the Terai, whereas in the Hills and Mountains, deterioration of the forest resource base is more serious. It is suggested that both generalisation of the deforestation rate from one region to the whole country and the production of average rates of deforestation only can lead to misjudgements of he problem

It is frequently stated that the main causes of destruction of the forests are population growth and the increasing demands of the people for forest products. There is a widespread belief that the cause of deforestation is increasing demand for forest products associated with population growth. This simple explanation would not produce a real picture of the problem. Evidence suggests that large scale deforestation has no linear relationship with population growth.This study reveals that these are not the principal causes of deforestation in Nepal.

As in many developing countries, it is the Government which determines how the forest should be used. Unfortunately, despite fine-sounding plans and policies there has been, no proper scientific management of the forest. This lack of effective management is a serious problem which demands a serious response. The forests of Nepal can only be sustained if they are adequately protected, wisely developed and properly utilised. Although the role of government is crucial, active participation by the people seems the first and foremost requirement for managing the forest efficiently and effectively.

Traditionally the forests have been exploited both by individuals and institutionally. Evidence indicates that governments policies and the politics of the past are the primary causes of the large-scale deforestation. In this context silviculture alone would not save Nepal's forests. Thus an appropriate socio-political environment is a basic pre-requisite to saving the country's forests.

PROBLMES

Deforestation is one of the serious problems Nepal is facing at presently, and its causes are also complex and interrelated. Government policies such as land reform and nationalisation of the forests have also stimulated the process of deforestation. This evidence reveals that large-scale deforestation is directly connected to political upheavals and policy failures.

Another common explanation for deforestation is poverty. It is generally stated that poverty brought deforestation and deforestation intensified the poverty, hence creating a vicious circle.

However, poverty is not a cause in itself, it is only a consequence of the socio-economic system of the country.

METHODOLOGY

This study was essentially based on secondary data and information and the author's personal experience of forestry in Nepal.

The available data and information on deforestation was examined to try to separate facts from myths.

FINDINGS

The findings indicate that deforestation is not only a 'problem' but is becoming a 'crisis'. Both the causes and the consequences of deforestation are complex and interlinked, and therefore selective perceptions and easy explanations of this problem only create confusion.

They also suggests that although the man-to-land ratio in Nepal is declining, the principal causes of deforestation are not population growth and the farming practices of subsistence farmers, but that politics and the policies of former governments should be largely blamed.

RECOMMENDATION

Unlike many other natural resources, forests can be renewed if an appropriate socio-political environment is prevailing. To reurn the country from the brink of ecological crisis, not only is the development of new forests necessary but the remaining forests should also be protected adequately and utilised properly. However, as this is completely a man-made problem, silviculture alone cannot solve it. First of all traditional attitudes of political leaders and bureaucrats must be changed. Programs based on peoples participation should be implemented, and if the active participation of real forest users can be achieved, the existing community forestry programs should yield better results.

As forestry cannot be separated from agriculture, an integrated approach could be effective. Fulfilment of basic needs for forest products should be a main objective of forestry activities. Programs for employment diversification, development of alternate energy sources, and crop intensification should also be implemented.

COMPARATIVE EVALUATION OF TWO COMMUNITY FORESTRY PROJECTS IN NEPAL

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ABSTRACT

This study was conducted to compare and evaluate aloan-funded and a grant-funded community forestry projects in Nepal. The specific objectives were to: (1) determine whether the two projects differ in terms of the level of resource inputs, support services and people's participation: (2) determine, compare and evaluate the socio-economic and biophysical impacts of the projects: and (3) determine the relationship of resource inputs, support services and peoples' participation in the two projects and their socio-economic and biophysical impacts.

Stratified random sampling was carried out to select 47 respondents from one village development commitee (VDC) of Bhaktapur and 79 respondents from three VDCs of Kavre Palanchok District. Data were gathered using a semistructured questionnaire and were analysed using means, frequencies, percentages, t-test and correlation analysis.

The results showed that the two projects were similar in terms of implementation, management, information and training. However they were different in terms of budget, manpower, technology and planning, the grant project being better in all these respects.

The two projects were semilar in terms of household income and vegetation cover but were different in terms of living of the people, land productivity and minimisation of soil erosion, the loan project being better in these respects.

In the grant project the level of living was significantly correlated with all the independent variables-technology, planning, implementation, management, training and information. On the other hand, in the loan project the level of living was significantly correlated with technology implementation but not with planning, management, information and training.

Household income, land productivity and minimisation of soil erosion were not significantly correlated with any of the independent variables in eiher projects.

Vegetation cover was correlated with technology, implementation, management and information but not with planning and training in the grant project. In the loan project, vegetation cover was not significantly correlated with any of the independent variables.

Most of the people had not received any type of training and extension materials in both projects.

PROBLEMS

Most of the community forestry projects in Nepal have been implemented after 1978. These projects vary terms of resources, activities and inputs. The nature of the funding also plays a significant role in the impact of each project. Communities within the districts are confused because different funding bodies may have different priorities and support strategies.

The World Bank, because of the sheer size of its loans, tends to be a dominant influence in the development of policy and procedures. A working style based on an exploratory *modus operandi* does not fit easily with the requirements of many bilateral and multilateral funding agencies each of which has its own institutional requirements based on bureaucratic priorities or the policies of its government.

For the comparative evaluation, two different projects were considered: one grant-assisted and the other loan-assisted. The Nepal-Australia Community Forestry Project (NACFP) is grant-assisted by the Australian Agency for International Development (AUSAID) while the Community Forestry Development and Training Project (CFDTF) is an IDA loan ecept for its training component,which has a DANIDA grant.

The evaluation of their performance and impact of such projects is both necessary and timely for it will tell whether they have any significant effects in terms of uplifting the socio-economic status of the communities and rehabilitating the degraded hills.

OBJECTIVES

The main objective of the study was to compare and evaluate a loan-funded and a grant-funded community forestry projects in Nepal. Therefore, the comparative evaluation of these two projects was done to answer the following questions:

1) Is there any difference between the two projects in terms of level of resource inputs, support services and people's participation ?

2) What are the socio-economic and biophysical impacts of the two projects ?

Is there any relationship between the socio-economic and biophysical impact of the two projects in terms of resource inputs, support services and people's participation ?

METHODOLOGY

This study was conducted in Dadhikot VDC in Bhaktapur District and Daraune Pokhari, Patlekhet, and Tukucha VDCs in Kavre Palanchok District of the Central Development Region of Nepal. The community forestry program in Bhaktapur district is funded by IDA loan while the community forestry programme in Kavre Palanchok district is funded by an Australian grant.

Two districts were purposively selected where community forestry programmes were in operation. One VDC was randomly selected in Bhaktapur district and three VDCs were randomly selected in Kavre district. The population in each VDC was stratified on the basis of the three major caste/ethnic groups.

Five percen of households were randomly selected as a sample. The unit of analysis at the household level was represented by the household head. There were 79 respondents selected from the grant project and 47 respondents from loan project.

The data collection was done from mid-August to mid-October 1995, using a survey questionnaire containing both structured and unstructured questions.

Interviews with forest users committee members, project chiefs and staff, district forest officers (DFOs), and other forestry staff were also conduced. Informal discussions also took place between the researcher and key informants during the field survey.

The data were analysed using descriptive statistics such as frequency, percentage, average and standard deviation and range, and inferential statistics like t-test and the pearson correlation coefficient. In all the tests, the 5% significance level was used.

FINDINGS

The following are the study findings:

1) The two projects were different in terms of budget, manpower, technology, planning, level of living of the people, land productivity and minimisation of soil erosion, but were similar in terms of implementation, on-going management and benefit sharing, household income and vegetation cover.

2) The grant project was better than the loan project in terms of budget, manpower, technology and planning, while the reverse was true in terms of level of living of the people, land productivity minimisation of soil erosion.

3) The findings indicated that technology played an important role in improving the level of living of the people in both projects. Moreover, technology contributed to the improvement of vegetation cover in the grant project.

4) More people participated during planning activities such as formation of the users group, preparation of the management plan and site selection for nursery and plantation in the grant project.

5) Participation in the implementation of community forestry activities such as nursery operation, planting, protection, and implementation of the management plan improved the level of living of the people and vegetation cover in both projects.

6) Participation in on-going management improved both the level of living of the people and the vegetation cover in the grant project, while in the loan project, it played an important role in the improvement of vegetation cover.

7) In the grant project, information played a significant role in the improvement of the level of living of the people and vegetation cover.

8) Most of the people had not received any type of training in either project.

RECOMMENDATIONS

The following recommendations are made:

1) Government should start implementing locally-funded community forestry projects with minimal budget and manpower inputs.

2) Livelihood programs should be incorporated in community forestry programs.

3) Distance education through radio should be explored as a method of providing training, improving skills and extending knowledge and information about community forestry programmes more widely.

4) User groups should be made self sustaining so that they can truly carry on with community forestry programmes even after the withdrawal of foreign aid.

5) This was just a preliminary and very limited study. There should be an in-depth socio-economic and biophysical impact study of all community forestry projects, including those assisted by NGOs in order to guide foreign assistance policy in community forestry.

6) Since very few people received training but most were eager to attend training programmes, a training needs assessment should be conducted as a basis for prioritizing training programs. These could cover community forestry organisation, grassland management, agroforestry technology and other income-generating livelihood programs.

THE POTENTIAL OF *EUCALYPTUS* FOR RURAL DEVELOPMENT FORESTRY IN THE EASTERN AND CENTRAL TERAI OF NEPAL

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ABSTRACT

Increasing population and decreasing forest resources in Nepal call for the establishment of plantation of fast growing tree species to fill the gap between supply and demand for basic products-firewood, poles, posts etc.

Eucalyptus species have considerable potential for plantation. Trial plantings of many species (both indigenous and exotic) at Sagarnath showed *E. camaldulensis* to be most encouraging for planting in the Terai. Under the same conditions, the best indigenous species, *Dalbergia sissoo* gave only half the growth of *E. camaldulensis*. *Eucalyptus* can thus provide plantation species which can yield good financial returns in a very short period as compared to indigenous species. But there is a growing belief that eucalyptus planting depletes the ground-water table, causing water scarcity; impoverishes the soil; does not allow undergrowth in the plantation, which is essential for maintaining nutrient status; disturbs ecological balance and the availability of minor forest products including grass and shrub fodder for domestic livestock and wild life.

Contrary to the above belief, however, it has been scientifically proved that *Eucalyptus* species enrich soils, need less of water for equivalent biomass production, recharge the water table and that watersheds under eucalypts have lower peak vases, discharge rates, resulting less soil loss. Eucalyptus are mostly planted on vacant lands, where they help in conserving the soil moisture. Further if planted round lands, they act like wind breaks or shelter belts leading to the reduction of soil loss and evaporation rate. The protective nature of eucalyptus forests is thus pronounced.

It is important to note that whatever plants are grown, they should make efficient use of sun - light, soil and water to synthesise organic matter which yields maximum value to the society. Eucalyptus can be efficient converter of solar energy into wood, which is very useful to the people. This is why *Eucalyptus* species is widely accepted. Intensive management of eucalyptus plantation should therefore be regarded as necessary to get fast growth.

Eucalyptus plantations cannot reach their maximum potential unless supported by continuos trial and research related to tree improvement by the application of genetic principles and to growth and coppicing.

Although *Eucalyptus* should not be taken as the answer to all problems, its fast rate of growth, excellent coppicing power, high biomass production and a rapid establishment make it perhaps the best option for planting in the eastern and central Terai of Nepal.

Eucalyptus needs high inputs to get good growth. Therefore, the planting of *Eucalyptus* should be practised only when the infrastructure for providing their requirements is available. Otherwise, the situation may be even worse than with plantations of indigenous species.

PROBLEM

The current population of Nepal is more than 17 million and it is increasing by 2.2% while the forest area is decreasing by 0.4%. The importance of reforestation was realised in the early 1970's. Since then plantations of various species under various projects and programmes has been carried out but the results have not proved to be sufficient to cope with the problem.

The selection of fast growing species with multiple uses, acceptable to the users, adaptable to a wide range of conditions and capable to giving good economic returns is the first necessity. Monocultures of fast-growing short-rotation forest species are becoming widely accepted in forestry practices. About half a dozen of *Eucalyptus* species are highly recommended for various forestry programs such as agroforestry, farm forestry, tree farms and industrial plantations in many countries, especially in tropical regions. Since 1979 the results with *E. camaldulensis* have been very encouraging at Sagarnath, central Terai of Nepal.

Depletion of natural forest is a serious problem for the future. The greatest sufferers are the poorer members of the society because of to their close dependence on the forest. *Eucalyptus* species have great potential for overcoming their problems.

The aims of this study were to evaluate the potential of *Eucalyptus* species in rural development forestry in Nepal and to assess the ecological effects of growing *Eucalyptus*.

METHODOLOGY

This dissertation is mainly based on a review of the literature.

FINDINGS

Consideration of the issues relating to *Eucalyptus* plantations show that there cannot be an unqualified answer to the question of this plantation. Choices between the available courses of action should be made after considering all the costs and benefits of the various options and identifying the best of them.

E. camaldulensis is superior to many other indigenous and exotic species in metting the large demand for fuelwood, poles, posts etc. in the Terai. The rate of growth and adaptability of *Eucalyptus* proves its potentiality to overcome the existing critical scarcity. The possibility of the product expansion out of *Eucalyptus* ensures its acceptance both in the public and private sectors.

However, if *Eucalyptus* is recommended in all situations it only reflects poverty of ideas. It is only one of many options available to local communities or individuals,. Recommendation of any species should match the requirements of the users. Therefore, Eucalyptus should not be offered to anybody without explaining their advantages and disadvantages vis-a-vis other species.

SUSTAINABILITY OF TRADITIONAL ENERGY RESOURCES

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ABSTRACT

Nepal is a country in the midst of a struggle for economic development. She strives to fulfil the basic needs of her people and yet at the same time struggles to preserve her national heritage of culture, flora and fauna. Not unlike most developing countries, Nepal faces a problem-how to allocate and provide a fair share of resources to the people without abusing either of them. One necessity for the living of Nepali people is energy, and in Nepal energy is drawn from the natural forests. Ironically, forest cover is an essential need for both people and wildlife conservation, not to mention the prevention of ecological problems. People's heavy dependency on forest resources and the need for conservation have a tendency to lead to questionable planning. To provide for sustainable development, planning and its implementation is a challenging responsibility in Nepal.

Will present patterns of energy use by local people and current plans for the further development of tourism in an area like Bachauli Panchayat, adjacent to the Royal Chitwan National Park, be sustainable in terms of available forest resources ?

To explore this question, a traditional supply/demand analysis was undertaken to evaluate sustainability of a defined forest area adjacent to the Park. In addition, a method of testing sustainability was evaluated. Fuelwood consumption by tourist lodges, stratified according to standards, was studied in detail for three different end-use categories-hot showers, campfires and cooking food. Total energy use, particular by different to ethnic groups, was studied in detail. Different types of bundles of feulwood, varying according to sex and ethnic traditions, were identified and 200 such bundles were weighed. Moisture contents of fuelwood that had just been collected and wood that were about to be used were measured. The area where the fuelwood was collected was defined, and standing biomass and annual harvestable yield were established for three different forest types. People from six panchayats were identified as users of this area. The total fuelwood collection in these panchayats was estimated from a survey of 179 households in addition to data from detailed study in four adjacent wards.

Projection of the local human population was estimated from a 100% census conducted in four wards and from other sources (i.e, CBD, FPO and Malaria Eradication Programme in Chitwan). Current tourist numbers were calculated from tourist lodges statistics for the year of 1987-88. Increase in the number of tourists was projected from statistics available from the Park headquarters. Growth rate of tourist numbers was projected not only according to past rate but also from the aims of official policy.

The future increase in fuelwood consumption by the local population and tourist lodges was estimated. Indicators of adaptation to fuelwood scarcity were identified in 58 households of different ethnic groups and in all tourist lodges. These indicators, i.e. trends in private tree plantation, changes in species planted, changes in use of fuelwood species, switch to fuelwood substitutes and people's perceptions of problems, were then used to evaluate the supply/demand analysis.

According to the traditional supply/demand analysis, the forest resource from which fuelwood was currently being collected would be totally depleted within the next 25-30 years.

The analysis was found to be a useful tool in describing present use patterns and to highlight the existing pressure on the locally available forests. As a way of evaluating stustainability it was found to be less useful, as local adaptations to change are not taken into account.

The paper concludes that the forest resources used by the people in Bachhauli and surrounding panchayats are under heavy pressure both as a result of population growth, reduced access to traditioinal forest resources and as a result of the growing tourism in the area. As the available resources are depleted pressure will probabley be directed towards the remaining Tikauli forest and towards the National Park itself.

Suggestions for remedies and courses of action to alleviate this problem are discussed.

PROBLEMS

"Green forests are Nepal's treasure." This national slogan expresses the strong dependence the people of Nepal have on their forest resource. In the last few decades, since Nepal has opened its borders, the national population has escalated often at the expense of the forest cover. In addition, areas have been set aside as national parks and conservation sites and these have reduced the accessibility people have to resources. When the increased attraction of tourists to the protected areas is added, it can be projected that energy demand may exceed the local supply, creating an acute situation for the local people.

To be sustainable, harvesting of natural resources must not exceed the capacity of the system to regenerate itself.

METHODOLOGY

To investigate the sustainability of fuel resources in Bachhauli Panchayat, six months were spent in Nepal between September 1987 and March 1988. Four months of this time were spent at the field site for the household, vegetation, and tourism surveys.

Before beginning the actual field work, letters were sent to the ward leaders and the panchayat officer in the area and these were followed up by visits to these people to further explain the background, affiliations, intentions and work in the area. Two field assistants were also hired.

FINDINGS

A traditional supply/demand analysis revealed that with the present use pattern, the existing biomass in the area would be completely removed within the next 25-30 years. The present annual increment (about 210 kg per capita) was not enough to fulfil the local annual demand for fuelwood so a part of the stock resource was also harvested each year. Local people and especially lodges were adapting to the situation by increasing the supply base by planting trees on private land.

Although both the local people and the tourist lodges will adapt to increasing scarcity, such adaptations have their limitations. A dramatic increase in the use of substitutes, i.e. dung and crop residues, could lead to a drop in the standard of living. Unfavourable effects of this could be a drop in crop yields as a result of the reduction of recycling of organic matter. An increase in the use of chemical fertilizers could partly compensate for this. Chemical fertilizers and high-yielding varieties of grains have been introduced to the area, but these are expensive, and without substantial government subsidies are out of reach for many farmers.

The concept of sustainability was found to be useful, as it requires an inter-disciplinary approach for assessing natural resource allocation problems.

RECOMMENDATIONS

The traditional supply/demand analysis was a useful tool for evaluating the present use patterns, but was less useful for predicting future use of energy. Such an analysis should also be used with care when making future policy decisions. It helps to highlight the problems but it rarely accounts for people's adaptations to a changing situation and the priority local people put on problems like increasing fuelwood scarcity.

A DELICATE IMBALANCE: EROSION AND SOIL CONSERVATION IN PIPAL CHAUR WATERSHED, KAVRE PALANCHOK DISTRICT, NEPAL

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ABSTRACT

This thesis documents an erosion budget for a small (0.55 km^2) watershed in the middle hills of Nepal, finding that approximately one-third of the annual 1870 m^3 of the moving material originates as mass movements, primarily from the stream zone, the other two-thirds being derived from surface erosion. Together, this represents a suspended sediment yield of approximately 2000 tonnes per km^2 per year. The thesis then looks at the application and motivation of soil conservation efforts in the watershed. Farmers' short-term efforts and agencies' long-term efforts are appropriate and effective for achieving their goals, but the parties' goals conflict. In addition, these two conservation strategies are limited in terms of technology and enforceability, respectively. The thesis suggests that increased conservation efforts, primarily through co-operative efforts on terraces and trails, can increase the effectiveness of forest plantations and, over time, decrease the net sediment outflow of the watershed.

PROBLEMS

Nature and people build landscapes. Over time, a landscape is formed by climate, relief, geological material, and endemic plants and animals . The naural forces make streams, form soil, build mountains and wear them away People modify the natural landscape, carving the soil-vegetation mantle into roads, trails, terraces, fields and forests. And as nature creates a baseline rate of erosion, so humans speed or slow that rate through what they do.

Erosion removes soil and rock from their parent material, and the eroded material leaves the watershed as entrained sediment. The watershed's outflow extends the influence of the watershed downstream through stream erosion and/or sedimentation, so the rate of watershed erosion can be of critical concern to people living downstream. The rate of erosion in a watershed may also have a profound impact on the people who live there. People change the rate of erosion and, therefore, the shape of the landscape, for very specific reasons. Human interests are generally not based on changing the erosion rate *per se*, but on managing elements of the human condition: food and water, fuel and fiber, transportation, health and shelter.

OBJECTIVES

This study investigated people's influence on erosion and how they are motivated to reduce it. The study had a series of objectives, which are:

1) to estimate the sources and rates of erosion of a watershed;

2) to determine the changes in erosion rates due to the actions of people;

3) to determine why people are changing erosion rates; and

4) to identify conditions in which people are likely to reduce erosion rates.

From the results program approaches to soil conservation were developed. The approaches are designed to help create conditions for human activities that reduce erosion.

METHODOLOGY

This study focused on a small area in the middle hills of Nepal, nearly Pipal Chaur watershed near Dhulikhel, in Kavre Palanchok District. It relied on physical measures of erosion, erosion estimation from the literature, and on a field survey of farmers. Policy analysis was then applied to the results derived from physical and social assessments.

The study established a basis for comparing erosion and conservation rates in this watershed, so as, to understand why and how farmers and development agencies practice soil conservation in the changing environment, to evaluate the effectiveness of those techniques, and to suggest improvements in the overall erosion control strategy for the area.

FINDINGS

The study suggested that:

- erosion control is based on the goals of the parties doing the control work not on the quantity of soil lost per unit area nor on the quality of the soil conserved;
- different parties have very different interests-agencies in increasing productivity on public lands over the long term, farmers in maintaining productivity of their private lands in the short term.
- depending on their goals, agencies use afforestation to gain physical and political control over grazing lands, where farmers repair landslide damage to maintain physical control over their terraces and flumes.
- neither agencies nor farmers address erosion in stream channels, on scrublands, or along trails, although these are rapidly eroding areas, unless doing so coincides with other, high priority goals.
- the identification of, and action concerning mutual interests would, presumably, increase the effectiveness of conservation actions by both parties.

RECOMMENDATION

The study demonstrates a process of erosion control evaluation that may be useful in similar cases, where one must develop a conservation strategy for an inhabited watershed, province or region.

EQUIPPING THE COMMUNITY TO IMPLEMENT COMMUNITY FORESTRY: EXTENSION FOR COMMON PROPERTY RESOURCE MANAGEMENT

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ABSTRACT

Community forestry programmes require effective local input into decision making for the management of a common property resource. This local contribution to decision making needs to be made on a collective basis incorporating all those with a right to use the common resource. Although an extension strategy of working with homogenous groups appears the most appropriate, this is often not feasible when dealing with an established resource, and some form of whole community extension is required.

In this context a decision-making group is a collection of individuals who recognise each other as members and are related in terms of their interest in, and use of, a common resource. This study focused on the use of group extension which has the objective of the collective adoption of interventions over common property resources. The achievement of such collective innovation-decisions is strongly dependent on both equity and organisational factors. The distribution of benefits needs to be perceived to be equitable, and a unit of social organisation is needed to sustain the programme.

Important elements of groups were reviewed to see how these affect the collective decision-making process. Group norms which affect values and attitudes are especially important because of the equity requirements of collective decision making. Results of experiments on the effects of group interactions on decisions and productivity are unclear. The style of leadership was identified as important.

Interactive communication models rather than linear ones provide better tools for understanding information exchanges occurring both within and outside groups. In particular the convergence model explains how individuals converge and diverge in their understanding, and this is a basis for developing collective decision making and action. For convergence to occur, interactive communication may need to occur over an extended period of time.

The most important current applications of community forestry are "joint forest management" in India and "user groups" in Nepal. Two extension approaches suitable for use in such contexts are suggested. Participatory rural appraisal (PRA) methods utilise the convergence model of communication by facilitating intensive communication leading to consensus and action. Interactive farmers' training and workshops utilise PRA techniques, but with the longer time period, group processes have an opportunity to work.

As well as more effective interaction, participants are also provided with a real environment in which to practice skills and attitudes which they will need in order to encourage collective decision making in the community.

The thesis concludes by looking at the implications for extension training. As well as requiring new skills, extension workers require changes in their attitudes and values. To achieve these, extension training needs to become more process-oriented than content-oriented, and to use many of the same methods that extension workers themselves use when working within a community.

PROBLEM

Although individual extension approaches may be the most appropriate for interventions aimed at farmers implementing innovations on their own land, some form of group or community based method is needed for community forestry, since community forestry requires the participation of the entire community.

Social scientists advocate using smaller social units than the whole community, but how this would work for the management of truly community resources, rather than resources privately owned by the group as whole, is not clear. One possibility would be to divide up the commons, allocating land either to individuals or to groups and thus effectively privatising them. However, it is the poor who rely most heavily on the common resource, and if the poor do gain ownership, then they often quickly lose control, being forced by their circumstances to sell, mortgage or lease their share.

So the study sought to find ways of effectively working with either sub-groups or the whole community for the effective management of common resources for the benefit of the local people concerned.

METHODOLOGY

This thesis is mainly based on a review of the literature.

FINDINGS

Collective adoption is crucial in some situations. Although the intervention in question (e.g. pest control) or the resource to be managed (e.g. forests), may fall under the natural sciences, the sociological aspects are essential and need to be designed into the programme from the beginning. In particular the social organisation that forms the basis of collective decision making needs to be carefully prepared.

Communication, especially interactive communication, takes time, and in any situation requiring collective action, time has to be provided in order to give the communication processes full opportunity. However time alone is unlikely to leading to effective group decisions and action; there is also the need for a change agent or local leader who facilitates the group processes and interactive communication and does this in such a way that the most is made of the human resources within the group.

Participatory extension methods that promote dialogue between local people and which in turn enable them to reach agreement on issues relating to their situation are necessary. This alone would result in an entirely bottom-up approach to identifying and solving problems. If outside analysis, resources and solutions are required as well, which is usually the case, then

dialogue between the community and extension workers is also necessary. Methods which promote this interactive communication will almost always be more appropriate than one-way communication. Many PRA methods provide an effective means of promoting such dialogues both within the community and between it and extension workers.

In order to promote the collective management of resources by an identified group of people, extension workers need to develop in the villagers the skills necessary for consensual decision making. Although this can be role-played in adhoc groups, the learning experience will be more effective if consensual decision making is practised within real social groups. A workshop situation allows for the development of some of the characteristics of a group, such as group norms and roles. Discussing knowledge, skills and attitudes relevant to the management of common property resources (CPRs) within this context will assist the development of some of these group skills.

It has been realised that the best way of equipping extension workers is to use participatory extension methods for much of their own training.

RECOMMENDATIONS

Changes in extension training are needed to equip forest extension workers to implement the extension methods discussed above. New knowledge is also needed and this can be imparted by changing the content of the training, as has been done at the Institute of Forestry, but in addition new skills (participatory appraisal, two-way communication, listening) and new attitudes (respect, releasing authority) are needed and these require new training methods.

INDIGENOUS FOREST MANAGEMENT SYSTEMS IN THE HILLS OF NEPAL

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ABSTRACT

The context of this thesis is the emphasis now given by His Majestry's Government of Nepal (HMG-N) to management systems which will ensure the long-term sustainability of Nepal's forest resources, and its recent policy of placing the ownership and primary responsibility of managing those resources in the hands of the local people who depend on them.

The thesis points to the importance of the historical perspective and of maintaining continuity between traditional practices and present-day situations in achieving desired goals.

The history of forest management in Nepal is sketched. It reveals that each of the four important geographical regions of the country - the Kathmandu valley and its environs, the Mahabharat, the rest of the hills, and the Terai - developed different management models, but that the forests of the hills were always regarded as forests for the local people, whereas those in the three other regions were exploited or used in the interests of the ruling elites. The forest management systems in the hills region were based on local initiatives and on indigenous knowledge.

The primary sources of historical information were documents such as inscriptions, orders, petitions, legislation and reports and verbal accounts from local people connected with forest management. Secondary sources included literature on the subject.

Fieldwork was carried out in three selected areas in the hills. Forests very different in type, origin, management history and present status and condition were revealed. The condition varied from severely degraded (Sallepakha) to improved (Kamang) and stable (Betini).

The field work led to the conclusions that management efforts should be directed towards achieving stable forests and that the best basis for such efforts would be protective management by local users and their own institutions. However, outside support would be necessary if severely degraded forests like Sallepakha were to be brought to a state of stability.

Outside support would be largely the responsibility of the forestry authority of the country. However it would need to be sensitive to the total needs of local people and not limited to maximising tree growth; to be readily absorbed without becoming burdensome; and to be conceived in collaboration with local people and not imposed from above. The forestry profession would need to change from being part of the bureaucratic machine to being a technical arm supporting local institutions.

PROBLEM

In response to the deteriorating forestry situation, HMG Nepal is moving increasingly towards transferring responsibility for the hills forests to their users, with the role of the Department of Forests becoming more that of an extension service and less that of an enforcement agency. If user-group forest management (probably better thought of as operational schemes under the responsibility of user groups) is to occur, then an understanding of the modes of management which have occurred historically may will be of value. It may be possible to build upon, or transform, existing or past practices rather than creating all anew.

A look into the historical development of forestry and the insights to be gained therefrom can be a substantial aid in understanding forest and environmental policy efforts in general. Not only can they help in formulating future programmes but also in their absence it is impossible to establish a soundly based forest policy for a country or to produce an adequate appraisal of any assistance project.

There are not enough studies from which to conclude anything on the past systems of forest management. No efforts have been made to explore the origin and evolution of local practices of forest management, nor to analyse their linkage with policy level decisions and guidelines.

METHODOLOGY

Field work was carried out between November 1989 and February 1990. Evidence was gained over the period of more than decade, as divisional/district forest officer. Three sites- the Betini, Kamang and Sallepakha forests were selected.

Two types of information were collected through a questionnaire and through discussions with local people. One was information regarding the patterns of use, which was obtained from all users. The other concerned the history of management, which was obtained from selected users. However, non-users were also sometimes found to be good sources of information regarding forest management in the wider context.

Although the questionnaire was designed to collect mainly qualitative information, it included a small number of quantitative questions in the first part. No effort was made to get the information using standard units (e.g. kg, ha etc.), as it was understood that people use their own units comfortably and confidently in giving information on landholding. Qualitative information was obtained from household heads, although other family members were involved in the discussion in some instances.

Respondents were not selected randomly or through formal stratification, because such procedures would have been virtually impossible to implement, given the constraints of time, distance, topography and available manpower. Instead, the procedure focused on 'household to household visits.

Key informants were selected on the basis of discussions with users during the study of usage patterns. The informants were selected on the basis of their interest in the matter, level of information available from them, and their involvement in forestry matters.

FINDINGS

Customary and indigenous rights have existed throughout the hills region since early times. They were related to: (i) forest use (ii) pasture land and (iii) soil and water conservation, and were documented.Near the mines existing practices were changed.

External support is required to increase the resource base in Salle Pakhar whereas it is different in Kamang and Betini. In Kamang, local people have managed to apply their traditional management practices to the newly created plantations. In Betini, local people are still able to sustain their forestry needs without any external support.

Local institutions gave no indication of being capable of increasing forest resources through afforestation of communal land (except propagation of fodder and fruit trees on a small scale) but always were involved in protection and management of existing forests. So if the resource base needs to be developed significantly through afforestation, communication of evolving technical know-how may be of significant help.

RECOMMENDATIONS

There has to be much more care in formulating and implementing new plans and programs. At the present time, many projects are being developed and implemented in the forestry sector, with varied objectives and approaches. There is too often the danger of destroying indigenous systems in the process of creating either new plantations or new institutions. As the projects are usually funded for short periods, normally of five years (very few are consistently working for long periods and aiming to create sustainable local systems), they are likely to leave, at the end of the project period, only partly completed forestry developments without having developed the local capacity to manage them properly. This takes a long period of action and interaction. The result is partly an added burden on the local people.

The study thus shows that technical knowledge alone is not enough for managing the forest resources of the hills region. However, it is not possible, in the present situation, to achieve a state of stable forest in its absence. It is thus clear that two approaches from different origins are emerging in the forestry of the hills: one is based on indigenous forestry improving its effectiveness through the support of technical inputs and the other involves conventional forestry adapting to fit into the indigenous system. Forestry authorities need to consolidate these two approaches in order to achieve stable forests most successfully across the whole hills region. This necessitates forestry professionals turning from being technocrats within the framework of bureaucratic organisation to being technicians sympathetic to and adapting themselves to the needs of local people and institutions.

MONITORING OF SOCIAL FORESTRY IN NEPAL: A CASE STUDY OF THE NEPAL-AUSTRALIA FORESTRY PROJECT

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ABSTRACT

Forests in the hills of Nepal provide firewood, fodder and grazing land for livestock, and help to maintain environmental stability for food production. Because of the continuous depletion of the forests and decline in soil fertility, hills people have to spend more and more time collecting fuelwood and fodder and greater labour input is required to cultivate land with low yields. Forest regenetation would allow more time to be spent on other productive work.

The philosophy behind the Nepal-Ausralia Forestry Project (NAFP), centred on Chautara is community forestry. This concentrates on improving living conditions by the production of enough forest products for direct consumption. Due to the long gestation period of forest production, frequent monitoring and evaluation are necessary in order to improve project performance during implementation. Though monitoring and evaluation are separate concepts in the case of the NAFP they have been functionally integrated through the existing information system of NAFP.

The monitoring and evaluation indicators are grouped into inputs, outputs and direct effects, indirect effects and long-term impacts. These indicators can be summarised under the following broad headings:

- numbers of trees planted in government (HMG), Panchayat Forest (PF), Panchayat Protected Forest (PPF) and private land;
- survival rates of trees planted;
- forest area brought under the management as PF and PPF;
- increases in knowledge, awareness and cooperation of the local people in forestry activities.

The data came from two principal sources: the Project office and household surveys. Precautions have to be taken when collecting data to ensure that it is accurate, replicable and up-to-date.

Simple techniques of data gathering and analysis should be used rather than relying on sophisticated computerised techniques. Techniques of rapid observation, case studies and periodic reviews should be used in order to cover matters, which are outside the routine sample surveys. Monitoring should be undertaken in a thoroughly professional manner the basis of which is an efficient record-keeping system within the Project. Evaluation, in this case, should provide quantified analysis and include interpretation of indirect effects and long-term impacts. Evaluation should be carried out by an independent research organisation.

PROBLEM

In the hills of Nepal, use of the forests by villagers for fuelwood, fodder, and grazing is a long-established custom. In most cases these uses of forests were managed by communal rules and regulations. These customs have become the main cause of over-exploitation of forests in the Hills.

In the present situation of continual depletion of forests in the hills, the NAFP is designed to increase the production of forest products (manily fuelwood and fodder) through the involvement of local people. It aims to eventually shift the responsibility of planting, protecting and maintaining forests and distributing forest products from government to rural communities.

Monitoring and evaluation of social forestry are new concepts, but are needed because of the long gestation period for forest products. The main purpose of a monitoring and evaluation system in the NAFP is to generate and deliver information which will help to increase the effectiveness of management in achieving the objectives of the project, and to provide information for other projects. Though monitoring and evaluation are separate concepts, in the case of the NAFP they have been functionally integrated using the existing information system of NAFP.

OBJECTIVES

This study aimed to draw up a set of guidelines for monitoring Project in the future. Given the limited statistical information available about the Project, it was restricted to:

1) exploring the relationships between the NAFP and the agricultural system of the Chautara region;
2) identification of the costs ant benefits of the Project (including social costs and benefits); and
3) providing a procedure or technique for monitoring and evaluating costs and benefits .

METHODOLOGY

This study was based mainly on a review of the literatures.

FINDINGS

The NAFP can collect data from two principal sources: the Project office and household surveys. Precautions have to be taken when collecting data to ensure that it is accurate, replicable and up-to-date. The project office can provide information on inputs, outputs and

direct effects; to assess indirect effects and long-term impacts, household surveys have to be carried out, as indirect effects and long-term impacts are related to the size of communities and take place over a long period.

In the household surveys, possible sources of error can be partially dealt with by cross-checking data in the field, conducting group surveys alongside household surveys and quantifying reported information wherever possible.

Household surveys have to be conducted in both command and control areas in order to distinguish the effects of NAFP from those of other influences. The NAFP is not the only source of change. Furthermore, household surveys can be improved by convincing people of the importance of the Project and inducing them to keep records of factors such as fuel consumption, stove use and amounts of fodder and firewood collected.

Monitoring and evaluation should employ techniques of rapid observation, case studies and periodic reviews in order to cover matters outside the routine sample survey area, and to some extent help solve urgent problems faced by the Project. Evaluation of people's attitudes towards the NAFP and forests is necessary, as social changes depend upon the receptivity of the community. Changes in attitudes can be obtained through people's awareness, motivation and co-operation. It is necessary to monitor the distribution of forest products since the success of the Project depends on broad community support.

RECOMMENDAIONS

It is not necessary for a permanent monitoring and evaluation unit to be established, but one or two personnel involved in the implementation of the Project should carry out regular monitoring activities. Job descriptions for project staff need to include well-defined monitoring activities, and Ministry of Forest and Soil Conservation should include monitoring activities in job specifications for District Forest Controllers (DFCs) and project management. Monitoring has to be undertaken in a thoroughly professional manner, but it will take time to develop an efficient and tested system. The basic prerequisite for monitoring of the NAFP is an efficient record-keeping system from which required information can be easily abstracted and reports prepared.

Evaluation should be carried out by an experienced private research organisation in order to examine the Project's performance, effects and impacts without bias and with a fresh outlook. Prerequisites for sound evaluation are careful sampling design and preparation of survey questionnaires. The organisation responsible for evaluation should adopt a standard sampling procedure and questionnaires have to be prepared for both household and group surveys.

Evaluation should provide, as far as possible, quantified analysis and interpretation of indirect effects and long-term impacts covering, e.g. production of forest products, labour-time utilisation, effects on agricultural and livestock systems, people's outlook and impacts participation.

In carrying out monitoring and evaluation, management faces the problem of resource constraints. While resources should be allocated to the most essential requirements, a degree of flexibility should be maintained in order that unanticipated events and trends can be incorporated into the system.

DISTRIBUTION OF AUTHORITY FOR THE CONSERVATION OF FOREST RESOURCES: AN ANALYSIS OF THE COMMUNITY FORESTRY POLICY OF NEPAL

Ghimire, Madhav Prasad.
M.Sc. (1989)
University of California, USA

ABSTRACT

The purpose of this study was to define the location of forest authority for enforcement and management that would balance the use and productivity of forest resources in the least costly manner. It relied upon data and analysis of the Community Forestry Development Project (CFDP) and was based on a review of the literatures. The study found that)1) the purpose of protection and management of forest areas; (2) local readiness to take effective responsibility, (3) governmental readiness to protect, manage, and support; and (4) local readness, central capacity, and effective distribution of authority are the conditions influencing the effective conservation of forest resources.

PROBLEM

This study sought to identify the distribution of authority between national and local governments that is most likely to sustain the forests of Nepal. Nepal has lost 25% of its forest cover in the past 14 years. The Government has sought to overcome this problem through a range of policies that include forest nationalisation, cooperative forest management by the national forest department and local panchayats, and full local control of forest resources. The currently prevailing policy, the Community Forestry Policy, assumes that the sustainability of forests is directly related to the degree of local authority for their protection and management and to the degree of central authority for their technical support. The study examined this hypothesis in the light of experience with the Community Forestry Development Project (CFDP), the largest and the only national application of the policy.

Nepal displays unsurpassed diversity in the kinds and productivities of its forests and in the pressures for use to which its forests are subject. A uniform policy of any kind would be expected to have rather different consequences under different conditions. The Community Forestry Policy, or a policy of forest nationalisation, would not be expected to have the same effects in all circumstances. By examining the experience of the nation-wide CFDP, a relatively uniform operational approach, the study sought to identify the conditions under which this distribution of forest authority is likely to be the most effective approach. By comparing CFDP experience with the consequences of other approaches, the study also sought to identify the conditions under which alternative distributions of authority are likely to be more effective than community forestry.

METHODOLOGY

The study was based on analysis of CFDP experience and a review of the literature.

FINDINGS

Conditions influencing the effective distribution of authority for the conservation of forest resources are:

1) the purpose of protection and management of forest areas;

2) local readiness to take effective responsibility;

3) governmental readiness to protect, manage, and support; and

4) local readiness, central capacity, and effective distributions of authority.

If distributions of authority are matched with the conditions in which they are most likely to be effective, it becomes possible (1) to design policies and programmes with the capacities to affect priority problems, regions, and social groups, or (2) to apply existing policies and programmes to the conditions under which their capacities are most likely to be effective. It also becomes easier to identify the sources of constraint on forest enhancement under different conditions and to develop means to relieve these constraints over time.

CONCEPT AND COMPONENTS OF SOCIAL FORESTRY DEVELOPMENT AND STRATEGY WITH REFERENCE TO THE FOREST POLICY AND PROJECTS IN THE HILLS OF NEPAL

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M.Sc. (1982)
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ABSTRACT

Forestry development programmes are as difficult to implement as they are important and they have been drawing the attention of national policy-makers.

Social forestry programmes, if carried out efficiently in the hills of Nepal, will be the most appropriate and applicable practice of forestry to meet the daily material needs of the rural people in their diversified mixed farming systems. Since the concept and components of social forestry is what was mentioned in the policy and forest legislation of Nepal, it becomes a must.

OBJECTIVES

The objectives were: to study the concept of social forestry; its relation with the Nepalese Government's present policy of forest development; and having regard to the formidable sociological, institutional and technical constraints, to consider how a social forestry program could be developed, implemented and managed in the hills of Nepal.

METHODOLOGY

No set methodology was applied in this study. The author's own experiences in village afforestation programmes when working at the Lumle Agricultural Centre, Kaski District, were drawn upon together with an extensive review of publications on forestry by the FAO/World Bank and other international and national agencies.

FINDINGS

Social forestry is, in fact, a modified version of the diversified mixed farming systems practised traditionally in the hills of Nepal. It represents an integration of agriculture, forestry, animal husbandry, horticulture, recreation and landscape architecture.

There are many political, economic, technical, institutional, social, cultural and geographical conditions and constraints in Nepal to be overcome before all wood-hungry communities can be helped to produce sufficient trees, before forestry and agriculture can reach their appropriate levels of integration, and before all those lands that are or should be forested can be planted, protected and managed.

RECOMMENDATIONS

The following recommendations are made:

- A strong and innovative forest policy and legislation framework for forestry development should be developed with a view to generating and maintaining the feeling in the that forestry is for the people, of the people and by the people;

- The need for closer integration between social forestry, agricultural and other rural development projects should be recognised and appropriate government, semi-government or non-government bodies should be established or reorganized at village, district and regional levels to promote the programs;

- Commitments should be made to set aside land for forestry and for village people to participate directly in plantation, protection and development of **farm forestry, community** forestry and environmental forestry in the hills of Nepal;

- There should be strong central government commitments to basic needs oriented project objectives and to the existence of an efficient forestry institution decentralised at least to district level to facilitate the two-way flow of information and innovations between the local people and the external bodies,

- Appropriate technical packages with frequent extension and training services to the people should the ensured, so as to maintain continuity of the programmes.

AN APPRAISAL OF THE EXISTING FARMING SYSTEMS IN THE HILLS OF NEPAL AND POTENTIAL INTERVENTIONS TO SOLVE THE PERCEIVED PROBLEMS

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M.Sc. (1991)
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ABSTRACT

The hills region of Nepal is facing tremendous environmental problems of forest devastation and soil erosion which cause a severe decline in food, fodder and fuelwood production.

This decline along with of timber shortages and livestock husbandry problems-all of which are related to the farming system - are reviewed and the existing traditional agroforestry practices in the hills are examined in this thesis.

The main problems, identified through both personal experience and a literature review, are analysed to determine the key constraints and underlying condition which are causing negative effects in the farming chain, and important intervention points are identified from the causal analysis.

The possibilities for improving existing traditional agroforestry practices and adopting new agroforestry systems are investigated. Improved agro-silvicultural, silvopastoral and agro-silvo-pastoral practices are also discussed and are considered to be top priority interventions, along with techniques for livestock health improvement, management of degraded natural forest, people participation in forest development and the integration of soil conservation measures into farming systems, so as to sustain them in perpetuity.

Finally, for effective implementation of the proposed interventions, the establishment of research-supported management, with a community involvement approach to agriculture, livestock and forestry, is recommended.

PROBLEMS

Nepal is a predominantly agricultural landlocked country. Particularly in the hills (also called the middle mountains), forests and trees are integral parts of the farming systems. Crop production, livestock husbandry and forestry are the three main and inseparably integrated components of much of the hills farming systems.

Hill farming systems can be described in general as being a complex arrangement of soils, water, crops, livestock, trees and other resources within an environmental setting that the farm family manages in accordance with its preferences, capabilities and available technologies.

The limited transport and communication infrastructure and mountainous terrain have led the people of Nepal in the hills to adopt a mixed farming system where trees play a vital role in

providing the energy inputs which ensure the survival of the system. Edible leaves make up a high proportion of the fodder fed to animals, particularly during the winter months when ground forage is in short supply. Large quantities of inedible tree leaves (both green and dry) along with other herbage are used as bedding material in animal stalls where they become mixed with animal manure.

In the farming system, livestock play a major role in regulating crop yield in a sustainable way by the transference of organic matter from the forest (through fodder and leaf litter) to the field. In addition, livestock provide virtually all draught power in the region.

Until three decades ago, Nepal used to have a high percentage of its land under forests and there was an adequate balance in the ecosystem of mixed farming when population pressure was low, fertility of land was high and resources of fodder, fuelwood and timber were plentiful. Farmers could afford to keep a large number of animals which helped in maintaining the fertility of the land. Forests near the villages used to be managed by local communities to meet their household needs for fuelwood, poles, construction timber, fodder and other forest products. In 1957, all the forests were nationalised. Thus the ownership of the forest lands shifted from private owners to the Government. However, the Government could not control the forests and widespread misuse of forests resources began.

To reduce the alarming deficit of forest resources, besides community forestry programs, the Government's attention is increasingly being focused on the introduction of multipurpose tree species on agricultural land. This new approach in agroforestry technology is hoped to increase food, fuel, fodder, and timber supplies and to reduce the further deterioration of the existing natural forest.

This dissertation also includes an assessment of appropriate agroforesry and others forestry ideas and practices which could be adopted from other countries in order to tackle the perceived land-use problems.

OBJECTIVES

1) to describe existing farming systems and land-use practices in their agro-ecological and socio-economic contexts.

2) to investigate and analyse these systems and practices in order to identify key constraints on productivity and potential intervention points.

3) to consider ways of overcoming these constraints, including agroforestry, other technologies, and appropriate ideas and practices from other countries which might be of interest for the study area.

FINDINGS

Subsistence farmers have not brought any scientific improvement to their farming activities. There is a need and opportunity to improve the land-use systems through the application of agroforestry and forestry interventions, so that sustainability is achieved and crop yields improved.

RECOMMENDATIONS

The following are some of the main agroforestry interventions which should be adopted extensively in the hills region:

Hedgerow intercropping is perhaps the most effective and commonly acceptable innovation for the main croplands in the hills.

Border tree planting is an important intervention where wind and heat adversely affect the food crops.

The livestock sector has been identified as the most seriously mismanaged part of the farming system,becouse of inadequate feeding, overgrazing and land degradation. To improve this situation, the four following silvopastoral interventions should be adoped:

- Fodder tree orchards
- Controlled grazing on forested land
- Livestock population control and stall feeding
- Improvement of pasture land

Consideration should also be given to the following other interventions:

- improvement in livestock health.
- management of degraded natural forest through community forestry programmes.
- extension programmes emphasising the achievements of actual users and involving extended periods in the field, living, working and building rapport with the villagers, holding informal discussions and making systematic observations.
- In the hills context, people's participation is considered the most effective approach for community plantation development and should be strongly encouraged.

COMMON PROPERTY, THE FOREST RESOURCE AND GOVERNMENT ADMINISTRATION: IMPLICATIONS FOR NEPAL

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M.Sc. (1989)
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ABSTRACT

This paper examines past and present situation of the forest resources and the land-use behaviour of the governments and the people involved in managing the common forests of Nepal. In the past land was used as the main source of revenue. Governments used to give incentives to convert forestlands into farmlands. The Rana regime started exploiting the Terai forests to export timber and granted a lot of lands in the form of Birta tenure.

The democratic government which succeeded the Ranas tried to control the forest resources by enacting a new forest legislation, including the Nationalisation Act in 1957. These unplanned legislative changes became counter-productive due to weaknesses within the Forest Department and the growing demand for forest resources by an increasing population.

Causes of deforestation and deterioration of the natural resources are discussed. Attitudes of the Government and of the people involved in managing the resources are explored. Hardin's notion of the " tragedy of the commons" and counter arguments to this view by many other authors are discussed in the context of forest resources of Nepal. Some policy implications involved in the problems of managing the forests as common property resources are presented in the context of understanding the way people think and act in the subsistence farming populations of the middle hills and the Terai of Nepal.

PROBLEMS

Common property has existed since pre-historic time. When a hunter and gatherer group split up because of disputes or growth of the group, the resource was also split. It is not clear whether the transition from hunting and gathering to agriculture created high population pressure or vice versa, but it is clear that as population increased resources became scarcer and the existing resources had to be shared among the increased population.

Nepal's forests are common property and as such they are usually abused. However, this is not entirely true. Commons must have a set of existing social institutional arrangements if the resource is to be managed successfully and not be over-used. When such an arrangement is lacking the property is simply a 'free for all'. The latter was the situation in many parts of Nepal, but some traditional owners have used institutional arrangements to protect local common property resources and many of these have been successful.

Approximately 95% of the Nepalese population depends on agriculture for a living. The forest resource is an integral part of the farming system just as much as arable lad and livestock.

Deterioration of the common resources has been further accelerated by frequent changes of policy by governments creating confusion in the use of the resource and in the attitudes of the people. A major state of confusion was created in 1957 when the so-called private forest was nationalised. The nationalisation was done for a good reason but it became a failure. It was an innovation of a new institution. The ownership was shifted from the feudal landlords to the Government and the former owners often tried to take advantage of the situation before the Government of took over.

In recent years government have realised the importance of local needs and involvement of local people for successful management of forest resources.

The present policy is the result of the past bitter experiences and the present needs of the people. However, the poor and landless people, who are the majority of the community are still not well off and are not reassured by the new policy. The landless and poor groups of the community are more dependent on the commons than those in positions of wealth and power. The proper formulation of policy will mean the greater involvement of those poore people who are directly linked with the forests.

Community Forestry Programmes (CFPs) in Nepal may indeed reflect such attitudes to common property resources.

METHODOLOGY

This dissertation is mainly based on a review of the literature.

FINDINGS

A CFP is merely a process of learning by doing. However, from past experience, the Government should be prepared to improve the policy before new problems arise, such as the control of sales of common and private forestry products, which could be easily organised throughout the existing co-operative societies or Sajha.

The present problem seems to lie in changing the conventional attitudes of the people and the government agencies rather than in fulfilling the physical targets.

The attitudes of people may be such as to seek personal benefits from common property resources (CPR) but their behaviour is influenced both by social attitudes and the co-operative behaviour of neighbours. Similarly, the attitude may be to co-operate but factors such as urgent needs, lack of alternate resources, unclear government policy, lack of assurance, socio-economic conditions and many other local factors may compel a person to behave in a destructive way. This philosophy can be related to way the people are using common property resources in Nepal. The social attitudes and the environment which they live force them to consider the attitudes of others and to restrict their own use of the commons, despie their urgent needs.

Attitude is also influenced by factors such as location of a village, natural factors (climate, vegetation, etc.) as well as socio-economic factors. Government activities can influence these

attitudes through legislation and aid programmes but the rate of change in rural populations will be slow. Older people will accept change less readily than those born into a changing world. A

multidimensional approach is needed to bring about the necessary change in people's general attitudes, including those directed towards common property resources. The problem is not found in just one or two districts. It is a nation-wide problem which will take considerable time to overcome.

Forestry policy in Nepal has been totally directed at protecting the resources from the people around the forests. However, the new laws concerning management of common forests by users can be considered as some of the most liberal among developing countries. The policy is heading in the right direction to conserve the deteriorating forest resources and to meet the increasing needs of the community.

The direction of the policy should be to involve tree-loving people in the system rather than those who do not or cannot pay attention to the management programs. The latter are often rich people and leaders who are involved in a wide spectrum of activities, whereas the poorer people and women are usually limited to farm and forest activities only.

Except for a few enlightened projects there is no record of managing the commons only by the poor and the women villagers. A strong leadership is necessary to conduct any sort of collective work in Nepalese societies. However in most societies the poor and lower caste groups are well considered and could participate equally in development work. Changes in attitude will bring change gradually in social structures. A strong external force may break the whole system.

The local process of development tends to be slow. Projects are necessary to support and to give impetus to the slow process of change in rural communities. Projects provide an incentive for communities to manage their own common forests.

Changing some community attitudes may not be difficult, but changing attitudes at all levels in society is not an easy task. The problem arises as to where to start when all levels need change. The best solution is to build trainer groups at central and district levels, which can then tackle the 'focus group' and field staff gradually.

RECOMMENDATIONS

The forest and farming systems are interlinked in the hills. It is clear that even if all accessible forests were converted into common forests and managed intensively they could not meet all the needs of the increasing population. Therefore, equal emphasis should be given to incentives for farmers, especially small land-holders, to plant trees in the form of private forests or agroforestry. This would reduce pressure on the system of common forest management.

It would be appropriate to prepare management plans at different levels- central level plans, master plans with policy information, and district level plans, with appropriate resource information.

It has been ten years since some of the resources were brought under collective management. Farmers have been encouraged to plant trees on their own land for their own use or for sale. Soon both the common property resources and the private resources may produce saleable material and the people will be wanting to sell the products in the market. The government has not yet produced any rules to govern the situation where the community sells surplus products. The existing sale rules do not cover those problems. Therefore, new sale rules should be developed under which both common property and private property forestry products can be sold freely in the market.

PREDICTION OF BIOMASS IN A PLANTATION STAND OF CHIR PINE (*PINUS ROXBURGHII* SARG.) IN NEPAL

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M.Sc. (1985)
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ABSTRACT

Chir pine (*Pinus roxburghii* Sarg). is one of the principal tree species in the middle hills of Nepal. Knowledge of how to quantify the total mass (above ground) of a tree is not available. Nineteen plantation-grown chir pine trees [range diameter (dbh o.b) - 10.5 cm min., 27.7 cm - max., height - 9.5 m min, 15.3 m. max.] were destructively sampled and the data obtained were used to test various linear (untransformed and transformed) and non linear models.

Branch, whorl, crown, stem bole - and tree equations are derived to estimate the mass content in the successive components. The branch level models are based upon simple linear functions of the squared branch basal diameter for total branch wood (fresh), branch wood (oven dry) and as quadratic equations for branch wood (fresh), branchbark (oven dry), cubic equations for branchbark (fresh), foliage (oven dry)and polynomial equation for foliage (fresh). The whorl level models are based upon a simple linear form of the product of the number and squared mean branch length in a whorl for total (fresh), wood (fresh and oven dry) and foliage (fresh), bark (dry) but upon squared mean branch length for foliage (dry) and upon simple linear form of the logarithmic product of mean branch length and its number within a whorl for bark mass content (fresh). The crown level models are based upon logarithmic transformation of the allometric function and present weight as a function of the reciprocal of the height of the crown base and dbh for crown (fresh) and bark (dry) and wood (fresh and oven dry) and as a function of dbh for foliage (fresh and oven dry) and for bark (fresh). The tree models are based upon the allometric function and present weight as a funcion of the squared dbh * height for tree, stembole (all fresh), stemwood (fresh and dry) and as a function of squared dbh for stembark (dry) and as a linear (multiple) form of the squared dbh and height for stembark (fresh).

PROBLEM

The forests of Nepal have to continue to meet the needs of the people for fuelwood, tree fodder, poles and building timbers both now and in the future. Of these products fuelwood (the only source of energy in the rural areas of the country) is first in order of amount consumed, the second being fodder for their livestock, with timber and poles third. Obviously the dilemma of the forest manager is to meet these requirements on the one hand and to try to improve the condition of often degraded forest on the other hand.

The main emphasis in the country's afforestation now is on the production of fuelwood from short-rotation crops managed to meet this need. The quantities of material that would be produced from management practices is still unknown. In a country like Nepal even small-sized wood is a valuable source of energy, especially in rural areas where villagers use even the smallest twigs for cooking and heating purposes.

In the past, the woody materials of a tree or a stand were universally quantified in terms of merchantable volume or timber value, which ignores material smaller than merchantable timber. Merchanable volume is not directly measured but rather is computed from relationships that are established between either single or a combination of easily measured dimensions (e.g. dbh, ht or form) and its computed volume. The computed volume is in fact the sum of the computed volumes of all individual logs from a tree; the computation being based on a formula given the variables for the merchantable or timber volume. At times when even small branches and twigs are used as a considerable source of fuelwood for cooking purposes, the quantification of the entire energy mass urges an approach which can better provide information more directly related to energy value.

OBJECTIVES

1. To quantify the entire energy-valued biomass components and its growth from plantation grown chir pine trees if managed under short rotation.

2. a) to develop a best fitting model for individual branch component biomass.
   b) to develop an alternative model for individual branch component biomass.

3. To develop a best fitting model for individual whorl component biomass.

4. To develop a best fitting model for individual crown component biomass.

5. To develop a best fitting model for stem component biomass.

6. To develop a best fitting model for tree component(s).

METHODOLOGY

A study plot of fixed area (0.0924 ha - assuming espacement of 2 m x 2 m) was laid out subjectively in the southern study site primarily with a view of not jeoparding it for the future study. Individual trees within plot were enumereted for diameter at breast height and tree height in early 1984 in order to produce a two dimensional stand table A total of 148 Chir pine trees were measured. The basal area and stand density of the study material is 42.60 sq. metre/ha (43.38 sq. metre/ha for sample trees in the plot) and 1602 no. of stems/ha.

A toal of 19 trees, approimately one sample tree from each cell of the stand table, were chosen for destructive sampling. The moisture content of the branch samples were determined and used for dry matter content estimaion of the remaining branches within each whorl. The Statistical Analysis System (SAS 1982) was used for the regression analysis.

FINDINGS

1) Two models (untransformed and transformed) using the variables (branch basal diameter and branch length) in various logical forms were tested to identify the best fitting model for branch component mass prediction purposes.

2) The residual least-squared procedure is employed for the above study.

3) The best fitting model is described by the statistical fit (lower Furnival Index, C.V. and higher R^2 values).

4) When comparison is made beween the models involving x (branch basal diameter) and z (branch length), the models involving x are beter than those involving z for all branch mass components (both fresh and oven dry) including total branch-wood (fresh) mass prediction purpose.

5) The best under lying model for prediction purpose is in linear untransformed from for all components.

6) The following underlying model is the best for prediction purpose for the following branch components:

   (i) the model involving squared x for total branchwood (fresh)
   $Y= -287.61+237.46x$ (R^2 =0.9062, FI value= 537.8)

   (ii) the model involving quadratic funtion of x for branch wood (fresh)
   $Y=151.5-221.49x+121.49xS$ (R^2 = 0.8960, FI value= 219.7)

In conjunction with the convincing graphical plots of the model (except for multiple model cases) and the residuals. A statement of the sampling precision for various components is essential for evaluating the results and for the choice of sample size for future work with similar populations.

RECOMMENDATIONS

For swollen whorl base, an ideal position for diameter measurement would be at a point between the whorl of interest and its immediate below whorl where the diameter is minimum.

The sub-sample, especially foliage, tended to show signs of fungus development at the beginning because of the lack of deep freezer facilities during the study period.

The volume measurement by water displacement proved difficult. The freshly cut disc and the water from the measuring system were prone to wind disturbance and rapid surface evaporation during the study period.

FUTURE RESEARCH

1) Because of the monopodial characteristic of the species (chirpine) the variation in biomass prediction is less likely for data from other localities unlike broad-leaved species where much more variation would be expected. However, the verification of such speculation and also the applicability of the fitted model for other conifer species is desirable.

2) Further research on the development of a best fitting model for whorl component prediction based on practically feasible and realistic approach is suggested.

3) A study on the determination of an optimum sample size for laboratory work is also suggested.

TOTAL AND MERCHANTABLE VOLUME EQUATION FOR NATURAL SILVER FIR AND CHIR PINE OF NEPAL

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M.Sc. (1984)
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ABSTRACT

Total and merchantable volume prediction equations were constructed for natural silver fir and chir pine trees of Nepal. The samples used in the study consisted of 268 trees ranging in diameter at breast height (dbh) from 5 to 42 inches for silver fir and 484 trees ranging in dbh from 5 to 39 inches for chir pine. The samples cover full range of sizes and sites in Nepal.

Six different candidate models were fitted as total volume prediction equations for both silver fir and chir pine. The best fitting equation among them was selected on the criteria of the smallest Furnival index, the value of R^2 and homogenous variance The Schumacher-Hall equation model, fitted after logarithmic transformation is recommended as a total volume prediction equation for silver fir and chir pine.

PROBLEM

Silver fir (*Abies pindrow*) and chir pine (*Pinus roxburghii*) are two important coniferous tree species growing along the Himalayan mountain slopes. Fir forests in Nepal range from 7500 to 11500 feet above sea level while the chir pine forests range from about 1000 to 7000 feet.

Tree volume tables to 4 inch and 8 inch top diameter were constructed and published during 1967 by the Forest Resources Survey, Department of Forests, Nepal. These volume tables may predict larger mechantable volumes than total volumes for certain combinations of height and dbh. In addition, these volume tables cannot be used for other than 4 inch and 8 inch top volumes. Recently, various model have been developed and applied for the construction of variable -- top volume equations. More reliable, accurate and versatile equations for the prediction of merchantable tree volumes would be of great benefit to Nepal.

Taper equations are useful in predicting the diameter at any section of a tree stem given the height to that section, and in predicting the height at any section given the diameter at that section. Such information is useful in estimating tree stem volumes for various product and size class.

OBJECTIVES

The primary objective of the study was to develop stem prediction equations based on measurements of dbh outside bark and total height for the natural stands of silver fir and chir pine.

The secondary objective was to develop taper equations.

METHODOLOGY

The volume data for silver fir and chir pine were gathered during 1964 as a part of the country-wide forest inventory project. All the sample tree data were from natural stands and can be considered as representative of existing stands.

Measurement data used to construct the volume tables were based on the Tree Volume Table for Nepal, 1967. These data were gathered throughout various forest stands in the plains and the hills areas of the country. Measurement of both standing and felled trees were made. Diameter measurements on the main stem of the tree were taken at eight-foot intervals, with additional measurements on the butt-log section. A total of 268 silver fir trees ranging from 5 to 42 inches dbh and 484 chir pine trees ranging from 5 to 39 inches dbh were included in the samples. Diameters were measured to the nearest 1/10 inch while heights to various points on the stem, including the tip of the tree, were measured to the nearest foot. Stump height was fixed at one-foot above ground for both species. The diameters were measured at 1, 2, 3, 5, and 6 feet above stump and at 8-feet intervals wherever possible thereafter.

Volume computation was done for all sections using Smalian's formula, except for the last section, which was calculated by using the formula for a cone. The SAS package program was used for all regression analysis.

FINDINGS

Total Volume Equation for Silver Fir

A series of candidate equations were developed and the Schumacher-Hall model in logarithmic form was selected as a suitable volume equation. This equation had the smallest index of fit, having high root mean square error and homogenous residuals. This should be used as a total volume prediction equation for silver fir in Nepal.

Total Volume Equation for Chir Pine

Similarly for chir pine a series of candidate equations were developed and a logarithmic combined variable equation, with the smallest Furnival index, high R^2 and homogenous variance was selected as the total volume prediction equation.

Merchantable Volume Equations for Silver Fir and Chir Pine

Merchantable volume equations both for silver fir and chir pine were developed by regressing merchantable volume against total volume. Equations having a high R^2 been found suitable for estimating the merchantable volumes both for silver fir and chir pine.

Similarly, taper equations both for silver fir and chir pine were developed.

RECOMMENDATIONS

The total volume equations developed should be applicable for silver fir trees with dbh over bark ranging from 5 to 42 inches and for chir pine from 5 to 40 inches. Since the range of sizes of the trees was exceedingly high, a common phenomenon in an unmanaged forest, the volume equations might not be as precise as desired if applied over a limited diameter range. They should however result in satisfactory precision if used in large stands with different sizes.

The merchantable volume equations are recommended for top diameter over bark in the range from 4 to 9 inches. This is because the regression analysis of the merchantable volume equations was performed with observations within this limited range. Extrapolation may result in unreliable estimates. Similarly the taper equations should be used for the dbh over bark range of 4 to 9 inches.

MAXIMIZATION OF FOREST BIOMASS PRODUCTION IN NEPAL

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M.Sc. (1983)
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ABSTRACT

During the last few decades the forests of Nepal have been substantially depleted because of population pressures. It takes time to control the population; however forest biomass could be increased by conserving and improving the remaining forests. At the same time, reforestation work should be done as much as possible, by encouraging extension forestry, community forestry and private forestry along with the development of national forest lands. It is believed that the development of forest biomass, in all its varied forms, will allow for wide-scale forest production, contributing to the creation of sound ecological environments for the people and the country.

The country is suffering terribly from soil erosion, floods, landslides, sedimentation and shortages of firewood, timber and fodder. Timber and other forest products have been sold to make money without concern for the importance of forests. Increased pressures upon the land have resulted in poor farming and in widespread deforestation. The latter is particularly critical since the forests are important sources of firewood and building materials, and as a soil stabilisation factor crucial to both water yields and agriculture. There is a great need to consider immediate remedies for these basic resource management problems. It will take time to stabilise the population growth; thus it is urgent to maximise the forest biomass production.

This paper describes the general conditions of Nepal, especially the problems of ever-growing population, resulting in destruction and deterioration of the forests. It tells how the Forest Department is trying to maximise the production of forest biomass by conserving the remaining forests and planting more trees, especially by encouraging private forestry and people's participation. The ultimate objective is to find means to boost forest biomass production to meet the needs of the ever-increasing population.

PROBLEM

Forest management in all four geographical regions of the country needs to be improved by adopting suitable silvicultural systems to increase the productivity of the forests. A scientific basis for land use needs to be adopted to provide assistance in controlling soil erosion, landslides and floods. More national parks and wildlife sanctuaries need to be established and to be managed not only to preserve wildlife, and flora, but simultaneously to produce forest biomass especially for the needs of the local people.

FINDINGS

In the early 1960s forest nurseries and plantations started to be established, and these activities are to be continued permanently under the Forest Department.

At the start only a few nurseries were created and areas of only a few hundred acres were planted. Year by year the work grew, and at present, under the sixth five-year plan (1980), 38.6 square miles are to be planted every year. The seventh five-year plan (1986 to 1991) envisages 57.9 square miles being planted per year. At present efforts are being made to cover all regions, zones and districts with various level nurseries, enabling plantation goals to be met. Such widespread efforts also educate the masses, stressing forestry as work vital for their lifestyles.

Nurseries are established at sites where there is good natural spring water, plenty of available labour and good soil and, of course, are close to the areas to be planted. The usual practice has been to have the seedlings ready for planting in polythene bags.

RECOMMENDATIONS

The system of selling standing trees should be discontinued, and mature trees should be cut only under the supervision of the Divisional Forest Officer concerned. Enrichment planting should be done as necessary, and as in other areas, technical supervision should be practised as far as possible. Timber should be sold from depots to meet the requirements of the rural and urban population, the sawmills, wood industries and other interests.

Forest biomass production is vital to the people of Nepal from a cultural, economic, social and ecological point of view. Thus reforestation works should be given more importance and more money. Reforestation and the importance of biomass production should be taught in primary, secondary and high schools, to make the people more aware of forestry problems. Textbooks should be published accordingly.

The Forest Department (Reforestation Section) should be strengthened to carry out more research work regarding nurseries and plantations.

Local species should be relied upon for large-scale reforestation, but exotic species should be tried on an experimental basis. Research work on local and exotic species should be done adequately to produce more successful forest biomass plantations.

Training in reforestation should be improved, and extra emphasis to reforestation should be given in schools of forestry.

Cattle, sheep, goats and buffalo should not be allowed to graze uncontrolled inside the forests. Controlled grazing should be enforced and efforts should be made to have the animals impounded inside farms where possible.

Private enterprise and individuals should be encouraged to grow more trees by offering tax deduction incentives.

The people should be encouraged to produce forest biomass by themselves in a self-help effort on a massive scale. The Forest Department should help the people with seeds, seedlings, cuttings and necessary instructions, while forestry extension programs should be developed on a wide scale.

National parks and wildlife reserves should be managed so as so help meet the great need for forest biomass.

FUELWOOD DEMAND ANALYSIS OF A CARDAMOM-BASED AGROFORESTRY SYSTEM IN ILAM DISTRICT, NEPAL

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M.Sc. (1992)
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ABSTRACT

This study investigated the perceptions of farmers towards cardamom farming, their preferences for fuelwood for cardamom curing, fuelwood self-sufficiency of the agroforestry system, productivities of the resources used and fuelwood demand of the farmers.

The data were collected in 1990-91 through interviews in four villages in Ilam district, namely: Panchakanya, Barbote, Sumbek and Mangalbare. The interviewees were selected randomly.

The data analysis included calculation by frequency counts, means and percentages. Production functions were estimated by the Cobb Douglas method and were used to find out the demand function. The inputs were classified as either land; man labour days; planting materials; equipment costs; fuelwood; and other input costs.

The study showed that most respondents were optimistic about the yields and thought that the yields could be increased. The main handicap was stated to be too little irrigation.

Most of the respondents did not know of a reliable source of planting materials nor of any agency responsible for the betterment of cardamom farmers. They were also invariably faced with problems of diseases due to lack of knowledge.

PROBLEM

It is necessary to determine whether cardamom farmers have favorable perceptions towards their crop, yield etc., and also whether they want to increase the area planted to cardamom, what species of fuelwood are preferred for curing and whether the cardamom-based agroforestry system is self-sustaining in terms of fuelwood requirements or not.

The area under cardamom in Ilam District is increasing owing to its high financial return per unit area. The production of cured cardamom mostly depends on fuelwood availability. The increasing the area planted correspondingly increases the fuelwood demand. The supply of fuelwood, then, will have a direct effect in the production of cardamom. As it is desirable to increase the area under cardamom, steps also need to be taken to increase the fuelwood supply for curing. This study attempted to show the relationship between the factors of production, the output of cured cardamom and the fuelwood demand.

All of the above will depend on the adequate supply of fuelwood for curing and ultimately will have a direct effect on forest utilization.

METHODOLOGY

The data were gathered in Ilam District, with the four villages of Panchakanya, Barbote, Sumbek and Mangalbare serving as sample villages. A three-stage random sampling method was used to select these villages. Data were gathered through a pretested interview schedule.

Analysis of data included frequency counts, percentages and means for ascertaining perceptions, weighted means for finding out preferred fuelwood species, and means for assessing the self-sufficiency of the agroforestry system. Production functions were derived through the Cobb Douglas production function using stepwise regression analysis. Demand functions were derived through profit-maximising conditions. A method of including dummy variables for age of plantation was used for the production function analysis of the samples from Ilam District. A similar method was used to obtain production functions of the different villages. For the production function of the types of crops, the villages were assumed to be homogenous in terms of management, so no dummy variables were used. The demand function of each village was then derived through the respective production functions.

FINDINGS

Most of the respondents were optimistic about increasing production and their emphasis was on providing more irrigation facilities.

Alhough an office of the cardamom development project existed, most of the respondents were unware of any agency providing reliable planting materials. It seemed that the office was only locally active and had not been able to extend its activities throughout the district. Panchakanya was the nearest to the office, and more of its respondents were aware of its existence than were Mangalbare and Sumbek respondents, who were quite far away.

Fungal, bacterial, and viral diseases and insect damage were widespread, yet calling in a technician was very rare either from lack of knowledge or reluctance to do so.

Study of the demand functions showed that everywhere and for all ages the demand for fuelwood was elastic to its price; i.e. decreasing by more than one percent in response to a one percent increase in price. This may be due to the fact that fuelwood has some substitutes in the form of bio-wastes and bamboo.

The elasticity of demand for fuelwood with respect to the price of cured cardamom was positive; e.g. there was a greater demand for fuelwood with an increase in the price for cardamom, With a bigger market available, and also if the smoky smell could be reduced, the price would increase.The demand for fuelwood is thus expected to increase in the near future.

The land and man-labour days had positive elasticities for all cases, showing increased fuelwood consumption with an increase in these resources. With the planting of more areas to cardamom, fuelwood consumption would increase.

Elasticity of demand for fuelwood with respect to planting materials, equipment and other input costs was negative wherever these were included. If these inputs were increased, there would be a decrease in the fuelwood consumption.

The factors affecting demand of fuelwood are both direct and indirect. The direct factors are the fuelwood price and both the price and the quantity of cured cardamom. Indirect factors include species of fuelwood and all the inputs included in the production function.

RECOMMENDATIONS

This study offers some suggestions to the policymakers for the betterment of the cardamom producers.

1) Since farmers were optimistic towards the yield but the constraint was irrigation, the Government should provide increased irrigation facilities.

2) Since most of the respondents were not aware of a reliable source of planting materials, and awareness depended on protimity to the cardamom development project office, there is a need for satellite nurseries scattered throughout the district.These could be established by the government agencies or by training farmers and encouraging them to establish nurseries.

3) Diseases were widespread, and most of the farmers tried to deal wih them by themselves owing to ignorance that there was an agency to help them. The extension workers should be encouraged to be more vigilant in this regard. Since the best cultivars for cardamom production had not been planted because of unavailability of seedlings, nurseries of these cultiuars should be established throughout the district.

4) In areas where there is viral disease, the farmers should be encouraged to plant disease-free seedlings. These can be raised from seeds which can be brought in from far-way areas where there is no disease. Except for Mangalbare, none of the villages were self-sufficient in fuelwood, so farmers should be encouraged to plant suitable tree species, even on marginal lands, to fulfill their needs.

5) The production function for the Ilam District has a slighly increasing returns to scale so, the farmers could still increase the inputs to get higher yields. Among the inputs, land, man labour days and fuelwood had positive elasticities, so these inputs should be increased. Planting materials, equipment and other inputs had negative marginal productivities, so these should not in increased as the production of cured cardamom is increased.

6) As the demand for fuelwood was elastic with price, any increase in prices hould decrease the consumption of fuelwood. Similarly, an increase in the price of cured cardamom which would occur a bigger markets became available in the Gulf countries, would lead to an increase in fuelwood consumption, due to elastic fuelwood demand with respect to the price of cured cardamom. To cope with this, more of the marginal areas should be planted to fuelwood species.

7) Since land has a positive elasticity with respect to fuelwood demand and the area under plantation is increasing, there will be a corresponding increase in the fuelwood demand, the same recommendation of increasing the supply of fuelwood to meet the demand is made.

FURTHER STUDIES

The demand for fuelwood was estimated from the production functions. Time series data for fuelwood consumption is needed to supplement this estimate. Although the coefficient of determination was quite high, this analysis should be validated field in the conditions. This study did not attempt this to lack of time and funds.

The data should not be generalised to cover the functional relationships beyond the scope of the data to which the analysis was applied, nor should extrapolation of the regression analysis outside the range of independent variable values be attempted. There should be more studies to undertake more variations in the variables so that it will include all the farmers who have more or less than the upper or lower limit of the variables in this study. Specifically studies which go beyond the limit of 0.05 ha to 1.75 ha which is the limit of this study.

ORGANISATIONAL STRATEGIES FOR COMMUNITY FORESTRY

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M.Sc. (1990)
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ABSTRACT

Community forestry has been recognised as a potentially powerful tool for dealing with the problems of forest resource scarcity and environmental degradation in Nepal and many other developing countries. However, to date, the potential of community forestry to contribute to the solutions of these problems has not been realised and community forestry programmes are often more characterised by rhetoric and lofty philosophy than by substantial achievements in action.

One of the major problems facing community forestry in Nepal and other developing countries is the fact that its administrative structures and its administrative personnel have largely been drawn form the traditional technocratically oriented State Forestry bureaucratic culture. Thus, despite the wide use of the language of community forestry, most community forestry projects have been traditional technocratic, top-down projects implemented in the name rather than the spirit of community forestry.

To overcome these problems, community forestry must translate its theoretic into reality by fostering local institutional development that can empower the rural poor to solve their own forest management problems and set their own forest management priorities. Thus process of local institutional development must be accompanied by a process of bureaucratic and reorientation so that central government forestry agencies can become catalytic support organisation for rural development.

Following a wide survey of the literature on community forestry, organisational development and rural development, and following critical reflection on the author's own experience working with community forestry and the structures of the Forests Department in Nepal, an organisational model for grass-roots community forest management in Nepal was developed. This model has two major elements. The first is to create institutional linkages between user groups and the local village Panchayat so that local people can indeed accept both decision-making power and full responsibility for the management of community forest resources. The second element of the model is to suggest roles for the Forests Department that could help transform its technocratic and legalistic orientation into an organisation capable of giving catalysing support of community forestry on a wide scale.

It is thought that this model offers considerable potential for improving the performance of community forestry in Nepal. However, it is recognised that the model needs to be proven in practice and it is recommended that it be applied on a pilot scale so that its relevance and efficacy can be fully evaluated.

PROBLEMS

The Government passed the forest nationalisation legislation. However, it did not have sufficient technical and administrative transtructure to adequately assume the responsibilities of forest ownership. Villagers were also given a strong incentive to destroy the forest so that the land could be claimed as private property rather than turned over to become national forest land.

In 1978 new legislation attempted to rectify this situation In this legislation the government has developed a system for re-establishing that lost sense of community.

At present Nepal has two approaches in forest management: national forestry and community forestry. The former completely relies on more capital-intensive management techniques, whereas the latter relies more on labour-intensive practices.

There are a number of community forestry development projects operating in Nepal. Most of these projects are founded to some extent by international aid agencies and while some general advances have been made, one project the Nepal-Australia Forestry Project - is widely regarded as being a successful role model.

The success of community forestry developments depends on the extent to which there is a delegation of initiative and decision making so that people can decide to the maximum extent possible on matters affecting them.

This implies a deliberate reorientation of the administrative system, local organisation and the institutions supporting production towards the entire rural population and their needs. Local elites capturing the benefits of particular community forestry projects. What is needed, therefore, is not an abdication by the Forestry Department but balanced development of community forestry organisations and institutions at the local, district, regional and national levels.

To date, however, this task has not received sufficient attention and considerable development of local institutions is necessary to make community forestry workable.

The aim of this dissertation is to contribute to this process by:

- Reviewing the academic literature rural and institutional development for application in community forestry activities.

- Developing an appropriate institutional and organisational model community forestry in Nepal at the local, district and national levels.

METHODOLOGY

A wide survey of the literature on community forestry, organisational development and rural development, and following critical reflection on the author's own experience working with community forestry and the structures of the Forests Department in Nepal, an organisational model for grass-roots community forest management in Nepal was tio be envisaged. This

model had two major elements. The first was to create institutional linkages between user groups and the local village. So that local people could indeed accept both decision making power and full responsibility for the management of community forestry resources. The second element of the model was to suggest roles for the Forests Department that could help transform its technocratic and legalistic orientation into an organisation capable of giving catalysing support for community forestry on a wide scale.

FINDINGS

Community forestry has been recognised as a potentially powerful tool for dealing with the problems of forest resource scarcity and environmental degradation in Nepal and many other developing countries. However, to date, the potential of community forestry to contribute to the solutions of these problems has not been realised, and community forestry programmes are often more characterised by rhetoric and lofty philosophy than by substantial achievements in action.

One of the major problems facing community forestry in Nepal and other developing countries is the fact that its administrative structure and its administrative personnel have largely been drawn from the traditional technocratically oriented State Forestry bureaucratic culture. Thus, despie he wide use of he language of community forestry, most community forestry projects have been traditional technocratic, top-down projecs implemented in the name rather than the spiri of communiy forestry.

RECOMMENDATION

To help overcome these problems already mentioned local institutional development should be fostered, so foested that the rural poor are enpowered to solve heir own forest management problems and set their own forest management priorities.

Further research on community forestry should cover a wide range of disciplines and approaches, ranging from applied monitoring and census taking through to more fundamental investigations of the biological and sociological processes that will influence the success or failure of particular community forestry programs.

EFFECTS OF GRAZING, UTILISATION AND MANAGEMENT ON THE GRASSLANDS OF ROYAL BARDIA NATIONAL PARKS, NEPAL

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ABSTRACT

The effects of grass harvesting, burning, fertilising, and grazing, on three grassland of the Royal Bardia National Park, in the Terai of Nepal were studied using a factorial experimental design. Hypotheses of (i) nutrient depletion of grasslands by continual harvesting and burning and (ii) differential use of areas by ungulates that were differentially managed in relation to forage quantity and quality were tested. Comparison of the community structure, nultitive quality and above-ground biomass of grazing lawns (patches of short grass communities) with neighbouring grasslands were made.

Grazing lawns differd from neighbouring grasslands in species composition and community structure. A 50-day grazing-free period made grazing lands indistinguishable form neighbouring grasslands in terms of above-ground biomass. Grazing lands have more nutritive forage in terms of digestibility and crude protein content. Sodium, magnesium and phosphorus were found to be below the critical requirements for ungulates. These minerals were found in higher concentration in forages from grazing lawns. Grazing lawns seem to be maintained by continuous gazing and enriched by deposition of urine, dung and by certain plant species not found elsewhere in the neighbouring grasslands.

PROBLEM

The management of protected areas in Nepal is tends more towards the preservationist in the mountains but more towards manipulative form of management in the Terai.

The Royal Bardia National Parks (RBNP), established in 1976, at present covers the largest chunk of forest of forest within a single management unit (968 Km^2) in the Terai region of Nepal. The Park management primarily caters to the conservation of biological diversity with an aim to strike a balance between anthropogenic use wildlife values. Grasslands of Royal Bardia can the categorised as Phragmites – sacharum – Imperata type.

METHODOLOGY

Research Design

Three grasslands areas (Phantas): upper Baghaura, Lamkauli and upper Khauraha were chosen for experimentation and biomass sampling to study the effect of grass harvesting by villagers and burning practised as a management tool. Experimental plots 50 m x 50 m was laid out in the central portions of these areas, where the grass communities were comparatively homogenous. In each grassland an area of about 5,000 square meters was

chosen as a study site.

Grazing and Management Treatment

A fence of 30 m □ 25 m was constructed within the experimental plot of 50 m □ 50 m blocks, in each Phanta to prevent access by ungulates to grass biomass. The height of the fencing was 2 meter. There management treatments, i) cutting (C), ii) burning (B), and iii) cutting followed by subsequent burning (CB), were applied to within and outside the fence .Grasses were cut at about 5-8 cm height from the ground.

The study plots which were surrounded by fire lines were burnt during late after noon. Burning was completed in the same afternoon. In case of and cut-burnt area, grasses were removed from the plot prior to burning as was practised by park management.

Fertiliser Treatment

The areas treated with fertilisers inside the fence were (i) 3 m x 15 m and (ii) 3 m x 15 m (iii) 5.25 m x 15 m in size for three treatment respectively. Di-Ammoniun phosphate (DAP) was applied at 7.75 grams/m to block (ii). Block (iii) was left without any fertiliser treatment as a control.

Sampling

Herbaceous biomass was sampled using a 1 m^2 quadrate at an interval of one month for tree months following initial management and fertiliser treatment

Grass biomass was separated into two categories (i) Green biomass and (ii) dead biomass. One gram samples of fresh biomass of each species were weighed in the field. These samples were then dried at 50-70^{o} C in air to constant air dray weight. A improvised solar oven was used in the field to facilitate faster drying.

Animal signs using belt transacts

Three 25 x 2 m belt transacts were laid within each management treatment outside the fencio enclosure. Individual ungulate pellets and pellet groups were identified by species and counted
for each first, second and third months. After each sampling the transact was cleared of all facial pellets.

Grazing Lawns

To quantify the difference in species composition and forage quality between grazing lawns and surrounding grassland communities, 6 different grazing lawns were sampled within central Baghaura Phanta. These grazing lawns were small areas with a maximum size of about 0.5 ha. A 6 m x 6 m area of each grazing lawn was fenced by 2 m high gabion to prevent grazing by ungulates six paired quadrates (50 cm x 25 cm) were clipped within catch grazing lawn, enclosure within each grazing lawn and within neighbouring grassland communities. Data were recorded on numbers, average height and biomass of herbaceous species.

Soil

Two paired soil samples from each grazing lawn and corresponding grassland community area were collected. The soil was collected from a 30 cm long, 30 cm and 20 cm deep pit. Once the upper 1-2 cm of root mixed layer is scalped, the remaining soil was mixed and a part of it used for laboratory analysis.

Belt Transact

Four paired 10 x 2 m permanent belt transacts were laid in each grazing lawns and tall grass community. Ungulate pellets were counted in the transits in December 1996, February 1997, April 1997 and May 1997. The pellets and pellet groups of ungulates were identified to species, and after each count the transacts were cleared of pellets.

Nutrient Analysis

A composite plant sample was prepared by adding dry ground individual plant samples in proportion to their occurrence in the plot. Crude protein (CP), acid detergent fibre (ADF), lignin and acid insoluble ash (AIA) content were determined for *Imperata cylindrica, Vetiveria zizanioides* and *Saccharum spotaneum* and the composite sample.

Soil Analysis

Elements for grass and soil samples were analysed at WADIA Institute of Himalayan Geology, Dehradun by using Inductively Coupled Plasma-Atomic emission spectrometry (ICP_AES).

Statistical Analysis

Data were first tested for normality using Kolmogorov-Smirnov non-parametric procedure and latter analysed using procedures of Analysis of variance and Student's t-tests. Discriminant analysis procedure was used to differentiate between quadrate samples of grazing lawns from grasslands based on herb layer community structure. The SPSS_PC based software was used for all analysis.

FINDINGS

Several experimental plots would need to be monitored for several years to study the deterioration of the grassland quality and to gain an insight into this pertinent management question. With a short term study like this, it was only possible to probe the above topic. Soil of the Terai are low in phosphates and nitrogen. Continuous removal of grass biomass from the ecosystem for human use and annual burning were likely to further deplete phosphate and highly volatile nitrogen from the system. Results in all the three Phantas unanimously show that there was no drastic response of above-ground biomass to the treatments although by the end of third month (most grass species were flowering by then) the plots treated with urea tended to have higher green biomass (but statistically different) green biomass than untreated plots.

Grazing lawns differd from neighbouring grasslands in species composition and community structure. A 50-day grazing-free period made grazing lands indistinguishable form neighbouring grasslands in terms of above-ground biomass. Grazing lands have more nutritive forage in terms of digestibility and crude protein content. Sodium, magnesium and phosphorus were found to be below the critical requirements for ungulates. These minerals were found in higher concentration in forages from grazing lawns. Grazing lawns seem to be maintained by continuous gazing and enriched by deposition of urine, dung and by certain plant species not found elsewhere in the neighbouring grasslands.

No difference in above ground production and forage quality between different fertiliser treatments. Bardia grasslands are not adversely effected by the current rates of biomass removal. The system was highly productive with high rainfall. It appears that the grassland ecosystem can sustain the current levels of nitrogen removed by replenished from atmospheric nitrogen through heavy rainfall, by deposition of silt through periodic flooding and fixation in the soil by microbes and legumes.

There were significant differences between management treatments for both forage quality and quantity for all three months in all three Phantas. The forage samples from cut-burnt plots consistently had greater crud protein values for all three months as also. During the first month crude protein values of forages from cut-burnt plots were almost double to those of forages from cut plots. Cut plots consistently had lowest crude protein values for all the three months, however, the difference in magnitude reduced as forages matured. Acid detergent fibre content of forages from cut plots was higher than those for forage from cut-burnt and burnt plots. There were no statistically significant differences amongst lignin and acid-insoluble ash values for forages from the different management treatments. There was however, a trend for forages from cut-burnt and burnt plots to have lower indigestible material (lignin + insoluble ash) than from cut plots.

The above ground biomass showed a contrary response in comparison to forage quality to management treatments. Cut plots had greater green above ground biomass following the first two months of treatment. Above ground biomass was only an index of availability to ungulates.

RECOMMENDATION

Cutting and burning as the best strategy for increasing the amount nutritive rich forage. However, it goes a step further to show the importance of other management (and unmanaged) options and wildlife values. The study of grazing lawns should be considered as preliminary, since the number of grazing lawns studied was small (six). The trends that emerge even with a limited sample size were ecologically interesting and merit more detailed investigation. A long-term study with exclosures on 15-30 grazing lawns from different Phantas would provide conclusive answers on succession, mechanism of nutrient, and mineral enrichment and equilibria of grazing lawn communities. It seems that the grazing lawns are natures way of managing nutrient rich grazing conditions amongst coarse tall grasslands.

AN ANALYTICAL APPROACH TO NATURAL RESOURCE PLANNING IN PHEWA TAL WATERSHED OF NEPAL

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M.Sc. (1982)
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ABSTRACT

Nepal's hills region suffers from critical shortages of food, forage and fuelwood. The impact of this increasingly severe problem is being felt in terms of rapid environmental deterioration. The problems are manifold and interrelated.

This study was therefore designed to carry out a whole system planning which includes an environmental component. A watershed level management plan is suggested for Phewa Tal watershed in central Nepal which considers interactions among resources and aims at reducing soil erosion problems. To seek decentralisaiton in the planning process, a multi-level planning approach was used.

Linear programming was applied as the analytical tool. Models were formulated at two levels: lower (single) level models for panchayats (village councils) and a higher (multi) level model for the whole watershed. The single-level model, designated as the basic model aimed at allocating the resources of each Panchayat to various management activities in an optimal manner. As a single plan maximising gross profit margins and meeting all the constraints was not feasible, five alternative management plans are prepared for each of six Panchayats. These plans are comprised of 34 output items treated for a typical years, averaging 15 year of planning horizon.

The watershed level model is then constructed with 30 Panchayat level plans acting as decision variables. Only 27 output items are considered in this model as the remaining seven items are of a minor nature. The watershed level targets are fixed, based on the survey results obtained through various studies conducted during the last few years. Alternative plans are formed from criteria based on the recommendations of a currently adopted Phewa Tal Watershed Management Plan.

Constraints are constructed to force the selection of one alternative plan or a set of partial alternative plans per Panchayat. At the watershed level, constraints are used to maximise or minimise certain output items or the use of resources levels.

The maximisation of the present gross value of selected alterative plans yields an infeasible solution when the constraints are enforced to meet: (1) all the watershed level target values for 27 output items, (2) minimum sediment production, and (3) maximum levels of budget, grant money, credit, labor, and compost,. Seven watershed level alternative management plans are developed by setting up criteria reflecting the prioritised needs of local people and the environment.

The usefulness of an optimal resource allocation and multi-level planning approach to the Phewa Tal Watershed in particular and to Nepal in general can be seen in the (i) feasibility of formulating whole system resource management approach, (ii) possibility of improving the production of basic human needs, (iii) existence of the method for carrying out decentralised planning, and (iv) applicability of mathematical programming in the management of the country's renewable natural resources. The problems associated with this approach are: (i) lack of adequate data base, (ii) lack of computer facilities, (iii) failure of this approach to accommodate socio-political considerations, (iv) lack of planning capabilities at the Panchayat levels, and (v) involvement of a high degree of uncertainty.

At a time when the government is stressing people's participation in planning and managing the country's natural resources in an environmentally sound manner, this work can be considered a useful guide for the concerned users.

PROBLEM

Hills in Nepal occupy about 85 percent of the total land area. About 8.5 million people live on approximately 1 million hectares of cultivated land of comparatively low fertility. The hill region of Nepal is characterised by an elaborate crop and livestock farming system where cultivated plants, forest trees, range vegetation and domesticated animals are integrated to generate the best possible mix of goods and services to fulfill the basic needs of the people. About 15% of the land area is composed of alpine meadows in the high hills (57%), open grazing land in the mid-hills (33%), and steppic grazing land in trans-himalayan zone (10%). Forest covers 31% of the area and about 28% is classified as wasteland. Only 7% is available for cultivation. Lands under forest and range are continuously converted into first agricultural land and finally to degraded (waste) land.

Several studies have been carried out in Nepal to recreate the balance between man and resources. In most of the studies, integration of various components giving stress on the important role of the environment is suggested. However, clear management guidelines are still lacking.

This study will present an approach which will suggest the appropriateness of prescribing a particular management alternative in a particular area. The prescribed options are "forced in' to operate within defined environmental parameters. Basically, the study will deal with the question, given the objectives of management, and their constraints, how should one allocate resources to various management activities in order to provide the best mix of goods and services. The study does not make any attempt to prescribe its findings. With the present level of information available, the study only focuses on the problem; how the present status of inadequate production levels can be improved via a well co-ordinated management plan.

METHODOLOGY

Linear programming was selected as the analytical tool. Linear programming models were constructed at two levels, namely the Panchayat and the watershed. Watershed level objectives were achieved through the coordination of Panchayat level models. The Panchayat level models aimed at the identification of an optimum product output and use levels for each resource using the management objectives and constraints provided.

A scenario for this study was set under the basic contentions that: (1) an integrated and complex fashion of natural resource utilisation pattern existed in the hills of Nepal, and (2) wide disagreement prevailed to the often held hypothesis that there are comparatively few significant inefficiencies in allocating the factors of production in traditional production systems.

FINDINGS

The results of the multi level linear programming provided the following guidelines:

1) Tentatively, there existed a significant possibility for increasing the availability of basic human requirements through reallocation of resources under prevailing conditions.

2) Resources in a subsistence production system may be managed more efficiently if the interactions are considered.

3) Through the alternation of management practices and effective sharing of resources between Panchayats the supply of animal forage could be more than doubled.

4) Dependency of Pokhara was a critical factor in offsetting the balance between demand and supply of products in the watershed. The human as well as animal pressure on the watershed can be alleviated only if Pokhara finds an alternate source for fuelwood and forage.

5) The excessive sediment production due to frequent land slides and soil erosion mainly from range, waste and fallow, and rainfed cultivated terrace lands, although partially attributable to natural phenomenon, can to a major extent be controlled through proper changes in land use practices. Fuelwood and foodgrain productions were inversely related to sediment production, whereas, no relationship could be established between AUY's and sedimentation.

6) The study area apparently has the potential not only to be self sufficient but also to produce surplus foodgrains. However, surpluses were held by large land owners and found their way into outside market.

7) There was wide disparity among individual Panchayats in terms of resources availability and need. Densely populated Panchayats such as Pokhara, Dhikurpokhari, Sarangkot and Kaskikot were found to be deficient in most of the output items. Panchayats with relatively lower population pressure were observed to possess surplus production potential.

8) Public lands were shown to be managed inefficiently. The solution supported agro-pastoral and agro-forestry systems of management on all types of public land to increase per unit productivity.

9) Rice technology with 50% improved varieties was found profitable but results on improved maize were not conclusive.

10) Improved breeds of buffalo, goat and cattle were included in most of the Panchayat plans. Sheep raising was rejected in many plans.

11) The use of multi-level planning indicated several advantages:

a) a drastic decease in model size,

b) establishment of communication between two levels of planning,

c) enhancement of the concept of 'popular participation' in planning, and

d) mobilisation of local resources and integration of activities over space by appreciating intimate linkages among resource elements.

RECOMMENDATION

Regulation and control of forest resources should be carried out to rectify the malpractices such as uncontrolled grazing and tree felling.

Simultaneous reforms in planning techniques is thought to be crucial for improving resource productivity. In this regard, usefulness of the multi-level planning approach shown through the study could be helpful.

Instead of looking for a complete solution for the country's local, regional/national problems, resource managers should first strive for partial solutions.

ASSESSMENT OF WILD FOOD PRODUCTS AND THEIR ROLE IN HOUSEHOLD CONSUMPTION PATTERNS: A CASE STUDY IN BARDIA DISTRICT, NEPAL

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ABSTRACT

Wild food plants supplement the staple diet and they make an important contribution to the nutritional quality by adding minerals and vitamins. They are culturally important for local people in their diet and give food diversity. This study examined the availability and nutritional importance of wild food plants for local people who live close to the Royal Bardia National Park in the south-western part of Nepal.

The study was conducted in five villages of the Thakurdawara Village Development Committee (VDC). General questionnaire method (N=97), annual recall of wild food consumption (N=50), and three days actual weighing method (N=32) were used for data collection. Fifteen wild food plants were analysed chemically for nutrient composition. Eighty-seven wild food plant species were recorded as being consumed. Of these, 34 were leafy vegetables, 6 were roots or tubers, 7 were fungi and 40 were fruit species. Wild vegetables and fungi were consumed with staple foods to make them palatable, whereas fruits were consumed as snacks by children and adults during grazing and fetching fuelwood in the forest. Some of the species were consumed for medicinal purposes. Wild vegetables and mushrooms were consumed more frequently than roots and tubers. Most wild vegetables and fungi were eaten during the monsoon period, but a few species were consumed throughout the year. More than 50% of the households consumed 9 or more wild food species.

There was no significant difference in wild plant consumption between rich and poor people. Similarly, there was no significant difference in annual consumption of wild food plants between households near the National Park or government forest and households further away. However there was a significant difference between total consumption of wild food plants between indigenous people (Tharu) and immigrants from other parts of the country (non-Tharu). The Tharu consumed more wild food plants than non-Tharu because of cultural food habits, and wild food plants are still an important food component among the Tharu. The contribution of wild plants to the total diet in a year was 13.8% among Tharu and 4.1% among non-Tharu, but consumption varied significantly between seasons. Highest rates were recorded in the monsoon (26.1% and 6.5%) followed by winter (12.1% and 2.6%) and hot season (3.3% and 3.4%) for Tharu and non-Tharu respectively.

Nutrient intake in the study area was adequate in terms of the recommended levels except for energy and riboflavin. Despite the small consumption of wild food plants on an annual basis (11.1% weighted average over both ethnic groups), they contributed high amounts of vitamin A and calcium. The study indicated that wild food plants are an important source of micro-nutrients as well.

PROBLEM

The majority of the people of Nepal live in rural areas. In earlier times most of the land was densely covered by forests. Villagers were settled around the forest and had direct linkage with forest for their basic needs. They used to get leafy vegetables, roots, fruits, nuts, seeds, oil, honey, wild animals, and insects from the forest according to their seasonal availability. Fuelwood, construction materials and other minor forest products such as medicinal plants, fibre plants, bamboo, species, resins and dyes were also obtained from the forest.

About 36700 ha (7.3%) of the total forest land in the Terai (505000 ha) is covered by the Royal Bardia National Park. After establishment of the Park, access to wild food was reduced, particularly for small and large mammals. Local people now have to depend on government forests and fallow land outside the Park for their wild foods. Overgrazing by cattle and goats, is degrading the government forests day by day, and the people who are dependent on forest food resources may even be suffering from food shortages.

The nutritional situation in Nepal is characterised by food shortages. From past experience, it has been found that malnutrition is a serious problem especially among children. The underlying causes of malnutrition are high population density population growth, inadequate food availability, illiteracy, poor environment, negative cultural attitudes towards food and feeding, and imbalance between food production and distribution.

However, forest food products may enhance the nutrient quality of the diet and hence reduce causalities from nutrient deficiency disease.

METHODOLOGY

This study was conducted in five villages in Bardia District and focussed on the wild sources of vegetables, fungi and root species and their contributions to the rural diet.

A five-month field study was carried out from August to December 1992 to collect qualitative and quantitative data. Questionnaire surveys, information collecting, plant identification and chemical analyses of wild food species were done during the period of field work. For this study, both primary and secondary data were obtained. However, emphasis was given to primary data, especially from the indigenous people of the villages.

Thirty percent of the households in each village were randomly sampled in the general questionnaire survey. These were stratified into two groups, rich and poor. Within each of the sub-groups, 30% of the households were selected for in-depth study. Wealth ranking was done on the basis of land ownership.

The structured interviews were based on three different questionnaires:

- a general questionnaire and survey;
- annual recall interviews;
- a 3-day weighing method.

Unstructured informal interviews were also carried out from which a wide range of information was gathered from National Park staff, village leaders and local villagers with special knowledge of the study subjects. Discussion was done for identification of wild species with villages by local name and their uses. Information was collected through meetings with experts within relevant fields, such as nutritionists, ethno-botanists and food technologists.

FINDINGS

The study showed that 87 different species of wild plants were consumed by the local people, surveyed. There were 34 vegetables, 6 roots or tubers, 7 fungi and 40 fruits. Wild foods were consumed in 235 (32%) out of 730 meals. The consumption of wild food was higher among the Tharu ethnic group than non-Tharus because of cultural value. 13.8% (52.2 kg/yr/pers) of the total diet was contributed by wild vegetables, mushrooms and root species among Tharu and 4.2% (15.8 kg/yr/pers) among Non-Tharu. Most wild vegetables and all fungi were available during the monsoon and their consumption was also higher during that period. The contribution of wild plants was 11% of the total diet in a year, contributing 20% during the monsoon, 9% in winter and 3% in the hot season. The contribution during the monsoon was highly important in the diet.

There was no significant difference in wild food consumption between the rich and poor groups or between people living close to or further away from National Park and government forest; however the consumption of wild plants was higher among those further away.

Wild food plants were found to be important sources of protein, vitamins A and C and calcium. Wild vegetables were an important and cheap source of vitamin A in the rural diet, and can reduce vitamin A deficiency. A large amount of vitamin A (7149 mg/100gm) is present in *A. caudatus* (Mate Saag). Fungi were good sources of iron and protein during the off-season and fruits were good sources of vitamin C.

Wild food plants play an important role in household food security as supplementary food sources, especially among the Tharu ethnic group. They enrich the rural diet by adding minerals, vitamins, and protein. However, forestry products alone cannot resolve the total food security issue. Many other factors, such as agricultural practices, animal husbandry, food preservation, food habits and social taboos, have to be taken into account if total food security is to be achieved.

PARK-PEOPLE CONFLICT IN LANGTANG NATIONAL PARK, NEPAL

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ABSTRACT

This thesis examines the sources of conflict between Langtang National Park and its resource-dependent local population. The following issues of conflict were addressed in the research: the local people's level of understanding of the purpose of Langtang National Park; crop and livestock depredation by Park wildlife; access of the local people to the Park's resources; tourism impacts in the Park and interactions between Park staff and the local people.

Out of 23 village units that are dependent on Park resources for wood and pasture, nine were randomly selected for detailed investigation. The investigation included structured questionnaire interviews of 212 randomly selected heads of households and 62 Park staff (who were currently working in different units within the Park administrative system). In addition, a self-administered questionnaire survey was responded by 33 office heads at Rasuwa District headquarters in Dhunche, located inside the Park boundary. Some in-depth interviews were carried out with selected people such as local leaders and wildlife biologists to get additional qualitative information.

A comparative study was made of the understanding of local people, Park staff and office heads regarding purposes of Langtang National Park. This study revealed positive perceptions of all groups on the issue and indicated that the purposes of the Park are not an area of conflict between the Park administration and the local population, however the degree of commitment to the purposes is less strongly held by local people. Wildpig was found to be the principal crop-raiding animal, followed by Himalayan black bear, monkey and deer species. This resulted in resentment of the local people towards the Park administration. Adoption of wild-pig farming by capturing young pigs and selective culling of old ones has been proposed as a solution to the problem and also a source for income generation for the local people through meat trading.

Adoption of land-use zoning and the declaration of buffer zones have been proposed as solutions to the problems of crop and livestock depredation by Park wildlife, particularly through implementation of community forest resource development activities in the buffer areas. Buffer zones can function as multiple-use management areas for the purposes of reducing the movement of Park wildlife towards settlements, reducing encroachment of the Park by the domestic stock of local people and providing the local people with access to additional Park resources in the future.

Tourism is seen as a source of national and local income in the Park area. Although no negative impacts of tourism were found in this study, the adoption of proper tourism planning procedures is needed to reduce or prevent negative impacts in the future.

The majority of the local people are familiar with the Park staff and perceive them as helpful and friendly. These positive relations can facilitate the involvement of local people in decision making regarding Park people relations in the future.

PROBLEMS

This thesis examines the possible issues and causes of conflict between the Langtang National Park administration and the local population in managing protected areas. It seems that conflict could arise partly because of both the dependence of local people on Park resources for the maintenance of their livelihood and the existence of controversial policy decisions which show failure to understand that conservation issues are inextricably linked to the social and economic needs of the local people.

It is inappropriate that the planning of protected areas and management plans for mountains be based on general management principles without considering the idiosyncratic social and economic needs of the local people. Parks such as Sagarmatha and Langtang have encompassed several villages and many generations of human settlement. In these national parks, the collection of firewood for household consumption and the "traditional" grazing of the Yaks and Yak-hybrids have been allowed in a response to the socio economic needs of the local people. It is expected that other aspects of conservation will be at cross purposes with various socio-economic interests of the local people and thus likely to contribute to conflicts between the locals and the Park administrators. Successful management of the protected areas in the mountain regions of Nepal depends on reconciling the conflicting needs for nature protection with the needs of People. With these considerations in mind, Langtang National Park (which was the first established mountain park in Nepal) was chosen at the research area in which to investigate park-people conflicts.

METHODOLOGY

The research tools used in this investigation were:

Structured questionnaire interviews of householders were conducted. The households which participated were chosen randomly. Altogether 212 household heads were interviewed, representing 5.3% of all households in the sample area.

Structured questionnaire interviews of all 62 Park personnel who were working in Park administration during the study period were also conducted.

A meeting of the 33 office heads of the District administration was held, at which the questionnaire was handed out to the head of each civil service office. Twenty office heads returned the questionnaires, a 60.61% return rate.

In-Depth Interviews

In addition to the questionnaire surveys, in-depth interviews with selected persons such as local leaders and wildlife biologists were carried out. The opinions of these people provided some additional qualitative information regarding the issues under study.

FINDINGS

1) Sources of conflict lie in the strength of convictions and beliefs about the purpose of the Park and the extent to which individuals or groups are adversely affected by the policies which are associated with these purposes.

2) Crop depredation by wild pigs is a major source of conflict. Crop and livestock depredation by deer species, monkeys, Himalayan black bears, leopards etc. are also resented by the local people.

3) There is not much perceived conflict as a result of the breaking of Park laws and regulations by the local people. However, positive conservation attitudes are best fostered among the local people by ensuring their basic needs for food, shelter etc. are met.

4) Tourism is seen as a source of national and local income in the Langtang National Park area.

5) Most of the local people know the Park staff and reported that the Park staff are helpful and friendly to them.

RECOMMENDATIONS

1) Wild-pig farming should be established by capturing young pigs, and should be accompanied by massive culling of mature pigs. Further study regarding the practical difficulties of these projects would be desirable before implementation.

2) Buffer zones should be established as a potential solution to the following two problems:

   (a) crop and livestock depredation by wildlife due to their free movement from core habitat areas to human settlement areas; and

   (b) the need for local people to access forest resources in future. Essential forest resources should be cultivated in the buffer areas through community forestry programmes.

3) Although no negative impacts from tourism were perceived by the majority of the respondents in the Park area, monitoring and research are needed to ensure that planning takes full account of the potential negative impacts of tourism development in the future.

4) Studies should be undertaken to determine the types of interaction between Park staff and the local people which best ensure that decisions on park people related problems will indeed be representative of all parties concerned.

5) There is a need to study the use of programmes for delineating buffer zones in different ecological areas, where different types of land-use practices are already employed.

CONFLICTS IN COMMUNITY FORESTRY IN NEPAL

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ABSTRACT

This thesis examines conflict in community forestry in Nepal. It investigates and analyses conflicts involving five forest user groups (FUGs)-two from the Terai and three from hill region. Information from the past studies on conflicts in community forestry is also examined. Conflicts in community forestry occurred at three different levels. within FUGs, between FUGs and between the Department of Forest (DOF) and FUGs. Six sources of conflict were: access to resources, changes in resource quality and availability, authority over resources, differing perceptions of value, information transfer and availability, and legal and policy issues. Conflicts over access, and conflicts associated with the transmission of information among the interested parties were the major ones. Measures to hasten the resolution of conflicts and to reduce their frequency are considered. Proper investigation of actors, stakes and resources, is to be conducted before or during the handing-over process of community forestry. More pooling of the expertise of field staff is needed to cope with the increasing number of FUGs. Training of DOF field staff for their effective mediating role in situations of conflict is essential.

PROBLEM

Natural resources are the main assets of developing countries, many of which largely depend on their forests for basic needs and socio-economic improvement. For many people, forests are the main sources of their fuel-wood, fodder, timber and medicines. For forest-dependent communities, and some others, forest is a source of income. Forests are also of value to society at large as ecological systems, habitats for diverse species and for purification of the air. Interest extends to business entities and government because of the revenue that can be generated from logging, eco-tourism and other services. In pursuing these activities individuals and groups do not have identical resource interests and so conflicts arise. Nepal is no exception to general rule, and conflicts arise in managing, maintaining and exploiting its forest resources.

To develop and manage the forests of Nepal, in 1989 the master plan for the forestry sector placed great emphasis on meeting people's basic needs for forest products on a sustainable basis in order to protect the environment. The central policy for community and private forestry programmes is to "develop and manage forest resources through the active participation of individuals and communities for them to meet their basic needs".

As a result, community forestry in Nepal has developed rapidly over the last decade. Large areas of the middle hills forests are in the process of being handed over to local communities. It is accepted that lack of participation of users results in failure of community forestry programmes. Their success depends on the active participation of local people in decision-making, planning and benefit sharing. In every step of the handing-over process, lack of proper investigation, negotiation and implementation are major sources of problems and disputes. In the context of the heterogeneous hills societies (different ethnic groups, different

economic conditions, different interests), common property management is far from easy. Due to the completely inequitable distribution of power within FUGs, conflicts arise where users' interests and potential users' interest have not been adequately taken into account during the handing- over process. Unresolved conflicts seriously hinder forest management and utilisation efforts and hasten resource degradation. Increasing scarcity of resources and inequitable access to forest resources are major sources of conflict. Very few studies of conflict management in community forestry have been conducted in Nepal. The time has come to recognise conflicts and move urgently to their resolution for sustainable and equitable management of forest resources. Much more information needs to be collected and analysed for an understanding of the factors related to conflict management and the development of appropriate tools and methods to help resolve and prevent conflicts in community forestry.

OBJECTIVES

The objectives of this study were to:

1) document possible sources of conflict in community forestry;

2) identify and analyse the different types of issues and conflicts arising in community forestry;

3) identify mechanisms to avoid, prevent or minimise conflict and come up with possible solutions and recommendations for conflict management.

METHODOLOGY

Information on community forestry conflict was collected in three districts; Makawanpur in the lowland Terai region and Rasuwa and Dhading in the middle hills region. The districts were selected one each from the high, medium and low motivation categories. The categoriasation was based on the level of motivation of the local communities (FUGs).

Primary data were collected in the field using participatory rural appraisal tools, particularly focus group discussions and interviews with key informants Village Development Committee (VDC) members, Forests Committee members, local leaders, school teachers and elderly people). A checklist questionnaire was prepared after consultation with District Forest Office staff, for the purpose of recording discussion. Focus group discussions involved different interest groups (rich, poor, higher caste, lower caste and women). Some people from marginalised groups (e,g. blacksmiths) were interviewed individually because of their hesitation to voice opinions in front of the wealthy and higher caste people.

A broad analysis approach was used which involved indentifying the possible causes of conflict by reviewing the context within which the conflict occured, categorizing of conflicts, determining the stakes associated with the conflict, the resources involved, the actors' relationship with the resource and resource use, the state of the resource and its availability.

Various university libraries were consulted to collect relevant literature on natural resource conflict. These secondary data have been used to extend and strengthen the context provided by primary data.

FINDINGS

1. Conflicts occur at three different levels, which are:

   - within FUGs-conflicts over issues such as stakeholders' exclusion, traditional users' rights, elite domination, unequal benefit sharing, deviation from operational plans and lack of participation during the implementation of operational plans;
   - between FUGs-conflicts over dualism of users, unclear foresr policy and boundaries; and
   - between FUGs and the DoF-violations of operational plans and issue of resources use and policy are among these.

2. The following six types of conflict in community forestry are important in Nepal:

   - conflict over access;
   - conflict due to change in resource quality and availability;
   - conflict regarding authority over resources;
   - conflict that is value based;
   - conflict associated with information processing and availability; and
   - conflict resulting for legal and policy reasons.

Among these, conflicts over access and conflicts associated with the transmission of information among interested parties were the major ones.

3. There are both negative and positive impacts of conflicts over forest resources, on parties involved in conflicts and for the DOF. It was noted that:

   - conflicts solved promptly have positive impacts while delayed, neglected and lingering conflicts have negative impacts (ecological, economic, social, institutional), as a result of which forest resources are being degraded;
   - currently, most of the conflicts reported here are continuing rather than being resolved.

RECOMMENDATIONS

1) Conflict in community forestry should be resolved within local customary systems, and intervention by third parties (e.g. government field staffs or rangers) should only occur as a last resort.

2) Proper investigation of actors, stakes and resources related to community forestry should be conducted prior to, or at the time of, the handing-over process.

3) Underprivileged groups in the community (e.g. women and the poor) should be empowered and fully involved in community forestry programs and should be allotted appropriate use rights (not only in terms of participation but also in decision-making).

4) There should be a clarification of the basis for allocation of national forest and community forest, particularly in the Terai.

5) There should be a well-defined forest boundary (in terms of resource use) for every FUG.

6) The existing expertise pool of the DOF is not large enough to deal efficiently with the increasing number of FUGs and conflicts; therefore adequate staff should be recruited.

7) Training should be organised to equip the field staff of district forest offices to play a fully effective mediating role in situations of conflict.

8) Proper co-ordination should exist between the DOF, FACOFUN, NMS, bilateral agencies and the various NGOs concerned with community forestry for the better understanding and management of community forest conflicts.

STATUS AND FOOD HABITS OF NILGAI (*Boselaphus tragocamelus*) IN ROYAL BARDIA NATIONAL PARK, NEPAL

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ABSTRACT

A six-month study of the status and food habits of nilgai (*Boselaphus tragocamelus*) was carried out in Royal Bardia National Park, south-western Nepal. Methods used were questionnaire surveys, field observations and microhistological analysis of faecal material. Between 57 and 86 animals were estimated to exist in nine different semi-isolated subpopulations inside and outside the Park, reflecting a decline of 80-90% since the 1970's. High poaching, tiger predation and habitat deterioration both inside and outside the Park were identified as major causes of the decline.

Nilgai were found to be mixed feeders. Browse species comprised about 45%, grass about 27% and agricultural crops about 17% of their diet. A total of 26 food plant species were recorded. *Callicarpa macrophylla, Mallotus philippinensis, Artemesia vulgaris, Eugenia jambolana* and *Casearia tomentosa* were the most important browse species. Short grasses, *Cynodon dactylon* and *Imperata cylindrica,* were preferred over tall grass species. Rice was eaten during all months from August to January but peaked during November and January, at 12.9% and 12.3% of the total diet, respectively. Mustard was particularly high during December (16.6%).

Crop damage by nilgai averaged 8.3% of the total crop loss caused by wild animals. The present distribution pattern and the food habit study confirmed that the nilgai antelope is adapted to a certain degree of human disturbance, including domestic livestock grazing. However, because of its large size and affinity for feeding on agricultural crops it is highly vulnerable to poaching. In order to conserve this species in Nepal, the remaining small subpopulations need to be protected and their habitats included in a buffer zone management plan for the park.

PROBLEM

The nilgai (*Boselaphus tragocamelus*) is the largest of the Asian antelopes, looking rather like African eland with a slim antelopine face and a large sleek body more like a zebu cow than an antelope. They are only found in the Indian peninsula from the base of the Himalayas to Mysore. They are found in a variety of habitats from level ground to hillsides, and from thin brush with scattered trees to cultivated plains, but not in thick forests.

In Nepal, nilgai were once widely distributed in the Terai, the southern plain. They are regarded as "blue cow" by the Hindus, which offers them some protection as a sacred animal. They occur in seemingly viable numbers in Koshi Tappu in the east, Parsa in the middle, and Shukla-Phanta and Banke-Bardia in the west, but them Bardia has the largest nilgai population in Nepal.

However, observations in Bardia indicate that the population of nilgai has been drastically reduced in recent years. Unsubstantiated reports from other parts of the country also indicate that the species becoming rare throughout Nepal borders. So it has become necessary to map the dirtribution and assess the current status of this species within Royal Birdia National Park.

METHODOLOGY

A. Population status

The following two methods were employed to estimate the present status of the nilgai population in the Park.

1. Field survey

A preliminary survey of the study area was conducted to find out the likely nilgai areas before the actual fieldwork started. This was done superficially by questioning Park personnel such as the warden, game scouts, elephant drivers and field technicians from an ongoing conservation project as well as naturalists from Tiger Tops lodge and Tented Camp.

2. Questionnaire survey

Two sets of questionnaires were employed to find out local views about the status of the existing nilgai population. The first set was distributed among 173 households within a distance of 500 m from the Park boundary along the southern boundary from west to east.

The second set of questionnaires was designed for Park personnel - Park warden, game scouts, and elephant drivers. Army staff of the Park protection unit and experienced naturalists and elephant staff from the Tiger Tops lodge and its Tented Camp were also interviewed. Tourist record files which have been maintained since the Tiger Tops was established in 1980 were also used to identify nilgai areas and compare earlier and the present rates of sightings of the animals.

B. Feeding habits

1. Machan observations

Machans were used to observe the feeding habits of nilgai within the main study area but were only useful during early morning and evening. Binoculars (7 x 50) were used to observe animals from a distance. The plant species eaten by the animals were identified and recorded in the field or brought to the research station for proper identification and to establish the grazing pattern.

2. Habitat study

The floristic composition of the nilgai habitat in the main study area was described from a crude vegetation analysis which was carried out in three main vegetation types; khair-sisso

forest, riverine forest, and wooded grassland. Eight plots in each vegetation type were analysed. The first plot was laid about 25 m away from the road with a distance of 20 m between plots. A quadrat size of 10 m x 10 m was used for shrub species and 2.5 m x 2.5 m for grasses and herbs.

3. Microhistological technique

This was used to investigate the food habit of the nilgai by examining the faecal samples.

4. Questionnaire survey of farmers

A questionnaire survey was conducted among the local farmers to find out the various crops and vegetables grown in the study area and the extent of damage done by nilgai. The growth stage of the crop species preferred by the animal was also noted.

FINDINGS

The overall population status of nilgai within Nepal's borders looks very bleak unless serious efforts are made to conserve them. Nilgai is the only species that has not fared well after the creation of national parks and protected areas.

The nilgai population in Royal Bardia National Park has declined to an unprecedented low level. Nine hotspots in Bardia hold the remaining remnant populations of probably less than 100 animals. One subpopulation outside the National Park, near the Baniyabhar jungle, is in a highly vulnerable state. The Chisapani flood plain population across the Geruwa River is also under threat from poaching. Poaching and tiger predation were identified as the major cause of decline of this species. Deteriorating habitat quality, due to denser vegetation structure inside the Park and more human disturbance in nilgai areas immediately outside the Park, are probably also contributing to the decline.

Nilgai seems to be primarily a mixed feeder. From direct observations and faecal analysis 26 plant species were recorded as eaten by nilgai. Heavily utilised browse species were *M philippinesis, C. macrophylla,* and *C. tomentosa.* Other browse species that appeared to be selectively eaten were *A. vulgaris* and *E. jambolana.*

The Nilgai habitats within the Park are not far from human settlements. The animal favours open forest with less dense understory vegetation. It utilises the peripheral areas of the Park as well as areas utilised by livestock. A relatively high occurrence of disturbed site plants like *Crisium, Artemesia, Cassia* and *Zizyphus* spp. in the diet indicates that this animal readily exploits areas with a certain degree of disturbance. The relatively high numbers of nilgai in the eastern sector of the Park could possibly be due to the presence of buffer forests and fewer numbers of tigers than in the western sector.

Nilgai also feed in cultivated fields, and between August and January an estimated 17% of their diet consisted of agricultural crops. The highest proportion of crops (24%) was recorded in December. Rice was evident from August to January. Mustard peaked during December and January. However, due to their few numbers compared to other crop-raiding species, nilgai only contributed about 8% to the total crop loss taken by all wildlife in the villages adjacent to the park.

RECOMMENDATIONS

The following measures could possibly be helpful in conserving the remnant nilgai populations in Nepal.

1) All nine nilgai hotspots inside and outside Royal Bardia National Park need special protection to increase viable breeding populations. The Baniyabhar subpopulation outside the park boundary is highly vulnerable, mainly because of the lack of protective measures. The Park authority should consider including this area under its jurisdiction and provide necessary protection.

2) All the nilgai habitats within the Park lie in close proximity of the Park boundary, and the animals move frequently into the remaining forest pockets outside the Park. Efforts should be made to include these areas in a buffer zone management plan for the Park.

3) Nilgai utilise areas that are grazed by livestock. Hence a certain level of livestock grazing in nilgai habitats should be allowed to prevent the habitats from becoming too dense in structure.

4) Nilgai is a serious nuisance in agricultural crops, and the temptation to poaching is very high. Intensive patrolling and surveillance of the remaining nilgai areas is therefore crucial.

5) To reduce agricultural conflicts barbed-wire fences, about 7 feet tall should be erected and maintained regularly to minimise crop damage in the most critical areas.

6) Public awareness programs should be initiated to disseminate conservation education to the local villagers about the importance of the Park and its wildlife resources, especially about the highly endangered nilgai species.

7) The remaining forest patches along the Park boundary should be managed as buffer area and improved so as to avoid further pressure on the Park resources. The local people should be included in the management system of the buffer forests by forming local users' committees. Local people should have their say in the formulation of the management plans and receive some benefits from the Park in order to encourage their cooperation.

8) Surprisingly little is known about the biology and behaviour of nilgai and its habit requirements. A more comprehensive study is therefore necessary in order to conserve this antelope in the long-term in Nepal.

SAMUDAYIK BAN BIKAS KARYAKRAMMA GRAMIN MAHILAKO BHUMIKA[1] (ROLE OF RURAL WOMEN IN COMMUNITY FORESTRY DEVELOPMENT)

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M.S. 1998
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ABSTRACT

The study attempted to reivew the community forestry development programme conducted by the Womens' Forest Users Group in the Kohlpur VDC, Ward No. 4 of Banke District in the Mid-Western Development Region of Nepal.

Data were collected through the questionnaire survey for which 20 (Twenty) out of 63 (Sixty Three) households were selected randomly. Nine FUG executive members were also interviewed as key persons. Direct observations were made to study the forest area, nursery development, plantation, management practices etc. Secondary data were also used.

The study showed that the community forestry development programme in the study area has become a model in the Mid-Western Development Region as a whole. The programme is being operated effectively under the active leadership of women through the Womens' Forest User Group. It is also found out that there is a strong role of women in management, protection, control and utilization of forests. Various recommendations were made based on these findings.

PROBLEM

Women in Nepal are found actively involved in the different areas of Social Development. Preliminary studies, in this regard, shows that womens' responsibility in all aspects, inside as well as outside home are increased further as men generally go out of home and in foreign countries as well for employment purpose.

On the other hand, women in Nepal by tradition are limited to household chores like cooking, washing clothes, taking care of children, fodder collection etc. They are found excluded in important social activities. Priority is given only to men at the decision-making level. Also the important activities performed by women in various aspects are not brought into light because of social partiality.

Various studies in Nepal prove that women are actively involved and participate equally or more than men in the collection of fuelwood, fodder, leaf-litter etc. These studies have also shown that women as the main forest users can protect, conserve and use forests equally or better than men.

[1] This thesis is written in Nepali language.

METHODOLOGY

The study was conducted in the Kohalpur VDC, Ward No. 4 of Banke District in the Mid-Western Development Region where the community forestry development programmes are in operation under the active involvement and participation of women.

Primary as well as secondary data were used to meet the study objectives. For primary data collection, 20 (Twenty) out of 63 (Sixty-three) households were selected randomly and the questionnaire survey was carried out. Besides it, nine FUG executive members were interviewed as key persons. Direct observations were also carried out to study the forest area, nursery construction, plantation, management practices etc. Secondary data were collected from the libraries, official documents, newspapers etc.

FINDINGS

Community forestry is being operated effectively in the study area under he active leadership of women through the Womens' Forest Users Group. It has become a model in the Mid-Western Development Region. There is a strong role of women in the control, protection, management, and utilization of the forests. The operational plan prepared under co-operation of the District Forest Office is being implemented effectively and efficiently. So, the programme being operated by the women can be highly appreciated and has become an example which may be helpful to decide how the forestry development works can be carried out successfully involving women and in implementing forestry development programs of the Government and NGOs in the future.

RECOMMENDATIONS

1) Emphasis should be given to more investments on plantation which should be carried out from private to government level to meet the daily needs of people for forestry products as well as for environmental conservation.

2) Awareness should be created for forestry development through adult education program on practical and useful forestry knowledge.

3) Forestry extension programmes specially on plantation and its maintenance should be made effective and seedlings should be distributed free of cost.

4) As there is enough livestock population technical and financial help for bio-gas plans should be provided. Other alternatives to fuelwood such as electricity, agro-products etc. should be utilized.
5) Improved stove should be distributed to the people to decrease the fuelwood consumption.

6) Sales depots should be established in order to make available of the peoples' daily needs, of timber and fuelwood and reduce their dependency on forests.

7) Employment generation opportunities should be created to uplift economic condition of the people.

8) Training, Seminar and Study Tours should be organized to increase efficiency of FUGs on effective forest management.

9) Forest encroachment should be controlled through effective law enforcement.

10) The tendencies to demoralize women users and to make partiality between men and women should be stopped through extension and creating awareness as well as by making necessary laws, in order to encourage women in development activities.

VARIATION OF *ALNUS NEPALENSIS* D. DON IN NEPAL

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ABSTRACT

Alnus nepalensis D. Don is an indigeous species occurring in Nepal at altitudes from 500 to 3500 m. It is important for reforestation of denuded sites in the middle hills of Nepal, because of its fast growth and ability to improve soil conditions. In an attempt to improve productivity of the species in plantations, systematic trials were established in different regions of the country. Seeds of 12 provenances were collected from 2 to 15 trees in three different altitudinal ranges between 900 and 2300 m within four watershed basins (Koshi, Bagmati, Gandaki and Karnali) from 27°04' to 29°22' (N) latitude and 80°28' to 85°05' (E) longitude. Seedlings were raised in four nurseries and planted at two sites. The experimental design was randomised blocks with 3 to 5 replicates.

There were highly significant differences between provenances in several characters of cones, seeds and seedling growth. Although no consistent relationships were observed between seed and seedling characteristics and geographic origin, they may show-up in field trials conducted over several years. The first indication of such variation was the faster growth of seeds from a low longitude seed source after one year at Pakhribas (summer plantation). Provenances from Bagmati and Koshi basins gave good germination. Seeds from provenances native to moist areas germinated earlier and faster but did not give a high percentage of germination. The differences in seedling growth in six-month old nursery plants (winter and summer sowing) were associated with altitude of seed source, and were still present six months and one year later in winter and summer plantation respectively at Pakhribas. The production nursery was not efficient in accounting for variation in population mean to separate environmental and genetic effects.

At this early stage the trials suggest that provenances from Kuwali and Pang and local seeds may be optimal for plantations in Pakhribas. However, they will have to be evaluated for several more years to arrive at any definite conclusion.

BACKGROUND AND PROBLEMS

Thus National Forestry Plan 1976 stated that the Department of Forests would develop a firm program of systematic forest research in order to upgrade the standard of forest management and make the maximum contribution to the country's social and economic development.

This a comprehensive program of provenance research and seed collection on the scale needed has begun only recently and with only a few species, the work of multiplication and improvement is essentially long-term. In order to co-ordinate and compare trials from many different sites it is necessary to develop an assessment method which comprises a sufficient number of characteristics to describe the variability between sites and provenances adequately. Many genetic, statistical, silvicultural, and practical aspects have to be considered in working out an assessment system which may function as a standard method.

OBJECTIVES

The Community Forestry Project regards *Alnus nepalensis* as the most favoured species for the middle hills because it is easy to raise, grows fast, and yields fodder, fuel and small timber.

The objective of this study was to identify the most suitable provenances of *Alnus nepalensis* for use in the development of fast-growing plantations on a wide range of sites and altitudes.

The main purpose of this research was to eliminate obviously unpromising provenances as early as possible, thus reducing the provenances to manageable numbers for more critical testing. The early identification of superior seed sources has become urgent because demand for seed is increasing in Nepal. Seed viability is important where one would like to complete the collection within a short-term for reasons of supervision and economics. The selection of provenances for fast rate of growth may be the most profitable action to take because, although timber quality may be lower, the annual amount of wood substance and therefore the amount of energy produced per hectare may be greater. This investigation has given the highest priority to qualities which affect utilisation. After survival, height is usually the most important production variable assessed in these studies because it is less influenced by tree competition than is diameter.

FINDINGS

If provenances are shown to have distinctive patterns of variation in taxonomic characteristics these may serve as an efficient and rapid means of characterising further provenaances. *A. nepalensis* provences did not show any sub-specific taxonomic grouping in this trial; this may be due to altitudinal closeness of the samples (923 to 2300m), collection of the samples during the deciduous period, and poor control of the sampling position within trees. Although some high altitude provenances like Kawali and Shyamshila had larger leaves and some lower altitude provenances had smaller leaves, the differences were not significant.

Seed size is an extremely variable character, varying from year to year with weather conditions, from tree to tree and even with location in the cone or fruit. There were highly significant differences between provenances in the several characters of seed germination but no correlations were observed between seed length or width and site factors.

The trails showed that the seed source may be important in choosing A. nepalensis for plantations sites. Many provenances are ill-adapted to the climates of the sites with respect to height growth and survival.

The pattern of variation in germination percentage showed no clear geographical trend. Although not significantly different, the provenances having bigger seeds grew faster than those with small seeds. The seeds from higher altitudes gave a faster germination than seeds from lower altitudes.

Provenances from higher altitudes grew slightly better then those from lower altitudes in the nursery.

There were highly significant differences between provenances in several characters of nursery seedlings. The two characters, seedling height and number of leaves, were highly

variable at the nursery level.

There were highly significant differences between provenances in several characters in the field trials although there were no consistent trends such as from north to south, cold to warm or dry to moist. No correlation was found between mortality percentage and site factors.

The lack of relevant climatic data presumably accounts for the generally poor explanation of detected provenance differences in the analysis. Only a limited part of the range of the species was sampled; the difference in environment between the extreme parts of *A. nepalensis* distribution (500-3500m) is probably greater than between stands at the same altitude at the extremes of latitude (27°05' N to 29°22' N) of the range of the species.

RECOMMENDATIONS

As these results were obtained only from short-term studies under relatively uncontrolled conditions in small production nurseries, new nursery trials should be planned to confirm the expected experimental findings.

More intense and systematic sampling of one altitudinal transect may reveal a pattern of variation. This preliminary investigation leads to conclusion that the 12 provenances were not enough to represent the whole of Nepal with its extreme variation in elevation within the range of *A. nepalensis*.

For the time being the local seed and provenances Kuwali and Peng can be recommended for planting in the Pakhribas location because of their low mortality and higher growth rates. A separate experiment with the individual parent tree identified should be carried out in the future.

As differences between the provenances are expected to be small, in future, field trials on smaller plots with greater replication may improve the chances of detecting significant differences which may exist. Longer periods of observation will be necessary before final conclusions can be drawn concerning provenance differences and relative provenance suitability for the improvement of yields on different sites.

As detailed assessment of *A. nepalensis* trials should continue for several years, fresh seeds should be used in future. Sound statistically designed field experiments should be repeated over several years at different altitudes and aspects. Protection should be given from livestock and great care taken with labelling and recording at all stages.

COST AND BENEFIT SHARING PATTERNS IN COMMUNITY FORESTRY OF NEPAL

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ABSTRACT

Community forestry is one of the main forest management systems of Nepal and it aims to provide basic needs and economic benefits to the country's rural people. The master plan for the forestry sector (1988) includes clear guide-lines to place all community forest management works under the control of user groups in order both to ensure equitable sharing of costs and benefits among the users and to encourage sustainable forest management. In spite of these enlightened and progressive ideals, equitable cost and benefit sharing among users has become one of the most challenging issues in the planning and development of community forestry. Conflicts and disputes often develop among the users over implementation of various forest operations and allocation of costs and benefits and corrects government policies and legislation are not helpful for solving these problems. Hence, a study of the fundamental issues involved in equitable cost and benefit sharing patterns is relevant to present-day challenges facing community forestry in Nepal.

This thesis reviews basic concepts in the identification, quantification and valuation of socio-economic and environmental costs and benefits involved in community forestry, and equitable sharing mechanisms that could be acceptable to community forest user groups in the middle hills region of Nepal.

Some strategies need to be devised to encourage users to develop systems for the fair and equitable sharing of benefits and responsibility for just and sustainable community forest management.

PROBLEM

The economy of Nepal is based on subsistence-farming systems in which trees and forests are integral parts. They provide timber, fuelwood, fodder, medicinal herbs, ritual materials, cattle bedding materials and compost for the rural population. To some extent trees and forests also help to alleviate soil erosion, flooding and other environmental damage in the middle hills and adjoining areas.

Unfortunately the forests of Nepal have not been managed on a sustainable basis for some time. As a result, in most parts of the country forests are declining both in quality and density. The past history of community forest management has clearly indicated that more equitable arrangements are needed for the sustainabilility of community forestry.

In most forest management systems, equitable arrangements for sharing costs and benefits are not easy to define. While studies have identified and valued direct benefits such as small timber, fuelwood, fodder, leaf litter and some minor forest products, there has been little work on the identification and valuation of the environmental and social benefits of community forestry. Similarly, while direct costs such as labour and construction materials have been studied the identification and valuation of indirect costs such as environmental and social costs have not. As a result, conflicts and disputes often develop among the users, particularly when the time for implementation of various forest operations, allocating the benefits, eventually arrives. Such conflicts prevent the implementation of sustainable forest management systems. Such problems are becoming major issues and current government forest polices and legislation do not encourage user groups to solve them. In this context, a study to identify real issues of equitable cost and benefit sharing patterns for sustainable community forestry management is highly desirable.

OBJECTIVES

The primary objective of the study was to identify socio-economic and environmental costs and benefits of community forestry and equitable sharing patterns acceptable to users. Specific objectives were:

1) to identify problems faced by the forest users in defining and sharing all costs and benefits;

2) to develop strategies which might encourage users to achieve equitable sharing of costs, benefits and responsibilities; and

3) to review current policies and existing legislation on community forestry with a view to recommending integrated forest policies that could help community forestry to attain sound and equitable social, economic and environmental goals.

The focus is on community forestry of the Middle Mountains of Nepal where it has been implemented on a large scale as one of the major forest management systems for the welfare of the rural people and protection of their environment.

METHODOLOGY

This study is based on a literature review.

FINDINGS

The topography, soils, and climate of the middle hills are very diverse. Consequently the region has an unusually wide range of forest types and many different types of agricultural land, resulting in the development of many and complex socio-economic systems in the region. Consequently, the need for and use of the forest resource varies from one community to another. In such a situation cost and benefit sharing within and between user groups can vary from place to place, making the management of community forests in some parts of the middle hills extremely difficult.

In the early stages of community forestry, programs were aimed at creating new plantations rather, than managing existing forests. The afforestation-oriented programs were not fulfilling the objectives of the local people and effective peoples participation was rare. Most programs were controlled by the Forest Department. After 1985, greater emphasis was given to the provision of benefits to the user groups and to sustainable management of community forests.

The problems of cost and benefit sharing have been, and will be, significant between and within different community forest user groups until all the costs and benefits are identified, and valued, and are shared on equitably. Unfortunately, in most areas of the middle hills, cost and benefit sharing patterns are not based on equity, and this is one of the main reasons for the failure of community forestry to operate on a sustainable basis. It seems, in fact that community forestry is making the rich richer and the poor even more disadvantaged.

In community forestry, some users are aware of direct and tangible costs and benefits but not the indirect and intangible ones. However, the latter indirectly contribute towards socio-economic development and environmental conservation, and ignoring them could be one of the reasons for the increasing disputes and conflicts.

Community forests, if managed on a sustainable basis, can not only satisfy some of the basic needs of user groups, but may also provide many other substantial benefits that can help to raise the living standards of rural people and facilitate development of the Middle Mountains. At the same time, the users have to bear many costs to accrue these benefits. However, community forestry will not be sustainable unless government development policies pay adequate attention to the. changing roles of forest resources.

RECOMMENDATIONS

The Department of Forest should help the users to identify and incorporate most of the relevant costs and benefits in their operational plans and distribute these costs and benefits among themselves on an equitable basis.

The users should be particularly encouraged to identify, and value some of the relevant intangible benefits and costs and distribute them equitably so to as to manage their forests on a sustainable basis. It is essential to undertake careful studies of the needs and objectives of all user groups, and of indigenous systems of forest management which are comparatively more equitable than sponsored system. Such studies could help to develop new forest policies based on equity.

Government policies and legislation should take into account all the costs and benefits of community forestry; and aim at ensuring their equitable distribution. They should therefore be framed to help the users identify and value all costs and benefits; and set up rules and regulations for costs and benefits distribution.

EXTENSION FORESTRY, WITH EMPHASIS ON THE IMPROVEMENT OF FODDER AND FIREWOOD SUPPLY IN THE HILLS OF NEPAL

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ABSTRACT

This study deals with the social aspects of forestry extension. It focuses mainly on approaches to extension which are currently being used in other sectors and which could be applied to forestry extension, especially in the hills of Nepal. The main aim was to improve fodder and firewood supplies.

The study is mainly based on a review of the literature. It found that in the long term, the increase and maintenance of fuelwood supplies requires planting of more trees in most situations. It also showed that shortages of fodder in general and green matter during the dry months in particular are the main reasons for the continuous decline in the productivity of livestock. No livestock development or improvement program can be successful unless there is a parallel food resource development program. Recommendations are made to improve the fodder and firewood situations in Nepal, especially in the hills.

PROBLEM

The limited transport and communication infrastructure and mountainous terrain have led the hills people of Nepal to adopt mixed farming systems where agriculture, livestock, forests and rangelands are intertwined.

With the assistance of various donor agencies, Nepal has recently designed and implemented some Integrated Rural Development (IRD) projects in which forestry development is one of the main components. As far as possible, local people are to be involved in most forestry activities, especially for the development and management of the existing forests in the villages and for extending the forest area by large-scale afforestation. This particular approach to forestry development has received different names in recent years. Some call it "rural" or "village" forestry, while others call it "community" forestry.

For rural forestry programs to be successful, the active participation of the farmers is required. One way to achieve this is education, which is the key to reaching people's minds and hearts and inspiring them to realise the great potential which forestry has for improving their lives - and not only to realise it, but to become actively involved in it to make it a reality. But this may not be as easy as it seems. Experts and officials involved in forestry development or any other component of rural development may know the nature and extent of the problems and basic technical and financial solutions, but there is no agreement on how to go about achieving active participation of the local people. For instance, all the forestry practitioners and planners are well aware of the fact that the rural people in the hills are

cultivating steep slopes which should, in fact, have been kept under permanent vegetation cover. But the problem is how to go about making people conscious of this, how to get the message across to the millions of farmers, how to make best use of the existing facilities of the communities, what should be the basic strategies for an effective forestry extension program and what type of research will be required to support extension program. This certainly involves more than just technical and financial considerations.

The study aimed to cover the social aspects of forestry extension and its focus of interest was to improve fodder and firewood supplies.

METHODOLOGY

This dissertation is mainly based on a review of the literature.

FINDINGS

The majority of people in the rural areas of Nepal will remain dependent, for the foreseeable future, on fuelwood or other readily available organic fuels, e.g. crop residues and animal dung. The use of the latter means a potential loss of food production. Even with maximum use of alternative ways of meeting future rural energy needs, e.g. bio-gas, solar energy, small-scale hydro-electric power and more efficient stoves, the organic fuels and fuelwood would still account for between 60 and 70% of the total rural energy demand up to the year 2000. In the long term, the expansion and maintenance of fuelwood supplies will require planting of more trees in most situations.

Shortages of fodder in general, and green matter during the dry months in particular, are the main reasons for the continuous decline in the productivity of livestock. Animals are fed poor quality grass, particularly in the dry season, and in effect are semi-starved for about seven months. This malnutrition for must of the year adversely affects the animals condition and productivity. Therefore, no livestock development or improvement program can be successful unless there is a parallel feed resource development program.

RECOMMENDATIONS

The successful growing of trees cannot be imposed on people; it requires their appreciation that it will meet some of their basic needs. The success of a community forestry development program entirely depends upon the feelings and willingness of the basic units of local society and the panchayat forestry committees. The committees therefore should be truly representative of village society. To motivate the local people and get them to participate in the program will require training of the people, follow-up visits, and various incentives apart from those of land and planting materials. Incentives in the form of grants for other development projects e.g. health posts, school buildings, drinking water or irrigation projects, could be included in forestry programs. Grants should be given on condition that the trees are planted on panchayat land and are protected. This, in turn, would require close coordination and cooperation at district level with chief district officer, district panchayat chairmen and district-based officials of other sectors and other development projects.

Farmers should also have access to technical advice and inputs and possibly to credit.

The effective promotion of community forestry demands quite different skills from those of traditional forestry. The extension workers should be familiar with social and economic problems in the areas they have to work in. In addition to their own subject knowledge, they should have some basic knowledge of mixed farming systems in the hills, some knowledge of agriculture, and livestock husbandry and, more importantly, social communication skills.

Considering the nature of forestry extension in general, and topography of Nepal in particular, a group extension approach might be appropriate. However, the aim of the group approach should be not just to use groups for extension work to facilitate pre-determined objectives, but to actively promote the groups development and eventual independence from the extension service. The structure of the groups should not be imposed, but should evolve in parallel with their development, and group members must have an adequate chance to participate in their evolution.

There should be close links between forestry research and extension. Research activity to support extension programs should be based on the farming problems, i.e. emphasis should be placed on the 'upward' flow of information from farmers to research workers.

Finally, the success of a community forestry program should be judged on the basis of the number of people of different categories who participated in and benefited from it, rather than just on the basis of the size of the area planted or demarcated, or the number of seedlings distributed. This demands extension programs to be objective-oriented rather than target-oriented. Government, therefore, must seek to organise rural people and make them aware of their situation so that they become adequate partners with government in the design of development.

COMMUNITY FORESTRY IN NEPAL: REVIEW

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ABSTRACT

In this thesis after general information about Nepal's terrain, climate, vegetation and socio-economics, the main causes of ecological degradation in Nepal as consequence of deforestation are discussed. Review of the available literature suggests that human and livestock population pressure is the main cause of soil erosion, shortage of forest products and migration of people from the mountains to the plains.

The dependence of cultivated land on forests for fertility maintenance and the localised severity of environmental degradation point to the tackling of the problems on a localised basis. The logic of such an approach to forestry is further corroborated by comparing the existing limited government capabilities to the enormity of the land degradation problems.

Various aspects of the Community Forestry Development Project (CFDP) as implemented in Nepal are reviewed on the basis of available information. Community forestry, as implied in this study means growing trees on public land to provide benefits which are shared by the community as a whole. Some existing administrative, social and technical constraints faced by the CFDP are also identified.

Whilst it important to deal with these constraints, it is also desirable that some auxiliary components be included in the programme. Suggested future strategies include: increased private planting by farmers; livestock population control and stall feeding; building up the fodder resource; increased participation of women; and developing alternative energy sources. The importance of resolving the problem of fair benefit distribution is also stressed. As a support to the project, some necessary research priorities, viz. silviculture, management and optimal utilisation of multipurpose tree species; trials of fodder grasses; studies on calorific values of fuelwood species and nutritive values of fodder species and socio-economic studies on forest utilisation patterns are suggested.

PROBLEM

More than 90% of Nepalese live in rural areas. Forests form an integral part of rural life, providing a great humbler of goods and services. These include: firewood, the chief fuel for cooking and heating; fodder for livestock; timber and poles for construction of houses, animal sheds and farm implements; leaf litter for green manure; protection from erosion; and other environmental values.

During the past few decades various factors have markedly reduced the ability of forests to supply the basic needs of rural communities.

Community forestry, as implemented in Nepal, means growing trees on public or communal land as opposed to private farms. It is intended to provide benefits which are shared by the

community as a whole. The main responsibility for planting and looking after the trees is taken by the community itself and the role of the Forestry Department is primarily a catalytic one, i.e. getting the process started and ensuring its continuity. Where substantial areas of degraded land await rehabilitation, community forestry appears to be a promising tool for socio-economic development and environment protection.

The Government of Nepal has long recognised the need to control deforestation. In an attempt to do that, all forests were nationalised in 1957. Further legislation to raionalise all land adjoining forests that had been left fallow for two years or more, was enacted in 1961. These acts were intended to bring the forests under effective protection and efficient management for the welfare of the people. Embedded in them was the egalitarian idea of taking away large forest holdings from "the haves" and providing for a more equitable distribution of this national wealth among the whole population.

However, this legislation was not conceived as directed towards forest development, but merely as a means of preventing the misuse of forests.

With the enactment of decentralisation legislation in 1982, emphasis has been given to the management of local resources through the active participation of the users. This legislation has made it necessary to formulate an integrated multi-sectoral district development plan with forestry.

Understandably, tree planting by individual housheols, depending as it does only on consideration of self-interest, will often be easier to install than collective tree growing on common property. Given the urgency to increase the supply of forest products, private planting could be a firm stepping stone towards this goal.

Although some private planting has been encouraged by CFDP, current regulations limit private forest holdings to small plots of trees. The production of fodder grasses on terrace banks could compensate for grazing losses as a result of excluding cattle from village forests. On poor lands not used for food production, fodder grasses like setaria grass *Setaria ancdps,* Elephant grass (*Pennisetum purpureum)*, kikuyu grass (*Pennisetum clandistinum)* and legumes like *Desmodium* and *Trifolium* spp. could be grown to ease the pressure on woodlots for fodder needs.

Management of existing degraded grassland is also an important issue for sustained forage production and also for erosion prevention. In fact, grazing and pasture management is a skill which Nepalese people must acquire in order to solve the problems which lead to the poor condition of many watersheds. One simple strategy is rotational grazing, which would involve subdividing the rangeland into several parts and grazing them in turn. Introduction of stall-feeding would be simpler to achieve than a blanket reduction of livestock population.

Many of the alleviatory measures discussed in the thesis involve agroforestry systems. These are more complex than other farming systems and include of many interdependent components. Implementing them will require a multi-disciplinary effort.

METHODOLOGY

This study is based mainly on a literature review.

FINDINGS

Traditionally, the collection of forest products has been women's responsibility. Women being the actual users of forests, are likely to be more conscious of the potential benefits of tree planting and forest conservation.

It must be admitted unashamedly that afforestation alone cannot solve the rural energy crisis and needs to be supplemented by other measures.

It can be believed that Nepal's salvation from the energy crisis may be to make forests a renewable and sustainable resource.

The continuation of community forestry project beyond the first tree harvest will depend heavily on the extent to which the problem of benefit distribution is acceptably resolved at a local level. For this, the active collaboration of village councils is crucial. It would, however, be optimistic in the extreme to suppose that the views expressed by councils would represent the interests and preferences of the poor. Those in power at the village level are usually financially better off and they, rather than favouring measures which aim to bring about change and social reform, are more likely to frustrate them.

RECOMMENDATIONS

Efforts towards increasing the supply base by planting fast growing species and sustained management of existing resource should be accelerated.

Species that produce the most calories per hectare, not necessarily the largest volume of wood, should be research. Likewise studies on the nutritive values of fodder species should be made. Other recommended research issues are: trials of fodder grasses and techniques for carrying surpluses of summer grass over to winter in the form of hay-silage; investigation of timber protection; establishment and maintenance of long-term research plots in all districts.

Many institutional issues posing as constraints to the community forestry programme need to be tackled. Firstly, the bureaucratic slackness concerning the transfer of Panchayat Forests (PF) and Panchayat Protected Forests (PPF) should be hastened. Ceilings of PF and PPF should be made flexible and allocated according to the needs of a particular community.

Participation of women could be increased by employing women extension workers. A local woman may be recruited to act as an extension agent.

Administrative constraints such as late budget release and unregulated staff transfers also need to be looked into. Staff transfers should be limited, as far as possible, to the first few months of the fiscal year. Prompt steps should be taken to integrate the regular forestry field staff and community forestry workers.

As a partnership between the foresters and the people for forest management develops, a logical and proper extension of community forestry should be to foster this partnership. The momentum of present endeavours needs to be sustained.

ASSESSMENT OF BAMBOO PLANTATION IN MID HILLS OF NEPAL: A CASE STUDY OF RAKHEE VDC

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ABSTRACT

This study aimed to assess the present status of bamboo plantations in the middle hills of Nepal.

The study area was at Rakhee VDC, in Kaski District. The sampling design was a two-stage random sampling, with villages as the first stage unit and cultivator households as the second stage unit. Five groups of villages were selected randomly from the village development committee (VDC) area to be surveyed and these were completely enumerated to obtaining the basis for selecting the second stage units. From this information, 50 cultivators were selected at random.

Most of the VDC population were upper caste. The agricultural land holdings decrease from upper caste to lower caste groups. The greatest numbers of bamboo clumps were owned by upper caste groups. The main source of propagules was rhizomes. Seedlings were not used for bamboo plantation.

PROBLEM

Bamboo is a multipurpose plant that establishes and grows very fast. It provides abundant quantity of materials for various purposes. Bamboo culms can be put to a multitude of uses. Its foliage provides a palatable source of animal fodder. New shoots of bamboo are used as a vegetable. It is the main raw material for paper production. The role of bamboo in soil conservation has been widely recognised. It has been called poor-mans' timber (cottage industry) and has been long established as a component of local tradition and culture. It has been recognised as an important forest product for both householders and community as whole in the Nepal.

The major problems of bamboo cultivation are: (1) low land holding situation, (2) lack of availability of markets, (3) lack of government support, (4) non-availability of the best propagules and (5) transportation problems. Various recommendations were made for the enhancement of bamboo plantations.

Although it is very useful plant for the local people, community and country as whole, bamboo has not been given much detailed study.

METHODOLOGY

The sampling design adopted was a two-stage random sampling with villages as the first stage units and cultivator households as the second stage units. Selection of units at each stage was done with equal probability without replacement. Five groups of villages were selected randomly from the VDC area to be surveyed and these were enumerated. The enumeration was carried out by the Government in all villages and was taken as a basis to construct a population frame for the selection of a representative sample of households. From the frame obtained 50 cultivators were selected at random.

In the preliminary enumeration of households in the selected groups of villages, particulars about household, whether cultivating agriculture land or not, size of holding, details of bamboo plantations and in case bamboo plantations, species, number of clumps, number of culms/clumps, area covered were recorded.

A questionnaire was used in the survey. This was divided into three main parts. In the first part, basic information of households and, in the second part information on various major activities in raising bamboo plantations were collected. The third and last part of the questionnaire was designed to record data on haresting the crop and post-harvest issues, i.e.:

i) criteria for harvesting the crop,

ii) nature of utilisation,

iii) income from the crop,

iv) multiplication procedure for next crop and

v) any problems concerning the crop, including marketability.

FINDINGS

The major portion of the VDC population (64% of households) were upper caste. Land distribution was not dependent on ethnic group.

Most of the people had land holdings capacity within the range of 15 to 20 ropani. Few people had less than 10 ropani. 24% of households had more than 20 Ropani.

The agricultural land area decreased from upper caste to lower caste groups. Most of the lower cast groups occupied agricultural land within the range of 5 to 10 ropani. Agricultural land of more than 20 ropani were found in the upper and middle caste groups.

The greatest number of bamboo clumps were found in upper caste groups. Most of the upper and middle caste households had 5 to 8 clumps and none had more than 8 clumps.

The villagers having the most land were putting more of it under agriculture but no linear relations were found between agricultural land and bamboo plantations.

The main source of propagules was rhizomes. Seedlings were not used for bamboo plantation. Three main species of bamboo were found in the study area, viz. Tame, Sate and Dhanu bamboo. Jhikare bamboo was also found at some places.

Villagers generate income from bamboo plantations. At the same time biotic pressures were on the bamboo crop. Bamboos were used mainly for households, firewood and soil conservation purposes.

The major problems of bamboo cultivation were found to be:

- small land-holdings;
- lack of markets;
- lack of government support;
- un-availability of best propagules; and
- transportation problem

RECOMMENDATIONS

Bamboo should be excluded from the minor forest produce category and should, in every respect of management, be treated as major forest product. The management of bamboo forests should incorporate all the essential elements of a tree silviculture system, i.e. it should include felling rules (e.g. marking) to ensure proper cutting, tending and regeneration.

Instead of applying the management rules to the whole community of bamboo forest or plantation each clump in the system should be treated as a unit of forest or plantation under treatment. This is very similar to a selection forest type, since though small in area is contains all age gradations and exploitable sizes. There can be an ideal selection system which may be called culm selection. It should be applied and no mathematical exploitation system should be applied as is done presently.

The general felling rules, irrespective of felling cycle should be:

- Cutting and other operations should be limited to October to June.
- Cutting of bamboo should commence from the top of the coupe and should proceed to the base in hilly areas.
- Cutting and cleaning operations should be carried out simultaneously.
- Every clump should be treated as a working unit. Cutting of bamboo should be decided on the basis of new recruitment. All the dead, drying and malformed bamboos should also be cut.
- When retaining the culms, priority should be given to bamboos on the periphery.
- The number of recruits should be counted on the basis of the felling cycle. If the felling cycle is one year, then recruits of that year should be counted: if two years, then the recruitment of two years should be considered as a guideline for number of culms to be cut.

- Congested clumps should not be governed by these cutting rules, and a separate set of cutting rules should be framed for them.

Specific recommendations

- A bank of bamboo propagules should be established.
- Training courses in bamboo plantation and management should be launched.
- A database should be prepared for the future management of bamboo.
- Markets for bamboo should be established.
- Bamboo plantation should be market-oriented.

Future research

The ecology of bamboo forests should be studied in detail so that it may also help to evolve better management systems.

AGROFORESTRY PRACTICES FOR IMPROVING DEGRADED MOUNTAIN ECOSYSTEMS IN NEPAL

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ABSTRACT

This analysis of mountain ecosystems in Nepal showed that limited biomass production and soil erosion are major problems in the development of the hills region. Studies from several countries were reviewed to determine the applicability of agroforestry land-use systems for Nepal. Fodder tree orchards were found to be most promising to increase fodder supplies. Information on the nutritive value of 50 fodder tree species was compiled and presented in a matrix. Techniques were described by which the leaf biomass production of trees can be calculated. Controlled grazing in pine afforestations offers the possibility of integrating livestock production with large-scale afforestation programs. Agrosilviculture systems were analysed to determine the effects of trees on agricultural crops. Such systems can increase soil fertility and achieve biological control of erosion.. The carrying capacity of pastures can be increased by establishing tree-grass complexes to improve soil fertility and microclimatic conditions. The impact of agroforestry systems on soil erosion was assessed using the Universal Soil Loss Equation and methods of adapting the parameters of this equation to the hill regions of Nepal were developed. A model of a "Standard slope" is presented by which the effects of agroforestry systems on both biomass production and soil conservation can be evaluated.

PROBLEMS

The Himalayan Kingdom of Nepal is a developing country which is endangered by the destruction of its natural resources. During the last four decades an enormous population growth has taken place in an environment which is extremely fragile because of the steepness of the terrain and the highly erosive monsoon rainfalls. Within one decade from 1961 to 1971 Nepal lost 50% of its forests. The ensuing fuelwood crisis and immense loss of arable land by erosion perpetuate a continuing deterioration of the population's living standards.

Considering the situation described above, all future means of solving the mountain land-use problems have to be directed towards the main issue of overcoming the deficit in the biomass and human nutrition in these areas.

Agroforestry - the combined cultivation of crops and forest plants on the same unit of land - is a technique practiced in most countries of the tropical zone. During the last few years the concept of agroforestry has gained importance in developing strategies for improving the productivity of fragile ecosystems. However research and practical experience in using agroforestry techniques in mountainous developing countries are very limited.

Past agriculture and forestry strategies in Nepal have been directed to the following objectives: By using improved livestock, seed and plant material, new cropping methods and fertilizer efforts were made to increase the productivity of he existing agriculture land. The present paper attempts to analyze the natural and socio-economic condition for possible future agroforestry production systems in a community level in the hill areas of Nepal.

METHODOLOGY

The model of a "Standard Slope" proposed as a planning total integrates information about productivity and soil erodibility of various land use types under different ecological conditions. Since the basic data necessary for agroforestry planning are not available for Nepal the attempt is made to collect information from other countries, and to examine whether and how this might be adapted to Nepal. Therefore some parts of the research can only be considered as theoretical as they have the character of a model. This research was carried out in 1978 within the German Agriculture Development Project, Gandaki zone, central Nepal.

FINDINGS

This study analysed the natural and socio-economic prerequisites for agroforestry in the hills regions of Nepal. The analyses of the mountainous ecosystem showed that the exponential population growth results in a progressively increasing biomass deficit. Extension of arable land on unsuitable slopes, overgrazing, and inadequate forest management practices result in a permanent degradation process and severe erosion damage.

This situation can be only improved using an approach which integrates biomass production and soil conservation. Agroforestry systems as practiced in several other countries offer viable alternatives to the present land use in the hills region. Fodder tree orchards established on the forest grazing lands were found to have the greatest potential for improving the livestock fodder production. Due to the limited crop production, agrosilviculture systems can only provide limited additional biomass. These systems have to be oriented toward the improvement of nutrient cycling and biological erosion control. Fodder production in mature forests can be only increased to a level which does not affect wood production. Future large-scale afforestation projects with fast-growing species might at least consider the temporary use of these areas for forest grazing, as is currently practiced in New Zealand.

The contribution of agroforestry systems to soil conservation cannot be precisely evaluated, because the necessary basic information is not available. The application of a predictive model show that the use of trees integrated with crops or pasture may reduce soil losses by improving soil conditions and vegetative cover. Agroforestry practices have to be adapted to traditional agriculture production systems. The Panchyat Forest rules of 1977 and the currently operating community forestry development programs are promising organisational frameworks for the application of the improved land-use practices.

RECOMMENDATIONS

The gaps in information identified by this study suggest that future research on agroforestry in Nepal should be directed towards the following subjects:

1) economic evaluation of agroforestry practices to optimise production goals (forage and wood);

2) influences of trees on soil nutrient cycling; and

3) improvement of models to predict the effects of biological erosion control.

INTERNATIONAL VISITOR ATTITUDES TO SAGARMATHA (MT. EVEREST) NATIONAL PARK, NEPAL

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ABSTRACT

This study was done in Sagarmatha (Mt. Everest) National Park (SNP), Nepal over a period of two months.

SNP is a prime destination for many of the tourists who visit Nepal. It is a World Heritage Site and thus has great importance for conservation as well as for tourism. The success of the tourism industry depends on visitors' satisfaction with their visits and the success of SNP as a conservation area is equally dependent on visitors' appreciation and sensitivity in terms of their activities while in the Park. This study explored visitors' reasons for visiting SNP, satisfaction with their visits, and local beliefs about the visitors.

Data for this research were collected from SNP visitors and local residents through questionnaire surveys and in-depth interviews. Due to field constraints, true random sampling was not possible.

Trekking, viewing scenery, Mt. Everest and Sherpa culture were the main reasons for visiting SNP. Visitors reported "highly achieved" for each of these and thus were highly satisfied with their visits to SNP.

This does not negate the fact that tourism brings with it many problems. In SNP rubbish disposal and firewood were seen to be the major problems. Among the locals, lack of knowledge and awareness were seen as being the major drawbacks in trying to solve these problems.

Visitors indicated a number of other issues which they felt needed attention, such as hygiene, sanitation and the quality of drinking water. These issues were not perceived as lessening visitor-satisfactions, as most visitors indicated that they anticipated these conditions. This information indicates that anticipated expectations of a destination were a determinant of the actual satisfaction. Visitors rated most of the SNP hotel and lodge facilities as "reasonable" or higher but in their comments and in-depth interviews they discussed needed improvements. Visitors evaluated these facilities in terms of what they anticipated not what they thought the facilities should be.

PROBLEM

No place on earth has been left untouched by human beings; whether it is the top of the world or the bottom of the ocean. Modern technology has given rise to greater mobility, and for many, increased income. In the last few decades, it has become easier and more affordable to travel to most parts of the world. Travel from one place to another, within or outside one's own country or has added to the appeal of the ever-growing tourism industry.

A philosophy of "customer satisfaction" should play a dominant role in the industry. Visitors' motivations and expectations are an important determinants of the destination visited. The long-term success of the tourist industry is fully dependent on the achievement of anticipated experiences and satisfactions by tourists at destinations of their choice.

Once tourists are allowed to visit a destination, impacts are inevitable. Positive impacts are measured in terms of economic gain and negative impacts are measured in terms of environmental degradation and cultural and social changes. Locals often see the industry as a lucrative source of income. As a result of tourism, the local economic base may change from a traditional subsistence economy like agriculture, livestock or arts and crafts to an entirely tourism-based economy.

As the tourism industry grows, its negative impacts may outweigh its positive benefits and are likely to affect visitor satisfaction. High levels of visitor satisfaction experienced at a destination encourage the tourism industry to flourish. Low levels of visitor satisfaction indicate inadequate management or responses to problems. For effective management of a tourism business, a manager has to identify visitor reasons for visiting a destination and attempt to address these, paying attention to the negative side-effects.

Since the 1950s, Nepal has become a popular destination for tourists, and tourism has become an important source of foreign exchange for the country, but some resources, e.g. forests and local unique cultures are being altered at an alarming rate. In the Annapurna, Langtang and Sagarmatha areas for example, tourism has increased the demand for firewood and aggravated forest destruction as well as influencing the locals lifestyle. Rubbish problems in the Parks are getting worse and there are negative impacts on the social and cultural values of the villagers.

METHODOLOGY

This research was based on the following three approaches:

- questionnaire survey,
- in-depth interview, and
- participant observation.

Two different sample groups-visitors (international tourists) and residents (local people and SNP staff) were chosen as respondents for this research. Tourists were asked to explore the reasons for and their satisfaction with their visits to the Park. Locals were asked to give their inceptions of the tourists.

The researcher had planned to obtain 300 self-administered questionnaires and 20 in-depth interviews with the visitors, 150 questionnaires and 50 in-depth interviews with the local residents and 50 questionnaires and 10 in-depth interviews with the Park administrative staff. However, time, money and field constraints (cold weather and difficult terrain), made application of the simple random sampling method impossible for this research. Therefore, systematic sampling was applied.

FINDINGS

The Himalayas, the scenery, friendly locals and the Sherpa culture are the main attractions for SNP visitors. These features of Khumbu have made trekking to this area an outstanding experience for most tourists. On the other hand, the rubbish problem, poor sanitation, unhygienic living conditions, damage to the forest, and dusty trails, are all of concern. These negative aspects were anticipated by many tourists and thus did not spoil their visits to the park. However, if these issues could be better managed, the positive outcomes for the tourists and locals would be well worthwhile.

It is not likely that what a tourist experiences in the 1990s - the culture, lifestyle, empathy and courtesy of Khumbu Sherpas - will be the same a few decades from now. There will be more development and more available facilities. However, the experience will be more artificial, modern and formal, and the culture will be "distorted" from the traditional values. In all of these matters, the presence of a World Heritage Site - Sagarmatha National Park - and its management are central and dominant for the future of acceptable tourism development. Integrated and strategic planning to address the issues highlighted in this study are urgently required.

RECOMMENDATIONS

Based on the research results, the following recommendations are made:

Visitors were concerned about the hygiene and sanitation in the Khumbu hotels, lodges and campsites. Park administration should impose certain reasonably acceptable standards so that health safeguards for both visitors and locals are addressed. Health and hygiene education should be available in the villages as well as in the hotels and lodges. A hotel management committee should be organised from among hotel and lodge owners and certain rules should be formulated and monitored.

Rubbish and firewood were also a major concerns. Certain strict policies should be promulgated and strictly enforced to address these issues. If the visitors are organised by a trekking agency that agency should be responsible for moving all their rubbish from the Park. For the climbing expeditions, although the rule of "pack in and pack out" already applies it should be more rigorously enforced.

Brochures about rubbish disposal, altitude sickness (preventive measures and remedies) and the values of the local culture should be published and made available to the visitors. An accurate map of the Park illustrating the main tourist trails should be available for sale to visitors at the Park Visitor Centre. An assessment of other sale items for tourists which could be made available at the Park Visitor Centre should also be conducted.

A conservation education program should be conducted to educate locals on how to handle rubbish and firewood. They should be taught about efficient wood stoves which consume less firewood. Alternative energy to firewood is necessary. Kerosene might be suitable but would need to be made available by the Park administration. For this, a feasibility study is needed to determine how its suitability and how its use could be encouraged. It is quite clear from discussion with respondents that it is not simply a matter of education or knowledge. What is

needed is a range of incentives (perhaps subsidies) so that conservation of firewood is more financially attractive than its utilisation.

The locals should also be taught about how rubbish disposal can be managed. It would be effective perhaps if the pollution-control project provided bags or baskets to every household or at least to every hotel, lodge, shop and tea-shop. Rubbish dump sites should also be set aside where all the rubbish can be collected and re-cycled, composted, buried or burned as appropriate.

Locals also should be taught about the importance of their cultural values. Among the locals there would be some people who are very good in cultural programs. These people should be organised to act as "guardians" of their cultural activities in ways that would retain cultural identity as well as entertain the visitors. It would be appropriate to include cultural studies in the Khumbu schools and to arrange meetings with the locals to make them aware of their own cultural values.

Most young Sherpas are guides or sirdars. They have a particular responsibility to pass on accurate information to the tourists. Most of the guides and sirdars are not aware of the values of the local resources and culture. Thus they should be trained properly so that they can share appropriate information with tourists about the values and beliefs of the local culture and resources. A leadership training course for the guides is necessary. The guides should also be trained to deal with the situations that arise while trekking in the Park (such as first aid, Park policies, altitude sickness).

To increase co-ordination between the Park administration and the locals it is important that the Park administration publish a regular bulletin about Park programs and policies or arrange regular meetings with the locals so that locals are aware of what is going on in the Park and can pass on accurate information to the tourists.

During the formulation of local policies a "bottom-up" process might be a more successful approach to address the community needs rather than a "top-down" process. Thus, a process of community development needs to be understood and practised by the Park personnel. For community tourism planning, site specific policies rather than general policies might be more helpful as the cultural and resources values might be different from pace to place.

FURTHER RESEARCH

The data for this study was collected over a two-month period (December and January). There could be differences among those visitors who visit in the other months, especially the high tourist seasons (March - April and October - November). Thus, a year-round study would result in more generalisable research findings. The majority of the respondents in this study were English-speakers countries because the questionnaires were written in English. There is a possibility that Japanese and Korean tourists, who primarily visit in December and January, might have different attitudes.

A majority of respondents felt that tourism increased inflation. A study about inflation and its effects might help to set a certain rate of increase in wages for porters and to address the local problems caused by inflation.

It has been mentioned that firewood consumption is high largely because of tourists. A study to assess the net yield of forests and the consumption rate of firewood and timber per year from particular forests is needed. This result would tell how much firewood and timber can be used per year on a sustainable basis. To address the actual impact of tourists on firewood, the study should set a control group of typical local households. These households would represent the actual use of firewood by the locals and their usage should be compared with that of the hotels and lodges. In ascertaining the firewood needs of locals versus that of tourists, a policy might be established whereby tourists are charged appropriately to compensate for the resources consumed during their visits. This type of approach would fit in with the previously mooted idea of a range of incentives to help resolve the firewood dilemma.

So far Khumbu tourism management has been on an "ad-hoc" and individual planning basis (e.g. almost every year a new park manager is appointed to the SNP). Each individual manager applies different rules (other than the fixed rules and regulations) in the Park depending on what he thinks is right. Sometimes laws are interpreted differently if not clearly defined. A tourism master plan for the Khumbu might help in managing the Park so that both the Park and the locals will both benefit.

To address the rubbish problem, a feasibility study for establishing a recycling plant is necessary. Such a plant, if not inside the Park but nearby between Lukla and Namche, would help to solve this problem. In addition, this plant could provide compost that would help in Khumbu crop production by the locals.

Because of the cold, decomposition of sewage is very slow in SNP. Thus, a study of toilet efficiency might be helpful to improve the hygiene and sanitation conditions of the locals. A study of portable toilets (these should be economical and effective) for use at the base camps is especially important to protect the water system of Khumbu from being contaminated by human waste.

EVALUATION OF AN NGO SUPPORTED AGROFORESTRY PROGRAMME: THE NEPAL AGROFORESTRY FOUNDATION (NAF) PROGRAMME IN KUNWARI VILLAGE OF RAMECHHAP DISTRICT OF NEPAL

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ABSTRACT

The findings reported in this thesis are based on field studies conducted in two villages, namely Kunwari and Gaikhura, in Ramechhap District of Nepal to assess the impact of the Nepal Agroforestry Foundation (NAF) support programme.

The major finding of the study reveals that the fodder trees promotion programme of NAF has played a significant role in increasing of the level of income of farmers in the project village (Kunwari). The regression model shows that 84% of the variation in the total farm income is due to fodder tree adoption by the farmers. Only 23.3% of the farming households are below subsistence level in the project village. This shows a quite satisfactory result when compared to national average (49%). Fodder tree adoption is also associated with the size of land and animal holdings. These components have positive relationships with one other. The species *Morus alba* is highly preferred by farmers among eight fodder tree species tested in a pair-ranking test based on criteria like growth, palatability and fodder in the dry season. *Premna latifolia* and *Leucaena* species have significant relationship with milk production in buffalo.

The analysis of cropping patterns shows that lowlands are more intensively used than uplands and thus have higher gross margin per hectare. Tree/crop interface effect indicated that crop yield is not hampered when trees are pruned frequently at low height (approximately 1.5 m) while the yield is hampered with unpruned trees. A linear programming model shows that growing kidney beans in uplands and soybeans in lowlands are profitable. Land constraints are common in both villages. However, shadow price of winterland is higher than summerland in the study villages.

The growing of fodder tress on farms has a direct impact on the condition of near-by forest. The forest near the project village is in better condition than that of forest near the control village. This is because the control village has to depend more on forest fodder (42%) than the project village (10%). A dominant proportion (38%) of fodder in project village is supplied through farm fodder tree source. There is not much difference between animal feeding practices. A small difference was observed between the grazing pattern, where 40% of households in the control village practiced grazing of livestock in the forest against 33% of households in the project village. Evaluation of the NAF extension process showed that the promotion of the agroforestry programme through a home nursery approach is more effective than through a community nursery approach, where farmer groups play a key role in the success or otherwise of the program. The study showed that the farmers who followed the home nursery approach at Kunwari are self-sufficient in fodder production.

PROBLEM

Before the implementation of the NAF support programme in the study area, the level of farmers' income was low. The low income was thought to be caused by poor soil fertility, insufficient fodder and low livestock productivity. It was thought that the knowledge of research on the management of fodder trees in agroforestry systems on terraces was lacking. Taking these matters into consideration, NAF started the fodder trees support program. The objectives of the programme were to: (1) restore soil fertility, (2) reduce pressure on common forests, (3) provide knowledge on fodder tree management practices to farmers, and (4) sustain increased numbers of livestock, meeting fodder, fuelwood and timber requirements. Since no organisation or individual has documented support program activities, this study has been designed to assess whether or not the program has been successful in achieving its objectives.

METHODOLOGY

An evaluative research method was employed to assess the impact of the program, where the project group was compared with a control group. The impact of the experimental variables on the project group was assessed in relation to the disparities in scores between the two groups. This research design is of the 'after-only' type, also called 'synchronical evaluation'.

Information was gathered from both primary and secondary sources and from survey as well as from non-survey sources. The survey sources include household, key informant and farmer group information while the non-survey sources provided information from field reconnaissance studies, direct observations and measurements, and secondary sources.

Direct measurements, included soil sampling, which was done in three crop zones, viz.: (1) the interface (under tree canopy), (2) the middle of the terrace, and (3) the base of the terrace wall in four farmers' upland fields in Kunwari. Altogether, eight samples were collected and analysed at Soil Science Division Laboratory in Khumaltar, Kathmandu. All the sample data on tree heights and tree diameters at 0.3 m height were recorded by direct measurement.

FINDINGS

The study showed that both surveyed villages are facing a shortage of fuelwood and fodder due to heavy pressure of grazing on forest and community lands. Any substantial increase in fodder and fuelwood production will have to come from private lands to cope with this situation.

1) Fodder trees and shrubs are of special significance in the two villages because small agricultural holdings are not capable of producing enough fodder and crop residues for the ever-increasing numbers of livestock. The farmers identified fodder as a primary need and are willing to grow fodder trees on farmland provided the trees are properly pruned and lopped to avoid shade effects on farm crops.

2) The relationship between farm income and fodder tree adoption is such that increasing fodder tree numbers has also increased farm income (from both animals and crops). This is a unique and outstanding feature in Nepalese agriculture.

3) Fodder tree adoption is related to level of literacy and farm size. Livestock holdings were found to be higher with increasing number of fodder trees and farm size.

4) The maximised gross margin of the project village was three times higher than that of the control village. The linear programming model showed that land is a major constraint in both villages. Relay and mixed cropping of legumes with cereals was profitable in both villages.

5) The crop-tree interaction showed that project farmers are more positive towards agroforestry than control farmers. Crop yields are not affected when the trees are properly managed through pruning in agroforestry practices but decrease with increasing tree height.

6) Nutrient content of the agroforestry plot vs the control plot indicated that organic matter and nitrogen content was significantly higher in the agroforestry plot but the phosphorus and potash levels were not significantly different.

7) Analysis of the fodder and fuelwood supply situations indicated that farm trees were the major source of supply of fodder and fuelwood in the project village. This shows that forest degradation and deterioration is becoming a problem in the control village due to extraction of more fodder and fuelwood each year.

8) One explanation of farmers for less stall feeding is that 83% of farmers in the project village and 93% of farmers in the control village have insufficient farm fodder.

9) An overall evaluation of the NAF extension process reveals that farmer group formation is very important for effective agroforestry programme implementation and thus for success in achieving the programme goals.

10) The agroforestry programme implementation through a small home nursery approach is much more sustainable than that of a community nursery approach. The 23% of farmers who are considered self-sufficient in fodder and fuelwood adopted the home nursery approach to produce fodder trees for their farms.

RECOMMENDATIONS

Poor farmers have inadequate compost due to their small numbers of animals. Therefore, they should be encouraged to make compost using crop residues and forest leaves which have no fodder value. At the same time, they should be encouraged to practice green manuring through cover crops like velvet bean and jack bean mixed with upland crops.

Since small animals like pigs, goats and sheep are not much kept although they are very profitable, farmers should be encouraged keep these animals more.

Traditional crafts (e.g. carpentry) and cottage industries (e.g. bamboo basket making) should be further encouraged by introducing better techniques and tools.

Pineapple, coffee, ginger, turmeric, cardamom and other shade-tolerant plants suited to the region should be used as intercrops in agroforestry systems to give immediate returns to small and marginal farmers.

More emphasis should be given to home nursery technology in planning and developing agroforestry.

Informal literacy classes which are being run by the project should to be extended to other places where the project intends to launch or implement agroforestry programs. Literate farmers were found to adopt more fodder trees than illiterate ones.

Since farmers are often reluctant to grow trees on farms because of shading effects on crop yields, pruning trees to breast height and planting them 1 m apart should be recommended.

National interest in promoting agroforestry in Nepal is essential. National policy-makers should emphasise the importance of agroforestry in bringing socio-economic and ecological benefits. A comprehensive strategy to promote agro-rforestry is needed.

FURTHER RESEARCH

1) As the cropping cycle of agroforestry is longer than one year, research related to intercropping of cash crops is most important. Investigations on the mechanism of mixed farming systems such as plant to plant and plant to animal interactions would complement existing research to help optimise the resources.

2) Documentation of farmers' knowledge about agroforestry species, their production and management, including the different social groups and strata under different ecological regions, needs to be investigated.

3) Research on the nutritive values of fodders from agroforestry species for the various types of farm animals and under various feeding practices is necessary.

INITIATION AND DEVELOPMENT OF ROOTS IN CUTTINGS OF THREE FODDER TREES SPECIES OF NEPAL

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ABSTRACT

In an attempt to improve tree fodder supplies, production of planting stock in Nepalese nurseries, using simple techniques, was examined.

Field experiments were conducted on the effectiveness of one and two year old branch cuttings and their time of planting for rooting success for three fodder trees species namely *Ficus auriculata, Ficus semicordata* and *Artocarpuss lakoocha.*

Rooting was not significantly affected by cutting age or by planting either in February or in March. *Ficus auriculata* had 77% and 86% rooting of the cuttings from the older cuttings compared to 8% and 4%, for *F. semicordata* and 31% and 46% for *A. lakoocha* for February and March planting respectively. The older cuttings were found to give higher percentage rooting except for late-planted *F. semicordatda.* Sections of the stems showed more root initials were organised in *A. lakoocha* and *F. auriculata* compared to *Ficus semicordata,* though all the species were found to have some root initials by day 10 after planting. The results show that *F. auriculata* could be rooted with hardwood cuttings in the Hetauda nursery in either February or March using material of either age. *A. lakoocha* gave reasonable rooting (35% and 46%) for both ages of cutting material when planted in March but only old material (31%) was successful when planted in February. *F. semicordata* gave very poor rooting for both types of material when planted either in February (7% and 8%) or March (5% and 4%).

Development of both shoots and roots on cuttings of *F. semicordata* was poor compared to the other two species. Further experiments conducted at Oxford using rooting hormones and wounding showed no improvement in rooting by cuttings in *F. semicordata. F. auriculata* showed better rooting of cuttings treated with synergol and seradix. However, the differences between control, wounding and seradix treatments were not significant.

PROBLEMS

Fodder tree seedlings are in great demand in the panchayat nurseries run by the Community Forestry Development Project in the Middle Hills of Nepal.

Until recently forest nurseries in Nepal concentrated on a limited number of species. In spite of the high demands for fodder trees, only small numbers of seedlings were produced. One of the reasons for this is that the seeds of fodder trees are often difficult both to obtain and to germinate.

Seeds of many fodder species ripen during the monsoon period between June and September. At the present time, seed is often obtained with the help of paid local people. Owing to the mode of payment, collectors often try to make more money at the expense of quality. Also, as the trees are grown in the vicinity of villages the collectors may well collect from trees having undesirable characteristics. Above all, local collectors lack knowledge and training in seed collection. These factors can lead to disappointing results in the nursery and can sometimes lead to the failure of whole planting programmes.

Although many of the problems encountered with reproduction from seed could be overcome by good planning, an immediate increases in production could be more readily obtained by means of simple vegetative propagation.

On the basis of the farmers' choice, *Artocarpus lakoocha, Ficus auriculata* and *Ficus semicordata* are important in Nepal as sources of fodder. The majority of the Middle Hills region nurseries could benefit from practical techniques for rooting cuttings of these species.

OBJECTIVE

The objective of the study was to find a reasonably simple system to propagate vegetatively three of the most preferred fodder trees in Nepal - *Ficus aniculata, Ficus semicordata and Artocarpus lakrocha.*

METHODOLOGY

Root production by hardwood cuttings taken from the top of the shoot were compared.

Seedlings of the three species had been planted in Hetauda nursery during the monsoon of 1985 and were readily available for experimental work.

Cuttings about 20 cm long with at least three buds were taken. They were given a slanting cut at the lower end and plain or horizontal cut at the upper end. Forty cuttings of each species and age were placed in each of the three replicates at random. In all 1440 cuttings were used for two dates of planting, 1 February and 2 March.

While laying out the experiment each plot position was identified and given a serial number. Sampling times of 10, 20, 40, 80 and 120 days after planting for both planting dates were scheduled. At the time of sampling all cuttings were assessed for bud and shoot development.

Anatomical studies of the species were also carried out. Transverse sections were made between the nodes and studied for root initial development. One tissue section of each species for each sampling date was examined. Particular attention was paid to phloem fibres, collenchyma and cambium. Emphasis was given to the cambial region because its meristematic cells were considered important in root formation.

For each of the treatments and both the dates of planting, 15 cuttings were taken, one at random from each replicate on five sampling days. Of the three cuttings taken from three replicates one was sectioned in Kathmandu, one at Oxford and one was discarded.

As *F. semicordata* cuttings showed poor rooting, it was decided to try a range of treatments to improve their performance. A comparison of *F. semicordata* with *F. auriculata* was carried out at Oxford in a controlled environment.

F. auriculata and *F. semicordata* cuttings were imported from the Kathmandu nursery in February 1988. The cuttings were collected on 1 February 1988 wrapped in polythene sheets and packed in moist gunny bags.

Twelve cuttings of each species were given four treatments. After the fourth week of the experiment the cuttings were evaluated every two weeks for bud and leaf development. After six months the remaining living cuttings were excavated and root number, root length, leaf area, root weight and leaf weight were measured.

FINDINGS

The sites of origin of roots in all three species were mainly confined to the cambial region. Root initials were usually found to originate in the cambial zone from ray cells adjacent to the phloem, parenchyma cells and callus. In a few cases root initials were found to develop in the outer pith and/or the primary xylem parenchyma in each species. A root initial was identified by its small cells containing large nuclei and dense cytoplasm.

Buds or Shoots on Cuttings in the Nursery

F. auriculata

It was observed that cuttings of all three species developed buds or shoots by day 10 after insertion in the rooting media, irrespective of the dates of planting. The early planted cuttings

showed fewer buds or shoots than the late planted ones at days 10 and 20 after insertion in the rooting media. However by day 40 both planting dates showed almost similar pattern. The older material showed better results for both planting dates.

F. semicordata

Buds or shoots were found to develop within 10 days after the cuttings were inserted in the rooting media. However they were poor compared to *F. auriculata*. At days 10, 20 and 40 young cuttings had done better than old ones. But after 20 days it was found that the older cuttings gave more of shoots for both planting dates.

A. lakoocha

In the beginning early planted young cuttings gave better buds or shoots. However after day 40 the late planted older material picked up well and a trend of increasing the shoots continued for all materials. This species was intermidiate in terms of bud and shoot development.

The study showed that in general older cuttings do better in terms of bud or shoot development in all three species.

Rooting of Cuttings

F. auriculata

Root development was observed in the specimens sampled at day 40. At day 120, when all cuttings were excavated it was found that for young cuttings 73% and 75% of early and late planted material respectively had rooted whereas for older material it was 77% and 86%. The older cuttings therefore seem preferable in the case of this species.

F. semicordata

Roots were observed at day 120 in the specimen cuttings. The rooting was poor (7% and 8% respectively) for early planted young and old materials compared to (5% and 4% for) late planted young and old materials. It is therefore suggested that this species needs further research to achieve a better success rate.

A. lakoocha

For both planting dates old cuttings rooted better than young ones. The rooting success was about one fifth to one third except for early planted young material. It is suggested that young material should be avoided for planting material production from the cuttings.

Anatomical findings

With all three species, root initials were found to organise within ten days after insertion of cuttings. They were found to develop in a range of tissues. Even after the organising of root initials *F. semicordata* showed poor rooting but the other two species performed rather better.

Pre-treatment

F. semicordata cuttings did not root well even after application of rooting powder (seradix 02), rooting liquid (Synergol) or wounding. However *F. auriculata* responded better to seradix treatment.

RECOMMENDATION

It is suggested that future research should be directed towards selecting the best time of the year for inserting cuttings in the rooting media.

COMMUNITY FOREST MANAGEMENT THE CASE OF NEPAL

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ABSTRACT

The user group approach to community forest management that has been adopted in Nepal is reviewed. Past and present forest management practices are described, forest policy is analysed, major problems in the systems are identified, and strategies for future planning and development are recommended.

The group approach has been found to be the only suitable and cost-effective way of protecting Nepal's scattered forests to sustain its farming system and the environment. Management of community forests is found to be primarily dependent on government efforts followed by willing participation of the people and effectiveness of the extension system. More than 120 user groups are involved in forest protection and over 40000 hectares of community plantations have been created through peoples' participation. Their management according to simple management plans is under way.

Despite considerable achievements and popularity, the community forestry programme suffers severe technical and administrative problems, such as lack of skilled manpower, appropriate management technology, interdisciplinary co-ordination and awareness among the rural communities. There is a great risk of not meeting the targeted objectives of the forestry master plan unless these problems are dealt with soon.

The need for a separate community forestry policy for the Terai region has been identified. To further speed up, interdisciplinary co-ordination, and research and extension linkages need to be strengthened and preparation of the community forest management plans hastened.

PROBLEM

Most Nepalese people still depend on forest resources for their livelihood. The forestry sector contributes about 75% of the total energy supply and over 40% of livestock nutrient. The rapid increase in human and livestock populations over the last three decades has put heavy pressure on natural forests through expansion of agricultural and grazing lands and the cutting down of more trees to meet fuel, fodder, and timber requirements. In consequence, soil erosion, downstream floods, siltation and loss of soil fertility are threatening the farming system and the environment.

Various attempts were made after the 1950s to protect the forests of Nepal, but because of the lack of peoples' participation and insufficient technical and institutional support, management efforts failed. The situation deteriorated after the nationalisation of forests in 1957.

Because of the urgent need to support rural people and improve the situation, a number of international aid agencies were approached during the late 1970s and as a result the Community Forestry Development programme was put into action through the establishment of the Panchayat Forest Rules and the Panchayat Protected Forest Rules of 1978.

The present forest management approach adopted in Nepal is to fulfil people's forest product needs through their own efforts.

OBJECTIVE

This study was aimed at reviewing community forest management practices in Nepal to determine the present state of knowledge, evaluating the effectiveness of the community forestry program; identifying the problems facing community forestry and developing a strategy for effective planning and management.

METHODOLOGY

The community forest management approach adopted by Lumle Agriculture Centre, western Nepal was taken as a case study

FINDINGS

There were 542 forest nurseries operating in 37 districts as of 1991. The maximum number of nurseries was 733 in 1987-88 but sharply declined to 467 in 1990. A total of 40732 ha of forest land was afforested during 1980-82. About 28584 ha was planted during 1985-92 alone, which is about 65% of the target set for that period. There is noticeable decline in plantation activity, which may be related to increasing attention on management of the natural forest.

More than 37000 sets of improved stoves have been distributed since 1980.

The community forestry programme of Nepal is passing through an evolutionary phase. The foremost achievement of this process is the gradual return of the forest lands to the people, firstly through the local development units and now to the actual forest users directly. A second important achievement is the implementation of the programs in a planned way through the forestry master plan.

An increase in the level of participation and public awareness is observed through more tree plantation, formation of forest users groups and more forests under protection. Participation of women in the forest committees, workshops and training programs and increasing involvement of schools in seedling production and plantation shows a growing awareness about forest management and popularity of the programme in the country.

RECOMMENDATIONS

Administrative and Institutional Arrangements

Lack of trained manpower has remained a problem, so the best use of the available trained manpower must be made. NGOs should be encouraged to develop manpower and more people should be trained. Students should be given sufficient training in community forestry at the Institute of Forestry (IOF). Secondment of experienced foresters from the Forest Department should be encouraged for this purpose.

Technical

Most of the survey and inventory records are old, and many changes have taken place on the ground. A detailed ground survey and inventory at district level should be carried out soon to update the resource base and to ensure efficient planning. The national development strategy should aim at reducing dependency on forests for energy and for animal diet.

PROBLEMS AND PROSPECTS OF COMMUNITY FORESTRY: A PARTICIPATORY APPROACH TO COMBAT FOREST CRISIS IN NEPAL

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ABSTRACT

This study is focused primarily on the main problems and prospects of the community forestry program in Nepal. For this purpose, an evaluation is made of the performance of the community forestry project (which covers one-third of the total land area of Nepal) during its first phase (mid-1980 to mid-1985). Also in the process a brief overview and discussion of pertinent features of some of the relevant social forestry programmes throughout the third world is included.

Over the major part of the past 200 years the central government of Nepal, has followed a policy which has led to the abandonment of many local systems of management and organisation of forestry in the country.

Where actual wood scarcity prevails, as is the situation in many middle-hill villages of Nepal, the protection of the forests from the desperate and greedy just by rules and regulations is all but impossible. In essence, even in Third World countries like Nepal, foresters are beginning to see the necessity of involving people throughout the countryside in growing trees. Over the past decade community forestry has emerged as a new area of development assistance.

A variety of programme approaches have been devised to encourage people and communities to grow trees themselves on their own land and around their villages. Some countries have relied on commercial incentives; others, like Nepal, have placed tree growing within a broader and more ambitious framework of social and environmental goals.

Community forestry will always require a great deal of painstaking preparations and hard work, and cannot be expected to produce spectacular results overnight. Yet the theoretical attraction of community forestry schemes is considerable. In addition, they offer one of the few practical approaches to tackle the problem of degradation of forests.

OBJECTIVES

The main purpose of this study was to understand the nature of the problem of deforestation in Nepal and the problems and effectiveness of the community forestry approach in combating the forest crisis that is rapidly approaching.

It has been made in the light of fundamental concerns that until we gain a better understanding of the context in which the many changes in people, land and resource are taking place in the Nepalese hills, the governments in Nepal will be in a poor position to control them.

METHODOLOGY

The study was undertaken by making an analysis of literature and reported experience about deforestation problems in Nepal and the community forestry approach being initiated there as well as in other Third World countries.

Much of the information contained in this report is based on the author's personal experience and information provided by professional associates in the Forest Department, particularly those who were working in the community forestry development programme in Nepal.

FINDINGS

Nepal is over-populated, and its limited resources are unevenly distributed among its population and are being used at an accelerated pace. The deforestation of the Himalayas has received widespread attention in recent years.

The implications of man's violence to the environment are serious throughout Nepal and particularly in the middle hills of Nepal.

In Nepal, much more important than the traditional shifting cultivators as agents of forest destruction are the shifted cultivators: rural people who have been deprived of their land or employment or both.

In the past, there was hardly any incentive for the inhabitants to safeguard the forest. Forestry, silviculture, forest management, sustained yield are almost empty words in Nepal. Very little is done to try to alleviate the pressure of farmers on forestland. The area of managed forest is extremely low, and at best 15 hectares of destroyed forests are replaced by one hectare of plantation.

In the past, institutional changes, without a clear sense of direction and vision of the future, have led to further confusion among the responsible officials and other functionaries when the changes were too frequent.

Nepal cannot conserve its forest cover without substantially enhancing the productivity of its forests. The demands of the rural, urban and industrial sectors for forest produce will go on increasing, further worsening the current deficits. Hence there is an urgent need to introduce practical scientific management to all forests belonging to the Government, which could enhance the productivity of Nepalese forests substantially.

Community forestry development programs have to be well integrated with the household production system in the hills. Unless the farmer takes as much direct economic interest and involvement in forestry as he now has in food crop farming and livestock, there is little possibility that the overall adverse environmental trends in Nepal can be reversed.

RECOMMENDATIONS

1) Great emphasis should be placed on forming forest committees, representating the local population, to advise on the preparation and implementation of management plans.

2) More emphasis should be given to handing over forest to the local people.

3) More emphasis should be given to preparing and implementing nursery operation plans, and to keeping nursery and plantation records accurate and up to date.

4) More empahsis should be given to timely collection and sowing of tree seeds.

5) Regional seed stores should be established in all development regions of Nepal.

6) More emphasis should be given to work planning.

7) More emphasis should be given to involving small farmers in afforestation and conservation by providing appropriate incentives in cash or in kind to utilise the marginal farm lands through proper land use.

8) Foresters involved in community forestry work should be trained in a broader range of techniques and approaches appropriate to constructive human relations and integrated rural development.

9) A programme of field training for forestry students in community forestry project areas should be developed and implemented. There is a need to develop a more effective training programme to train them in preparation of management plans.

10) A programme of incentives for government personnel, including a rotational posting policy between the hills and the Terai districts, living and medical allowances in remote hill districts, better training and housing and *esprit de corps*, will be necessary to motivate and attract foresters to serve in the hill districts.

11) Promotion and other rewards depend on good job performance, and real accomplishments.

12) Government budgetary and accounting systems should be made more appropriate.

13) Some funds should be allocated to experimental sideline activities.

14) Involvement of women in all project activities should be encouraged by all people involved in the program.

15) Coordination among agriculture, livestock, and forest department staff at the field level should be improved, to exchange information and integrate field programs.

16) The use of improved stoves should be encouraged.

17) Grazing in the forests should be strictly controlled.

18) More effort should be made to encourage privatisation of nurseries and forests by providing appropriate tax concessions, bank loans and the incentives to individuals and institutions that reforest barren lands.

19) Achievement of leaders and local people should be published in the press.

20) More effort should be made to improve public awareness of the key role of forestry in food production, and in environmental improvement.

21) Emphasis should be placed on establishing appropriate forestry research and demonstration units, particularly for fast-growing fuelwood, fodder and multipurpose tree species, silvo-pastoral management and other agroforestry systems.

To be successful in the long run, the community forestry programme in Nepal needs:

1) strong long-term political commitment;

2) assessment of villagers' needs;

3) appropriate technical solutions;

4) a system of incentives;

5) an effective extension network;

6) meaningful involvement of local people in the preparation and the implementation of management plans;

7) appropriate training for forestry field staff; and

8) appropriate research support.

FLORISTIC COMPOSITION, BIOMASS PRODUCTION, AND BIOMASS HARVEST IN THE GRASSLAND OF THE ROYAL BARDIA NATIONAL PARK, NEPAL

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ABSTRACT

The present study was carried out in five phantas (grasslands), Upper Baghaura, Lower Baghaura, Upper Khauraha, Lower Khauraha and Lamkauli, in the south-west corner of the Royal Bardia National Park (RBNP). The study had two main objectives: (1) to describe the floristic composition of the phantas and floristic changes between 1976 and 1992, and (2) to estimate production and harvest of biomass from these phantas. Quadrat sampling along transect lines was used for describing floristic composition and for estimating biomass production and harvest rates. Line plot sampling by visual observation was also used to estimate biomass removal by grass cutting.

Floristically, all the phantas were different. In all they comtained 122 plant species including 62 forbs, 31 graminoids, 18 trees, 5 shrubs, 4 pteridophytes, 1 climber and 1 epiphyte. Lower Khauraha was the most diverse phanta, having a high number of forb and tree species, presumably as a result of different past and present disturbance regimes. A significant positive correlation between the density of forbs and proportion of barren areas was observed ($p < 0.01$) in this phanta. All phantas could be classified as *Imperata* grassland. There were four associations: *Imperata-Narenga* in Upper Baghaura, *Imperata-Saccharum* in Lower Baghaura, *Imperata-Desmostachya* in Upper Khauraha, and *Imperata-Vetiveria* in Lower Khauraha and Lamkauli. Floristic composition of the Khauraha phantas had changed between 1976 and 1992; 5 new species were recorded and 7 previously recorded species were absent. In these phantas, the prominence of *Desmostachya bipinnata* and *Saccharum spontaneum* had increased remarkably, and *Imperata cylindrica* and *Vetiveria zizanioides* to a lesser degree.

Biomass production varied significantly among the phantas. Mean above-ground biomass was estimated at 10.27 t/ha and was highest (13.98 t/ha) in Upper Baghaura. Variation in biomass was related to floristic composition: productivity was higher in phantas with a higher relative proportion of tall C_4 grass species. On average, *Imperata cylindrica* was the main grass component contributing about 39% of the total standing biomass in the phantas. Because of its large size, Lamkauli contributed 31% of the total biomass of all phantas combined.

PROBLEM

Grass is an important natural resource which plays an integral part in subsistence living in On average, 46% of biomass was harvested from the five phantas during a two-week grass cutting period. Mean harvest rate was estimated at approximately 4 t/ha. Grass removal was not uniform among the phantas. In order to maintain floristic composition and land productivity and allow for a sustainable harvest of the grass resource, the Park authority needs to develop proper monitoring techniques.

Nepal. People use it for various purposes, e.g. grass fodder, various household goods and thatching. Grassland, in the RBNP is an excellent example of an area that has been exposed to a situation of balancing human needs and conservation.

Traditionally, people have been collecting thatch grasses, binding materials, and reeds from the area that is now protected. Their access to these resources was stopped when the area was declared a Wildlife Reserve in 1976, but after 1978, recognising the traditional dependence of local people on them a provision was made for local people to have legal access to the grass and grass products. Since then, people have been allowed in to cut grasses for two weeks every year, normally at the end of the dry season.

Resource availability in terms of floristic composition, cover, and annual biomass production of grasses in the RBNP is unknown, and total annual biomass harvest, sustainable supply of grasses and the overall impact of biomass harvest have not been estimated. Fire has been frequently practised as a grassland management tool but its impacts on grassland fauna and nutrient levels have not been studied in Nepal.

OBJECTIVE

The study therefore aimed to provide basic information for management of this vital resource, particularly regarding floristic composition and net primary productivity of the grassland. It also aimed to estimate the current rate of biomass harvest and to address the issue of whether it is possible to continue to carry out the grass cutting in the present way without degrading the resource base.

METHODOLOGY

Quadrat sampling along transect lines was used to describe floristic composition. The location of the first transect was determined randomly and was then followed by other parallel transects at regular intervals of 300 m with the help of compass. A total of 20 transects were laid out. Quadrats of 1 m^2 were placed along each transect line at regular intervals of 25 m. The total number of quadrats was 214.

The vegetational data were quantitatively analysed for species frequency and relative density. Sample sub-plots of 20 x 50 cm size were nested inside each quadrat. Within the sub-plots, percent canopy cover of grasses and forbs was estimated visually. Shrubs and regenerating trees up to waist height were also included for estimating canopy cover. Stems of grasses, forbs, etc. inside the sub-plots were then counted individually to calculate density. Since it was difficult to recognise individual grass stems, each tiller of a grass plant was considered as one individual.

Most grasses encountered in the quadrat plots were collected and were identified, where necessary at the Godavari Herbarium in Kathmandu.

A crude method of visual estimation was also conducted to estimate grass removal from the phantas. For this, 20 additional transect lines were laid out equally spaced between the original 20 in order to double the sampling intensity. Frequencies of 'cut' and 'uncut' plots were estimated visually. A total of 321 quadrats were recorded for this analysis.

FINDINGS

A total of 122 plant species were recorded from the five phantas, including 62 forbs, 31 graminoids, 18 trees, 5 shrubs, 4 pteridophytes, 1 climber and 1 epiphyte. Lower Khauraha was floristically the most diverse phanta, having a high number of forbs and tree species, the origin of which appeared to be connected with its past and present disturbance regimes. Grass components dominated the phantas in terms of both canopy cover and density. *Imperata cylindrica* in association with *Vetiveria zizanioides, Saccharum spontaneum, Saccharum bengalensis, Narenga porphyrocoma,* and *Desmostachya bipinnata* contributed more than 75% of the canopy in the phantas. On average, *Imperata* alone made up for a cover of approximately 52%.

All phantas belonged to the *Imperata* grassland type. *Imperata* formed four associations with *Narenga porphyrocoma* in Upper Baghaura, *Saccharum spontaneum* in Lower Baghaura, *Desmostachya bipinnata* in Upper Khauraha and *Vetiveria zizanioides* in Lower Khauraha and Lamkauli. Floristic similarity among phantas was relatively low, and indices of similarity were inversely related ($p < 0.05$) to the distance between them.

Five new species including tall grasses, namely *Narenga porphyrocoma, Saccharum bengalensis, Bothriochloa ischemum, Coix lachrymajobi,* and *Prunella* spp. were recorded during the present study. The prominence of *Imperata cylindrica, Vetiveria zizanioides* and especially *Desmostachya bipinnata* and *Saccharum spontaneum* had increased. Emergence of an unpalatable *Prunella* species might be due to the various disturbances. Productivity followed the floristic pattern of the phantas. Phantas with tall C_4 grasses had a high productivity.

Graminoids provided more than 99% to the total standing biomass, of which *Imperata cylindrica* was the chief contributor with, on average about 39%. Five common species in all phantas, *Imperata cylindrica, Saccharum spontaneum, Narenga porphyrocoma, Vetiveria zizanioides* and *Cynodon dactylon,* contributed more than 76% of standing biomass.

On average, 46% of the total standing biomass was cut from the five phantas. Harvest rate was highest in Upper Khauraha, where 85% of the total biomass was removed. The preference of phantas by villagers was mainly due to availability of quality grasses.

RECOMMENDATIONS

The impacts of grass cutting and burning in RBNP have not been studied previously. The estimated harvest rate appeared to be very high, especially when combined with annual burning. A large amount of nitrogen is lost through burning, but grass cutting may be even more serious since it removes organic matter from the phantas without any replacement. The situation in Upper Khauraha seems to be critical since the harvest rate in this phanta is quite high. Research into all these matters should be conducted. The Park authority should monitor the harvest rates in all phantas and in Upper Khauraha in particular, in order to keep harvests within sustainable levels.

NATURAL REGENERATION IN SOME PLANTATIONS IN DOLAKHA DISTRICT, NEPAL

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ABSTRACT

Many plantations have been established in the Middle Hills of Nepal in the last 10 years. In these plantations natural regeneration sometimes occurs. This regeneration may be advantageous as it allows for more options for future management. Eventually, conversion of pine plantations into mixed or pure broadleaf stands, which can better provide for the needs of the local people, seems possible. Local people depend on the forest for a whole range of products, such as fuelwood, fodder and construction timber. Therefore some knowledge about the regeneration events seemed necessary.

The present research was carried out in several plantations at altitudes from 900 to 2500 m in Dolakha District, Nepal. Some seven characteristics which seemed important for the occurrence of natural regeneration were measured. The amount of regeneration found was of importance for the vegetation. Presumably because it indicated the state of degradation of the site. Altitude and slope exposure seemed responsible for the spatial distribution of species in the regeneration events. Soil conditions were often directly linked to the physiognomy and contributed to the species differentiation and amount of regeneration found.

Competition from other vegetation often resulted in suppression of the regeneration. Seed regeneration suffered a lot from a dense grass or shrub lover, maybe because of root competition. Rootstock regeneration was suppressed by shrubs, which tended to dominate by vigorous growth. Seed regeneration in most cases was limited, because many sites were devoid of trees and many trees had been subject to severe lopping.

Protection resulted in the occurrence of regeneration events because of exclusion of grazing. Cutting, although diminishing the competition of other vegetation, more probably led to the disappearance of the regenerating seedlings, as they were cut with the other vegetation. Gathering of litter had the same effect. A more careful mode of cutting may improve natural regeneration.

PROBLEM

In 1978 the Integrated Hill Development Project (I.H.D.P.) initiated afforestation with people's participation. Most plantations have been started since that year, and only around Jiri are older ones.

Most plantations consist of pine species, because of the exposed and degraded nature of the planting sites, but plantations of the more favoured broadleaf species were also established, including *Prunus cerasoides* and *Alnus nepalensis*. More demanding species like *Quercus lanuginosa* and *Lithocarpus elegans* were planted in small numbers.

Soon after the establishment and protection of a plantation, natural regeneration of broadleaf species appears. Local people prefer broadleaf species to pines for fodder, fuelwood and construction timbers, so the main goal for plantations should be the production these materials. Therefore this natural regeneration is considered to be advantageous because it allows for more management options to meet future local demands. It will enable forest management to convert pure pine plantations to mixed or pure broadleaf stands which can provide a full range of the forest products required by local households.

However, not much is known about the incidence and success of natural regeneration in plantations. As the regeneration is different in each plantation, more knowledge about the factors contributing to natural regeneration seemed worthwhile.

OBJECTIVES

The objectives of this study were:

- to determine the factors which contribute to natural regeneration;
- to describe the types and density of regeneration appearing in various plantation;
- to recommend possible protection and management practices to improve the success and incidence of natural regeneration.

METHODOLOGY

Three plot classes based on the altitudinal ranges of the most prominent tree species found in the areas were defined, and a least 70 plots per altitudinal class were surveyed.

A total amount of 18 different sites to be measured were distinguished. After the fieldwork had been completed they were classified according to the forest types found in the area.

The plots to be measured were square or rectangular and were divided as equally as possible over the 18 sites. The plot area varied from 100 to 1000 m^2 depending on the amount of regeneration found.

In each plot characteristics which presumably had some relevance to natural regeneration were surveyed.

These characteristics were:

1) altitude and exposure of the slope;
2) physiognomy of the original vegetation;
3) plantation management and utilisation;
4) amount of natural regeneration events;
5) distance to a seed source for each species;

6) location of regeneration in the plot and plantation;
7) general condition of the plantation.

To obtain a complete impression of the regeneration events the plots were situated on a number of sites which represented differences in vegetation cover between trees, grasses, ferns and *Eupatorium adenophorum* etc.

FINDINGS

The amount of regeneration is different for the various vegetation types. Altitude and slope exposure determine the natural distribution of the regenerating species. Differences in the amount of regeneration at different altitudes or exposure are evidently due to local variations.

Site condition seems an important factor for the appearance of natural regeneration. Obviously biotic factors, like competition and availability of seed sources, consolidate the effect of this factor.

These factors seem to account for the small amount of regeneration found in grasslands. Besides usually no rootstock regeneration appears in grassland, because no old rootstock remains.

Closed plantations shows a larger of seed regeneration than shrublands. Generally residual forest has the largest amount of natural regeneration, evidently because here these factors provide the best regeneration conditions.

The human factor (forest management and utilisation) seems to largely determine the appearance of regeneration in the plantations.

Protection has enabled both rootstock and seed regeneration to proceed in a number of plantations.

Cutting also has an impact on regeneration events. It diminishes competition from grasses, *Eupatorium adenophorum* and ferns, which adds to the chance for seedlings to establish but unfortunately the young seedlings are bound to be cut along with fodder, and bedding material etc., because they are too small to be noticed.

RECOMMENDATIONS

Cutting should be eliminated once out of every five years. Since removal of vigorous, unpopular shrubs (e.g. *Eurya acuminata)* favours more useful regeneration and may result in better seed regeneration in the shrubland, such shrubs should be systematically cut.

As young seedlings are likely to disappear after the forest floor is swept clean, a careful method of litter collection should be adopted and could probably save most of these seedlings.

Forest management and utilisation should be based on the encouragement and protection of natural regeneration.

Natural regeneration from rootstock or seed is some times so prolific that for the future management priority should be given to the natural regeneration. A modest thinning of the original trees or cutting of the rootstock leaving the leaders may lead to a quick regeneration of the forest where as plantation species may not even survive.

Enrichment planting of some highly favoured broadleaf species should be carried out on these sites.

AN ASSESSMENT OF CROP DEPREDATION DUE TO WILDLIFE IN SHIVAPURI WATERSHED AND WILDLIFE RESERVE

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ABSTRACT

This study was conducted at the Shivapuri Watershed and Wildlife Reserve in Sundarijal, Kathmandu. The study mainly aimed to assess the agricultural loss caused by wild animals, especially pigs. The study area is entirely located within the walled boundary of the Shivapuri Reserve, and there is no barrier between the forest and the agricultural land in it. Because of this, the crop losses are serious. About 92% of households living within the Reserve were found to be affected by wildlife depredations and on average each affected household lost about Rs 3132 annually. Undoubtedly, wild boars are the most damaging animals in the study area. Although they prefer root crops like yam and sweet potato, they cause more economic loss in maize and millet crops.

Although problems of crop depredation by other wild animals were always there, the locals learnt how to cope with them in the course of time. Moreover before establishment of the Reserve, people thought that their losses were offset by their free access to forest resources.

Since the wild boars were only recently introduced in the Reserve, local people considered the problem to be caused entirely by the Reserve management. Long-term success of any reserve can only be anticipated if there exists harmony between the reserve management and the locals. For this reason, any misunderstandings arising between local people and reserve management should be resolved amicably. The management should not underrate the problem of crop loss but should adopt timely measures to ameliorate the damage. Several recommendations are made in the thesis to rectify the existing situation.

PROBLEM

It is becoming increasingly necessary to broaden our knowledge about the consequences of ongoing environmental change and, at the same time, to learn how to combat the detrimental effects which occur. In this regard any successful natural resource conservation strategy, requires a careful assessment of all problems concerning reserve management. Here, it is essential to study the economical and social aspects of human activities which influence wildlife, and at the same time, those activities of wildlife that affect human socio-economic activities.

Conflicts between local people and wildlife must be resolved for successful reserve management. Moreover, any conservation strategy that fails to pay attention to the needs of the local people not only jeopardises peoples' lives but also leads to the destruction of the natural values the strategy aims to preserve.

Thus, in designing a sustainable conservation strategy, careful assessment of the causes and effects of conflicts is essential.

Traditionally Shivapuri forest had supplied firewood to Kathmandu valley and had remained an age-old traditional hunting ground for Rana and other ruling aristocrats. But the massive increase in populaiton and corresponding deforestation led to erosion and dwindling water supply. Bearing the degrading environment in mind, and to avoid further degradation the Government declared the area as a watershed and wildlife reserve in 1976. With the establishment of the reserve, local people nearby were deprived of their ancestral rights and no longer could collect wood, fodder and graze their cattle in the reserve. Thus these kind of regulations brought about conflicts between the local people and the reserve management.

Sources of conflicts in Shivapuri fall into two broad groups:

1) the prohibition on the free use of forest resources in the Reserve; and

2) crop depredation and live stock losses in adjoining villages by wildlife from the Reserve.

OBJECTIVES

Although crop depredation has been a long-standing problem in the Shivapuri Reserve, and serious complaints of this have been lodged repeatedly with the Reserve management, a complete study quantifying the crop losses has never been done. Moreover, no research has been carried out to specify local people's needs and their opinions regarding the Reserve management.

The main purpose of the study was to assess the quantity of the crops loss by wildlife depredation in the Sundarijal VDC.

The immediate objectives were:

1) to estimate the actual amount and annual monetary value of crops lost through depredation by wildlife;

2) to determine the most destructive wild animal;

3) to determine the frequency of wildlife attacks on the crops;

4) to document problems, needs and views of local people in connection with natural resources management, including wildlife and buffer zones and to recommend possible measures to alleviate problems.

METHODOLOGY

This study was based entirely on field surveys which were conducted during the month of February and August-September.

Three different methods of primary data collection were applied, namely, household surveys, informal interviews and group discussions and direct observations.

At least one group discussion was held in each village. The number of villagers participating in such discussions ranged from 6 to 22.

FINDINGS

About 92.01% of households living in the settlements within the walled boundary of reserve are affected by wildlife. Each year 242 affected households (average 92%), out of 263 households, lost about 93.29 tonnes of grain.

Although monkeys, birds and porcupines also damage the crops, wild boars are the most serious problem for farmers as far as crop raiding is concerned.

Preventive measures adopted by farmers are mostly primitive and labour intensive. On average, farmers spend 126 nights a year watching and protecting their fields.

Crop depredation by wild life depends on various factors e.g. distance from the Reserve boundary; the numbers of crop raiding animals in the Reserve; variations in numbers of crop-raiding animals over time and space, nature of barriers between the crop land and the reserve; and types of preventive measures used by farmers.

RECOMMENDATIONS

Controlling Wildlife Damage

Before the Reserve management resorts to control measures, economic evaluation should be carried out to ensure that effective control can be accomplished for less cost than the appraised damage.

Before initiating control programmes, one of the immediate tasks should be to investigate how conflicts can be minimised. In this regard emphasis should be given to the involvement of local people and sustainable benefits for them.

Monitoring of Crop and Livestock Depredation

Since most damage is in agriculture land within the Reserve and within 1 km of the boundary, these are the high-risk areas, and should be continuously monitored for crop and livestock damage.

Confining Wildlife within the Reserve

Local people are eager to keep the walls repaired in their area, but repairing the walls cannot solve the problem by itself.

Removal of Wild Boar

It must be understood that most of antipathy of local people towards the Reserve is due to the wild boar, which is exotic and only recently introduced to the Reserve. Any reserve can only

thrive in long run if people have positive attitudes towards it.

Although wild boars are the main cause of the problems described, their removal should only follow from careful study of its consequences.

Cash Compensation

Cash compensation for live stock and crops is not recommended. Cash compensation is expensive; moreover it always leaves room for controversy and only aggravates the problem.

Sustainable Management of Wildlife

Game farming and community forestry should be practised outside the Reserve with the active participation of local people and benefits from these activities should ultimately flow to local people.

The Reserve management should encourage the growing of crops and vegetables which are not palatable to wild boar in crop raiding zone and at the same time provide market.

Eco-tourism

Because of its proximity to Kathmandu and its peaceful setting, there is strong potential for eco-tourism in the Reserve. Local people should be involved in this activity, which can improve the local economy and thus encourage the use of other sources of energy such as biogas and electricity, which would also help to reduce dependency on forest resource.

To sustain tourism in this area in the long run, over-exploitation of local natural resources should be strictly prohibited and funds should be allocated for the maintenance and cleaning of the Reserve.

BUFFER ZONE MANAGEMENT IN NEPAL: A CASE STUDY IN ROYAL BARDIA NATIONAL PARK WITH EMPHASIS ON SUSTAINABLE USE OF FUELWOOD AND TIMBER RESOURCES

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ABSTRACT

Royal Bardia National Park (RBNP) is the largest of the parks in the western Terai lowland of Nepal. Poverty and rising population increase pressure for more forest products for local use, especially along the southern boundaries of the park. With experience from past national parks rules and policies, the Government has realised that areas adjacent to the parks should be managed to provide forest products sustainably and that benefits from the parks should be shared with local people. Thus the provisions for buffer zones around parks and redistribution of revenues to local communities were included in the recent amendment of The National Parks and Wildlife Conservation Act 1992.

A six-month study was conducted in six village development committees (VDCs) to the south-east of RBNP in order to propose appropriate approaches to a buffer zone management programme. An intensive inventory was conducted in order to estimate the potential sustainable fuelwood and timber supply from the buffer zone forests (an area of 83 km^2). A household survey (n=185) was conducted in the six VDCs on the demand for fuelwood and timber, livestock holdings and crop damage by park wildlife.

Forests resources in the study area are abundant and for the time being can meet the needs of the villagers in the six VDCs. But the forests are not evenly distributed and people use forests irrespective of VDC boundaries. Forests near settlements are more degraded than those far away.

Livestock is an the integral part of the local farming system, and people in the study area keep large herds of livestock. Even though there is plenty of grazing land people perceived shortages. The problem is quality rather than quantity. Crop and livestock damage depredation was reported to occur in all VDCs, but the extent of the damage varied. There is a gradual trend of decreasing in crop damage by wild animals in wards adjacent to the National Park and buffer zone to wards further away.

Local people's expectations from a buffer zone management programme are listed. People expected improvements in fuelwood supplies, employment generation and better medical facilities.

In order to meet the demands of local villagers and to improve habitats for wildlife, an Inner Buffer Zone Forest (IBZF) and Outer Buffer Zone Forest (OBZF) concept is proposed. It is assumed that an IBZF will provide timber for the people and habitat for wildlife, while an OBZF will provide people's daily needs for fuelwood, small poles and grasses. Recommendations regarding grazing, prevention of crop damage, and local community development are proposed.

PROBLEM

Poverty and the increasing human population of Nepal demand more land for food and more forest products for people's daily requirements. Within two decades, large tracts of forested area have been converted into agricultural land. In order to protect bio-diversity, about 13% of Nepal's total land area has been reserved as National Parks etc. up to now. In the lowland (Terai) areas, strict regulations are imposed on access to the park resources, except that grass cutting is allowed for the local people for two to three weeks a year. Experience has shown, however, that legal protection is often not adequate to guarantee the continuing integrity of protected areas. The main problem is that the local people see such protected areas as government-imposed restrictions on their traditional rights.

Department of National Parks and Wildlife Conservation (DNPWC)'s framework for buffer zone management addresses the issues of increasing human population, rapid deforestation and habitat loss around protected areas. The basic principles of buffer zone management may be sound, but their application can be very difficult. Despite a high level of protection by the Royal Nepalese Army, experience has shown that without the participation of local communities it is very difficult to maintain the country's ecosystems and biological diversity. Thus, lessons should be learned and experience shared and fully appreciated before implementing buffer zone management.

METHODOLOGY

Discussions with RBNP staff were conducted to ascertain the extent and boundaries of the buffer zone forests. Maps prepared by the Maintenance Survey Office, Bardia, were used to identify the boundaries of the VDCs. Aerial photographs were used for inventory work. The inventory method used in this study was adapted from the method used by the Forest Survey and Statistical Division of the Ministry of Forest and Soil Conservation, Nepal, which was stratified random sampling using forest types, stand sizes and stocking classes as stratification variables. The stratification was done through aerial photography. Random points fixed on the aerial photographs were found with the help of reference points and were visited in the field. The number of plots was calculated to yield a sampling error not to exceed 5% at 95% confidence level by a proportional allocation method. Altogether 213 plots were laid in the buffer zone forest to get the resource information at the required sampling precision.

A household survey (n=185) was conducted on the demand for fuelwood and timber, livestock, and on crop damages.

FINDINGS

Forests resources in the study area are abundant and for the time being can meet needs of the villagers in the six VDCs. But the forests are not evenly distributed and people use forests irrespective of VDC boundaries. Forests near settlements are more degraded than those far away.

RECOMMENDATIONS

Management of the buffer zone forests should be directed to yielding equitable distribution of forest resources as well as improving the degraded forests near settlements.

Buffer zone management should provide incentives for economic development which does not put extra pressure on limited natural resources.

The management of buffer zones should be the responsibility of both parties (RBNP and local users). Local users in co-operation with RBNP will be the most effective way to manage the buffer zone forest.

The buffer zone forests should be classified into Inner Buffer Zone Forest (IBZF) and Outer Buffer Zone Forest (OBZF). The IBZF should be a partially restricted forested area which separates the OBZF from the National Park and should be managed for timber production and wildlife. The OBZF should be divided among different village units and should be managed under a user-group concept.

There should be one buffer zone management steering committee (BMSC) for the whole RBNP. This committee should be responsible for the supervision and overall allocation of financial resources needed to the different buffer zone management committees (BMCs) upon their request and needs.

Local people should be employed in various forestry activities such as IBZF management, collection of drift wood, establishing nurseries and agroforestry activities.

Local people should also be encouraged to establish small cottage industries. If needed, a fund or some other assistance should be provided by the BMC. Markets for the products should be ensured before implementing any type of cottage industry programme.

Better medical facilities should be provided in the study area, as they are very important in gaining local support and participation.

USABILITY OF DIGITAL ELEVATION MODEL IN FOREST INVENTORY BASED ON SATELLITE IMAGERIES

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ABSTRACT

This study was conducted on satellite imageries of Nawalparasi District covering about 2,636 km^2 in the western development region, southern Nepal. The increased population puts pressure on the forests of the district as sources of income and potential agricultural land. Thirty per cent of the land is covered by forest. The latest inventory of the forest resources in the district was done in 1990 with the help of the aerial photographs of 1989-90. The calculated volumes of the inventory plot were used in the study. Digital elevation models were developed using ARC/INFO software. Two Landsat TM recorded on a magnetic tape, taken in 1990-1991, from the path 142, row 41 and quadrat 2, were used in the study.

The correlation coefficients between the forest stand volumes and spectral values were in general low because of the large small-scale variations (within pixel) in stand volume. The highest correlation coefficient (0.49) was found between the volume and the inverse of spectral channel 7. In cluster analysis (stratification) of the principal components digital elevation data did not help to reduce the variances within the strata. The maximum reduction was 15%. Six models have been developed with and without using digital elevation data for the prediction of volume. Digital elevation data slightly improved the R^2, which is, however, not very good. The transformation of data did not give better results than the original data. The maximum R^2 was 0.28 with the inverse of spectral channel 7 and the inverse of aspect.

Many reasons are realised responsible for low the explained variance. Among them the bad tree-crown lopping practices, inaccurate diameter and height measurements, inaccurate plot location and time difference between the satellite imageries and field data collection are important. The study area is also too small for the generalisation of any results.

PROBLEM

The background of this study lies in the forestry and forest-planning situation in Nepal. Aerial photographs have been used extensively in the stratification for laying out plots for field data collection. The forest characteristics and volume prediction are done entirely on the basis of the collected data from the plots.

Satellite remote sensing provides a method to collect input data for planning and modelling using Geographic Information System (GIS).

Accurate volume calculation must be based on accurate diameter and height measurements which could be difficult to achieve in Nepal. The bulge, buttresses, bifurcation and other abnormalities are common at breast height, making accurate measurement difficult. The broad-leaved trees with wide crowns make it difficult to determine the leading tree and so to make accurate height measurements. Height and diameter measurements are more difficult in

the hills where the terrain is difficult. Due to the inaccurate height and diameter measurements the same sized trees can give different volumes.

OBJECTIVE

1) Development of models for the volume prediction of the forest.
2) Stratification of the forest area into homogenous strata to reduce the variances within each stratum.

METHODOLOGY

Radiometric Correction

Because two imageries were used in the study, the analysis began with radiometric correction to eliminate clouds and other atmospheric differences. Histograms matching the spectral characteristics of two images, which are important in mosaicking scenes that were taken on separate days. Histograms of the same area of both the images were calculated prior to using histogram matching. After the corrections, the two imageries were joined together.

Geometric Correction

Geometric rectification was done with the help of ground control points located on the aerial photographs, maps and digital elevation models to bring the image into correct UTM co-ordinates. The rectified images were extrapolated from ground control.

The TOPOS mapping system was used to get the co-ordinate values. The system is a vector-based map editor running on a microcomputer under the MS-DOS operating system. The system is designed especially for digitising maps and for creating thematic maps.

Calculation of Slope, Aspect and Elevation

The rectified ERDAS image (ortho-image) was first converted into set grids, using NEAREST neighbour assignment.

The principal component transformations were calculated from the values with and without digital elevation data (elevation, slope and aspect).

For the prediction of volume, attempts were made to develop models, using the Landsat thematic mapper.

FINDINGS

The correlation of the channel value with the stand volume was always negative which means that areas with high volume are dark in the image. This is true only in forested areas; because water and black volcanic rocks also look dark. CH5 and CH7 show high correlation with the stand volume. High correlation coefficients were found between the plot volume and inverse of CH7. The correlation coefficient between volume and the logarithm of TM channel 7

was -0.45.

Volume was best correlated with the first principal component (PC1), when digital elevation data was not included in transforming the spectral values into principal components.

Volume was best correlated with the third principal component (PC3) when the digital elevation data was included in transforming the spectral values into principal components.

Volume was best correlated with those principal components where more weights were given to the CH5 and CH7 indicating that CH5 and CH7 possess most of the information on field data that is relevant in volume prediction.

RECOMMENDATIONS

A good correspondence between satellite imagery and forest characteristics requires both height and location accuracy and good correspondence in the size and form of the sample units. Better correlation coefficients could be obtained if the time difference between satellite imageries and the field data is minimised. In the study the difference was more than one year, which is a sufficient time to change the structure of accessible forests by the villagers in Nepal.

Pure textural features were less advantageous than pure spectral features for stratifying plots into homogenous forest parameter strata.

The use of satellite imageries could be more reliable in a bigger area, for example, regional or national planning rather then a small district for any definite conclusion. An expert system, consisting of riles for combining multi-data and multi-criteria for inventory purposes, could also be considered.

GROWTH AND DEVELOPMENT OF CHIR PINE SEEDLINGS IN RELATION TO NUTRITION, TEMPERATURE AND LIGHT

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ABSTRACT

Chir pine (*Pinus roxburghii* Sarg.) is now being planted extensively in Nepal and it is important to increase knowledge of the response of the species to environmental factors. Effects of nutrition (N, P, K), temperature and light on seedling morphological features, dry matter production and water soluble carbohydrates, and of nutrition on leaf pigments were examined in either controlled or uncontrolled environments.

The marked effects of nutrition on morphological features and dry matter production were due to nitrogen. Low levels of phosphorus promoted shoot dry matter production while higher levels promoted production of root dry matter. The effect of potassium on most variables was insignificant, the most notable exception being height growth, which was stimulated by increase in potassium supply. The NXK interaction was important with respect to morphological features and dry matter production.

The N and P content of plant parts increased with increased supply of nitrogen and phosphorus respectively. Added nitrogen depressed P content in stems and needles while added phosphorus depressed foliar N content. Both nitrogen and phosphorus markedly increased the concentration of foliar pigments. Added potassium was ineffective in this regard except at the highest concentration investigated.

Nitrogen increased the carbohydrate content of stems and phosphorus that of roots, whereas foliar carbohydrates were unaffected by the nutrients. Greatest carbohydrate accumulation occurred at higher light intensities and at low night temperatures.

Chir pine seedlings grew best under a 30°/20°C day/night temperature regime. Day temperatures in the range 20 to 30°C and a thermoperiod of 10°C generally favoured both height growth and shoot dry matter production. Constant day and night temperature in the range 20 to 30°C tended to inhibit shoot growth. Root dry matter was favoured by very low to low night temperatures (5-10°C) and low to moderate day temperatures (10-25°C).

These results should be helpful with respect to establishing plantations and improving growth with fertilisers.

Future research on nutrition of the species and its response to light and soil moisture stress is needed.

PROBLEMS

The emphasis of the afforestation programme of Nepal is on production of fuelwood and timber in short-rotation crops to meet the increasing demands for these products. Large areas of chir pine are now planted annually, mostly on previously unproductive sites. Under these conditions, it is important to know the growth habits of chir pine and what factors are most important in determining its growth.

It is well known that the growth of trees responds to favourable environmental conditions. Although numerous studies on nutrition, light, temperature and moisture have been made on a large number of *Pinus* species, very little is known about the growth and physiological responses of chir pine to these factors. No information is available on the effects of temperature and moisture stress on the growth and development of this pine. Therefore, the main aim of this study was to examine the nutritional requirements of the species and its response to light and temperature.

METHODOLOGY

Effects of N. P. and K. nutrition on growth and development were studied by preparing experimental stock from chin pine seeds collected from forests near Kathmandu. Macro and micro nutrient stock solutions were prepared and a 3 x 3 x 3 factorial design with three replicates was used to investigate the effects of a number of different factors simultaneously. Seedlings were grown in the glass house for five months and harvested. Pigment analysis was carried out.

Another experiment was designed to further investigate the effects of nitrogen and phosphorus, particularly at low concentrations, on growth and development of chir pine seedlings. Deficiency of these nutrients rather than over-supply is more likely to occur under field conditions. Seeds were collected from a single tree at Kathmandu. Seedlings were raised in Canberra and graded when they were four weeks old. A 3 x 3 factorial design was used with three replicates. The height was measured and the development of deficiency symptoms was recorded.

Seeds were collected from two natural stands near Kathmandu. Seeds were sown and the seedling were transferred to a special cabinet of CSIRO after about one and half years time. In the cabinets, natural day length is supplemented by incandescent light to provide a 16-hour photo period. Multiple regression analysis was carried out.

Seeds from a single tree near Kathmandu were collected. After germination, they were transplanted into pots which were kept in an open glass-house. Four light intensity treatments were applied and it was measured by Radiant Flux Densiometer.

FINDINGS:

The growth in height and stem diameter, development and extension of branches, and dry matter production were all strongly influenced by nitrogen. Phosphorus, on the other hand, had no effect on morphological features but low concentrations affected dry matter production of shoots and higher concentrations affected dry matter production of roots. The concentrations of 100 ppm N, 15 ppm P and 40 ppm K in the nutrient solution proved the most favourable

combination for growth and dry matter production of chir pine seedlings whereas concentrations of 165-300 ppm P were the most suitable for root growth and development.

Pigment content was most influenced by nitrogen supply, which appears to be crucial for pigment accumulation in chir pine.

Effect of low concentration on N and P on growth and development

A general symptom of nitrogen deficiency of *Pinus* species is chlorosis of the foliage. Nitrogen supply affected the growth and development of most plant parts markedly. Height and diameter growth, branch formation, leaf development and dry matter production all responded to nitrogen.

Effect of temperature on growth and development of chir pine seedlings

Little information is available on effects of temperature on the growth and development of chir pine.

Hot days combined with warm nights and warm days combined with hot nights gave the best height growth. Height growth of chir pine does not appear to be adversely affected by a high night temperature (30°C) and lower day temperature (20-25°C).

Effects of light intensity on growth and development of chir pine seedlings

Morphological features such as stem diameter, branch number and dry matter production of various plants were all positively affected by increase in light intensity, whereas height growth, height/diameter ratio and height/branch number ratio were negatively affected. The growth of seedlings under low light intensity suggests an ability of chir pine to withstand shade if other factors are favourable.

AN INTRODUCTION INTO SOME ASPECTS OF *PINUS WALLICHIANA* MANAGEMENT IN JUMLA DISTRICT, NEPAL, INCLUDING PRELIMINARY STUDIES OF BIOMASS

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ABSTRACT

This research arose from the need to improve the management of *Pinus wallichiana* forest in Jumla District and to quantify the supply and demand for this major resource.

The raw data were collected while the writer was working as a volunteer on a community forestry development program with the Karnali-Bheri Integrated Rural Development (KBIRD) project during 1983-84. Analysis of the data and production of the biomass tables were carried out at the University of Aberdeen.

None of the techniques used in this present research are new. Intentions were to collect all the available relevant information and to use selected methods already tested elsewhere in order to carry out a series of pilot studies with the aim of approaching practical solutions to certain forestry problems in a remote and difficult environment.

Soil erosion caused by deforestation is not a major problem in Jumla, and the forest area is large enough to support the needs of the local population at present. If managed properly *Pinus wallichiana* forest can be very productive, but the amount of damage and encroachment that is occurring in the forest has become a serious problem.

The question thus arises-what area of pine forest is adequate to produce a sustained yield of the essential forest products and to ensure adequate soil and water conservation in Jumla?

This thesis attempts to synthesise the relevant information in order to contribute toward an answer to this question.

PROBLEMS

Forest biomass has been defined as the quantity constituted by living organisms in the forest ecosystem in terms of oven-dry weight. For the purpose of this study, however, its meaning is confined to the above-ground portions of trees. Biomass measurements are not new, but their use as management tools by forest managers is a relatively new concept, and one that is gaining increasing importance.

To date in Nepal researchers have developed regression equations and tables in order to estimate biomass for 30 species. These researchers have carried out the work with their own objectives, not from a single programme directed towards general use by forest managers in Nepal.

It is important that standard procedures are used when biomass is measured, so that the data and results are comparable and compatible.

A large proportion of the forests of Jumla contain *Pinus wallichiana* as the major species. These forests are being rapidly degraded or destroyed, mainly for fuelwood and to create agricultural land, while little is known of the supply of and demand for that species. *Pinus wallichiana* is both the fastest growing and most widely used species in Jumla, but whereas the techniques of plantation establishment are largely developed, there is as yet, no possibility of quantifying the use of the existing forests for the development of community forest management plans. In order to implement community forest management, it is essential to estimate the existing quantity of forest products and the potential production. Fuelwood and needle-litter for compost are two major uses which can only be quantified in terms of weight. It was for these reasons that this study of the biomass of *Pinus wallichiana* in Jumla district was initiated.

A large amount of information about the area was already available, including topographic maps; land utilisation; land systems and land capability maps; aerial photographs and reports from various field visits to the area. Various volume tables and yield tables for *Pinus wallichiana* are also available (in imperial units) but these have been constructed in other areas than Jumla.

Little of the existing information and tables was being used, since none of the information was easy to obtain and its value was not fully recognised.

OBJECTIVES

1) to create single tree biomass tables for natural *Pinus wallichiana* forest in Jumla, relating above-ground (stemwood, branchwood, and foliage) biomass to diameter at breast height, for use as management tools;

2) to compare results from Jumla in western Nepal with biomass data for *Pinus wallichiana* plantations in eastern Nepal at lower altitudes, where the species is harvested in smaller sizes;

3) to convert the available *Pinus wallichiana* volume tables for Nepal, India and Pakistan and yield tables from north-west India to metric units and compare these with data from Jumla;

4) to determine the relationship between 'height intercept' (defined as the mean distance between annual branch whorls for the first 5 whorls above breast height) and tree height at age 20 years, in order to predict yield by the assessment of site quality independent of the age of natural *Pinus wallichiana* forest. Site quality is defined in the Indian yield tables by dominant height on age relationships;

5) to analyse the historical and current management of *Pinus wallichiana* in Jumla with particular attention to:

   a) quantities of fuelwood and needle-litter collected from the forest;

b) the amount of lopping, pollarding, basal cutting and ground burning which occurs;

c) the sizes of timber used in construction;

6) To carry out a pilot survey of *Pinus wallichiana* forest to:

a) assess the diameter class distribution;

b) quantify the damage done to trees in relation to size classes;

c) relate stand basal area and mean diameter measured in the forest with crown density and forest maturity classifications given on land utilisation maps for the same locations;

d) estimate the standing woody biomass of *Pinus wallichiana* and relate it to the demand for fuelwood;

7) to analyse the development of biomass, particularly branch biomass with age and make suggestions concerning pruning for fuelwood;

8) to review literature on the effects of pruning on biomass productivity and analyse the branch biomass data in relation to yield predictions after lopping trees;

9) to explore the possibility of predicting biomass from aerial photographs via the relation between crown-projection and above-ground biomass; and

10) to use the results of the pilot studies to make suggestions for further research into the management of natural *Pinus wallichiana* forest in Nepal.

METHODOLOGY

The process and techniques of biomass table construction are best considered in four parts:

1) defining the population for which the table will apply, and selecting representative samples of that population;

2) measuring the biomass and predictor variables of those selected sample trees;

3) estimating relationships between the measured tree parameters and tree biomass; and

4) choosing the best model for construction of biomass table, and validating the model using an independent set of raw data.

The population of natural *Pinus wallichiana* lies in a 300 km^2 area around the District centre of Jumla in east latitude 29° 10' to 29° 20': between altitudes 2280 and 3660 meters and covers 9023 hectares (30%) of the land area.

The diameter frequencies for the population sampled showed that few *Pinus wallichiana* trees have a dbh greater than 100 cm in Jumla, other than trees connected with religious beliefs. Trees of dbh greater than 50 cm are not useful in Jumla. The diameter range sampled for biomass was 2.0 to 42.8 cm dbh and the height range sampled was 2.52 to 19.56 m.

The age range sampled for biomass was 10 to 52 years although there are many trees well over 100 years old.

No attempt was made to exclude forked, leaning or edge trees. Larger trees in the population tend to be open grown and this is reflected in the crown dimensions of the sample population.

The sample population was chosen from those trees in the population which were not damaged in any way by man. This greatly affected the method of sampling, since a large proportion of the population has been damaged and biomass removed. This represents a major dilemma in constructing the biomass tables, since the tables do not represent the whole *Pinus wallichiana* population in the sample area.

FINDINGS

This survey can only be viewed as a limited pilot survey, since statistical methods were not applied and time constraints limited the sampling.

Some of the main points arising from analysis of *Pinus wallichiana* forest on the maps available include the following: 60% of the forest lies below the altitudinal limit of agriculture; but only 10% is on land capable of cultivation for agriculture; and over 90% lies on steep to very steep slopes. The major soil types carrying *Pinus wallichiana* appear to be various forms of cambisols with a loamy or skeletal texture, and hard rock at a shallow depth. These are described as lithic subgroups of soil groups, seem to be widespread, and may be related to the poorer site quality classes for *Pinus wallichiana.*

Desmodium and *Indigofera* spp. appear to be indicators of good sites for *Pinus wallichiana.* On sites which have been protected, a larger number of regenerating seedlings appear to survive on the northern than on the southern aspects. Protection of regenerating areas is a larger problem than initial survival.

The scale of damage to *Pinus wallichiana* trees is clearly shown in the survey, with only 0.4% of sawntimber-sized trees showing no lopping damage, The sampling for biomass trees was dominated by the search for undamaged specimens of the appropriate size classes. Lopping clearly affects diameter increment, as shown by the core samples, as well as the ratio of crown to stem diameters. Since lopping is so intense in Jumla, it is doubtful whether yield tables, volume tables or even biomass tables created for a population of undamaged trees are any use without adjustments to allow for the damage present and how it affects future yields.

RECOMMENDATIONS

The major fault of the biomass tables produced is that they are of little use in their present form. In Jumla, the majority of pole-sized and sawntimber-sized trees have been severely lopped for fuelwood so that the tables apply to a minority of trees in the population. The use of the biomass tables produced would be greatly enhanced if the biomass of damaged trees in Jumla could be measured in relation to diameter class and broad categories of damage, so that correction factors could be used to predict the standing biomass of the whole *Pinus wallichiana* population in Jumla.

EROSION IN THE MIDDLE HIMALAYA, NEPAL WITH A CASE STUDY OF THE PHEWA VALLEY

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ABSTRACT

Data on erosion processes and other aspects of environmental change in the Himalaya are scarce and unreliable, and consequently policy decisions have been taken in a quantitive vacuum. Published estimates of denudation for large catchments in Nepal vary from 0.51 to 5.14 mm/yr, and indicate a dynamic geomorphological environment. A review of the literature on erosion in Nepal revealed a consensus that: (1) mass wasting is the dominant hillslope process; (2) activity is seasonal, with virtually all wasting occuring during the monsoon; (3) geological factors are the most important determinants of slope stability; (4) sediment delivery to channels is high; and (5) little quantitative evidence exists to link landsliding to deforestation. Although few data exist, loss of forest cover does appear to be related to surface erosion and gullying, and a hypothesis linking the expansion of unmanaged, eroding areas to reduced nutrient subsidies from the forest is proposed.

A reconnaissance survey of sediment production and transfer mechanisms in the 122 sq.km km^2. Phewa valley in the Middle hills of Nepal identified a variety of mass movement processes. The commonest events were shallow translational failures on slopes of, typically, 36° to 45°, with volumes <1000 m^3 and with recovery taking less than ten years. Larger slides occured on slopes oversteepened by fluvial action. Sediment flows developed in areas of weak rock and unfavourable structure and were associated with groundwater discharge. Flow velocities accelerated during the monsoon. The highly fractured and deeply weathered zones around faults were the sites of "mass movement catchments", complex failures responsible for approximately 90% of all sediment production by mass wasting in the watershed. A first estimate of surface lowering by mass movement processes in the Phewa valley is 2-3 mm/yr. Locally, surface erosion on overgrazed pasture may be 5-6 mm/yr. No data were available on soil losses from cultivated areas, and, similarly, losses due to shallow creep, gullying and solution remain unknown.

The fluvial transport system in the valley bottom is unable to transport all the material with which it is supplied. Sediment yield to Phewa lake was not calculated owing to insufficient data. Discharge estimates and intensity-duration-frequency analysis of rainfall records indicate that in Pokhara storms of 275 mm/day have a return period of approximately 10 years.

The primary controls on mass movement processes in the Middle Hills are geological and climatic and therefore are not amenable to modification by man. However surface erosion is a consequence of poor land managament and therfore might be controlled, given the right institutional environment.

PROBLEM

As elsewhere in the Himalaya, the Middle Hills of Nepal are densely settled and support an agroecosystem which is dependent on energy and nutrient subsidies from the forest for its continuation. The land surface has been extensively modified in order to allow arable agriculture, and increasing population and unfavourable institutional arrangements have resulted in degradation of the forest resource.

Recurrent, and supposedly worsening, landslides, floods and associated sediment deposition downstream have resulted in concern being expressed that some critical environmental threshold has been reached and shall further deterioration has become inevitable. The principal cause of this environmental deterioration is widely perceived to be deforestation.

Owing to remoteness and lack of infrastucture, little work has been done to define rates of natural processes in the Himalaya, or how these processes are currently affecting the landscape. Original studies on hillslope and fluvial processes are few in number, sometimes of limited availability and often of doubtful accuracy.

OBJECTIVE

The objective of this study was to reduce the overall uncertainty concerning erosion processes and rates of sediment production in the MIddle hills of Nepal.

METHODOLOGY

Fifty suspected mass movement sites identified by air-photo interpretation in the Phewa watershed and surrounding area were visited on foot. Morphometric and other characteristics of 22 of these sites in the Phewa watershed and 4 outside it, were determined. Slope angles were determined by clinometer and morphometric measurements by hand-held tape for smaller slides, by pacing for larger ones and, for extremely large failures, by measurements from air-photos. Slide age was estimated from a combination of scar freshness and degree of recovery through vegetation establishment, local interviews, and existence and relative size on the 1958 topographic maps and the 1972 and post-monsoon 1978 air-photos.

Other characteristics recorded in the field were the nature of the failure surface; the nature of the failed material (soil, untransported regolith, colluvium, bedrock); soil texture; structure, horizonation and drainage; root penetration of the regolith, bedrock geology (including lithology, bedding, dip, jointing, faults, and competence), surface and subsurface moisture regimes, topography, connections to the drainage net, debris delivery to channels, land use, elevation, aspect, association with other failures, and possible causal mechanisms and triggers.

Angle of failure surface and approximate age were obtained for a further 11 slides. The relatively homogenous bedrock types in the Phewa valley precluded any assessment of failure variation between lithologies, and insufficient data were collected to examine the effect of slope age on failure.

FINDINGS

1. In Nepal, the causes of mass movement, sensu stricto, are primarily geological, and so cannot be influenced by man. Intervention is extremely expensive, and can only be justified where high-value infrastructure is threatened. Even then, it is not always successful.

2. Mass movements and associated erosional features are the principal contributors of material to valley bottom sediment transport systems. They are probably responsible for the very high peak sediment loads recorded in Himalayan rivers.

3. Infrequent catastrophic events, up to several orders of magnitude larger than the majority of failures, have had, and will continue to have, a major effect on the landscape in Nepal. These usually involve slope failure and subsequent landslide dams and dam-bursts.

4. Deforestation is unlikely to affect the scale and timing of large slope failures but may increase the incidence of shallow debris slides. In volumetric terms, these small slides do not appear to be major contributors of sediment to river systems.

5. Throughout the middle hills, deforestation and the abandoment of marginal arable land are associated with an increase in the area of barren land and unproductive communal grazing areas. These sites are rapidly degrading and, locally, are responsible for high rates of sediment production through surface erosion and gullying.

6. Soil losses from terraces, khet (irrigated rice fields) or well managed bari (reinfed agriculture land), are probably low, although not as low as the loss from forested areas.

7. The nutrients carried by eroded soil are useful, if not essential, in maintaining fertility in fields at lower elevations.

8. Notwithstanding the role of erosion in nutrient transfer, the degradation of surface soils is a serious problem in the Middle Hills. This is due to not only the loss of soil off-site, but also to deterioration in some of the physical and chemical soil properties which affect fertility. The most important of these are structure, permeability and organic matter content. The consequences are a lower production potential and a higher susceptibilty to erosion.

9. If the productivity of marginal areas drops sufficiently, due to soil deterioration and loss, they are abandoned. In the absence of management, free-ranging livestock increase site degradation by trampling and the suppression of vegetation. Owing to the generation of excessive run-off these areas then become the sites of gulley initiation.

10. Once started, gullying is difficult to control, and can rapidly destroy terraces and other productive land by lateral and headward expansion. The large volume of coarse sediments produced by gullies cutting into mantle materials forms a hazard to bottom lands. Gully prevention is simpler than cure.

11. Forests, which supply the nutrients to maintain crop yields, have retreated due to excessive harvesting of forest products and damage to young growth. Localised

excessive harvesting occurs where, for socio-economic or political reasons, normal methods of distributing demand over a larger area have broken down. Concentric rings of forest degradation then spread out from consumption centres, i.e. villages. Such a pattern is widespread in the Middle Hills of Nepal.

RECOMMENDATIONS

1. Particular consideration should be given to:

   sitting of: linear features (roads, canals etc.), which require careful alignment to avoid the most unstable areas.

   lowering specifications: environmental impacts can be reduced by, e.g., reducing road widths, so that a smaller area of ground is affected.

   adjusting the design and management of hydraulic installations to cope with high sediment loads.

   adapting specifications to ensure the survival of structures when major hazards cannot be avoided, albeit at the cost of slightly lower performance.

   planning for high levels of siltation behind dams.

2. emphasising in conservation programs the need to reduce surface erosion and gullying by improving management on the low-productivity areas.

3. supplying alternative sources of fodder, such as forage crops, so as to reduce the pressure on the forest. However, any attempt to diversify fodder sources must confront the problems of the extra labour demand which it may create.

4. the fact that although not insoluble, the scale of the problem of environmental deterioration in Nepal defies imposed solutions. The most effective kind of management involves day-to-day decisions, and should devolve directly to resource users. The community forestry programme is a useful step in this direction.

5. improving forest productivity by reinstating methods for spreading demand over a larger area. Where this improvement is insufficient owing to an absolute limit on yields imposed by the degraded condition of the forest, improved silvicultural practices can assist geographical control of harvesting in increasing productivity.

EFFECTS OF VEHICLE GENERATED AIR POLLUTION ON ROADSIDE SHRUBS IN THE KATHMANDU CITY

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ABSTRACT

Kathmandu the, capital of Nepal, is in a basin-shaped valley and is poorly ventilated. Streets are narrow, damaged and dusty, with heavy vehicular traffic. Air pollution due to dust particles and engine exhaust fumes is very common in the city and has adverse effect on the environment as well as on humans and, animal and plant life.

For the observation of impacts of air pollutants on the roadside plants, Kalanki-Thankot, Balkhu-Kalimati and Sat Dobato-Jawalakhel were selected as polluted areas in the city. Kirtipur, well away from the city was selected as the control point for comparison. Four species *Eupatorium adenophorum, Duranta repens, Lantana camara* and *Sambucus hookeri* - were selected from the roadside vegetation to observe the effects of air pollution.

Visible injuries like chlorosis, necrosis, leaf cutting, defoliation and dust particle deposits were present on the plants from polluted sites. Tolerance of the species was graded according to pigment level, germination percentage and other parameters. Pigment level and germination percentage were highest at the polluted sites on most of the tolerant species. *Eupatorium adenophorum* was found to be the most tolerant species, them *Sambucus hookeri, Lantana camara,* and *Duranta repens* in that order.

PROBLEM

The Kathmandu valley lies almost at the centre of Nepal. It is almost entirely sumounded by mountains, and has much flat land which is dusty, streets jammed with heavy vehicular traffic and large numbers of improperly planned industries. Air pollution is very common in the city and is seldom dispersed.

Most plants are sensitive to air pollution, which affects the photosynthetic capacity, retards growth, decreases yield etc. Accumulation of toxic substances in the biosphere is causing serious changes in the structure and function of natural ecosystems. In forest areas, trees are damaged first by low doses of pollutants in the atmosphere. As exposure to pollutants increases tall shrubs are the endanger, destroyed followed in order by lower shrubs, herbs, mosses and lichens.

There are various causes of air pollution, particularly motor vehicles exhausts, industrial emissions, either dusts from various sources, fuel burning etc. Pollutants are emitted into the atmosphere as suspended particles (dusts, lead etc. or gases and foul adores smoke, sulphur dioxide, carbon monoxides, oxides of nitrogen, hydrocarbons, etc.). Physiologically dust particles clog stomatal apertures and inhibits gas exchange by leaves, so when dust completely smother a leaf pose difficult situation for plant. Air-borne chemical dust around factories in humid weather proves highly deterious to plant life. Deposition of such particles on moist leaves can result in annular chlorotic (yellow) patches or bleached patches on laminar surface.

Since plants are stationary they are continuously exposed to air pollution; therefore the injury to plants is proportional to the intensity of air pollution. However plant species and varieties show stricking variation in their sensitivity to air pollutants and most plants are relatively tolerant and are only injured by very severe alr pollution episodes.

OBJECTIVES

Objectives of the present study were to:

1. survey and enumerate the roadside shrubs in the study area;
2. determine the state of different sources of air pollution; and
3. observe the effects of air pollution on roadside shrubs.

METHODOLOGY

The effects of air pollution on plants were observed on the basis of comparative study between the plants of greater polluted area and lesser polluted area. Three areas - Kalanki to Thankot, Sat Dobato to Jawalakhel and Kalimati to Balkhu, within the Kathmandu city are taken into account for the pollution study. Tribhuvan University campus at Kirtipur, which is far from the city was taken as an unpolluted area for comparison purposes.

The following four shrub species common in all the areas were selected for the study:

(a) *Eupatorium adenophorum* Spreng.

(b) *Duranta repens* L.

(c) *Lantana camara* L.

(d) *Sambucus hookeri* Rechder.

Various morphological, physiological, anatomical etc. parameters were taken into account. For each parameter five different samples of plants of each species were taken except for the chlorophyll test, for which three different samples of plants of each species were taken. Altogether, from the four sites 80 different samples of plants were taken for observation or testing.

FINDINGS

1. *Lantana camara* plants had hairy and rough leaf surfaces, which are excellent dust collectors.

2. Chlorotic and necrotic lesionsthe to air pollutants developed on leaves of all four plant leaves due to air pollutants.

3. *Eupatorium adenophorum* was the most tolerant of the four species studied. Total chlorophyll, chlorophyll a, chlorophyll b, carotene and germination percentage was high in plants from the polluted areas than in the controls.

4. *Sambucus hookeri* was the second most tolerant species. Total chlorophyll, chlorophyll a, chlorophyll b, and carotene level were similar in polluted and non-polluted (cannot) sites, out germination percentage was high are for the polluted areas.

5. *Lantana camara* was the third most tolerant species. Total chlorophyll and chlorophyll a were higher at the polluted environment, but chlorophyll b, and carotene levels and germination percentage were lower at the polluted areas.

6. *Duranta repens* was the least tolerant of the four species. Total chlorophyll, chlorophyll a, chlorophyll b, carotene and germination percentage were all higher in the controls.

ECOLOGICAL AND FLORISTIC STUDIES ON SOME ADJOINING FORESTS OF CHANDRAGIRI

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ABSTRACT

The woody vegetation in hill forest adjoining the Chandragiri range in the Kathmandu valley was studied in relation to altitude, slope aspects and soil factors for a period of one year.

Representative areas of each forest type were selected for quadrat studies. Quadrats of size 20 m x 30 m were laid randomly, taking the size of the forest type into consideration. These were used to determine density, frequency, basal area, similarity index for the forest types, felling, and other wood utilisation of the most frequent species, along with the collection of soil samples. Only the trees, shrubs and woody vines were considered for taxonomical studies.

The floristic studies revealed the presence of 124 species (trees - 61, shrubs - 51, and woody vines - 12) belonging to 101 genera and 53 families. Rosaceae alone included as many as 12 species showing the apparent dominance of this family.

Within a range of over a thousand meters (1380 m to 2510 m) four distinct forest types were found, based on species composition. Slope aspects were important in forest type occurrence, which was also governed by soil behaviour. Human interference in the forests was found to be selective in relation to both forest types and plant species.

PROBLEM

Forest coverage of Nepal is distributed into its various geographical regions in both the hills and the Terai. Various forest ecosystems are surviving on the slopes of the Mahabharat and Churia (Siwalik) ranges as well as the higher mountain ranges, but all are also under continual attack by the local people.

The central part of the country, including the Kathmandu valley, has been considered to be a peeping window into the treasure of Nepalese flora. Being the capital, Kathmandu has become centre for extensive study site of nearby vegetation. The hills around Kathmandu valley show various forest types, ranging from *Schima-Castonopsis* to the *Quercus semecarpifolia* on Phulchoki, the highest peak of the valley (2715 m).

Nepal's forests are considered to be interesting ecological, phytogeographical and taxonomical study fields.The area for this study is located 10 km from the centre of the city on the Mahabharat range to the south-west part of Kathmandu valley. It is one of the extensions of Chandragiri range.

METHODOLOGY

The forest types were first empirically sorted out by thorough observations of slope aspects, and altitudes. In selection of representative areas special emphasis was given to less disturbed plots representing the forest types.

Representative areas of each forest type were selected for quadrat studies. Quadrats of size 20 m x 30 m were laid randomly. Taking the size of the forest type into consideration, two to five quadrats were laid for each forest type and were used to determine density, frequency, basal area, similarity index for the forest types, and other wood utilisation of most frequent species, along with the collection of soil samples.

The soil was collected separately from each forest type from the depth of the 15-20 cm of quadrat's surface laid for vegetational studies. From each of the quadrats 4 samples were collected independently and mixed together. It was bagged in polythene. The whole bulk of soil was divided into two parts, one of which was used to determine pH, moisture content, and water-holding capacity on the following day, and the another part for the determination of organic matter content and texture. Only the trees, shrubs and woody vines were considered for taxonomical studies.

FINDINGS

Within a range of over a thousand meters (1380 m to 2510 m) four distinct forest types were found based on species composition. On the lower range (lower limit 1380 m) *Schima-Castonopsis* forest occurred, succeeded by pine (lower limit 1520 m), *Quercus lanuginosa-Lyonia ovalifolia* (lower limit 1900 m) and *Rhododendron arboreum-Quercus semicarpifolia* (lower limit 2230 m). However slope aspects were also important in forest type occurrence. Pine forests were restricted to slopes facing south-east to south-west. It was also found that the forest type was also governed by soil behaviour along with the above mentioned factors. Soil types changed from loam to sandy loam (at the top) with altitude.

The similarity among the forest types were evidently a horizontal rather than a vertical. Diversity of species was greatest at the lower altitudes. Basal area coverage, which varied from forest to forest, was always linked to greater litter depth and organic matter content of the soil. On the basis of species, basal area and frequency estimations, *Rhododendron arboreum* exceeded all other recorded plants at species level, while on the basis of forest types, *Schima-Castonopsis* exceeded the other forest types. Other important plant species and relatively common were *Lyonia ovalifolia, Myrsine capitellata, Quercus glauca, Myrica esculenta* and

Schima wallichii in that order of frequency. Human interference in the forests were found to be selective in relation to both forest types and plant species.

The floristic studies revealed the presence of 124 species (trees - 61, shrubs - 51 and woody vines - 12) belonging to 101 genera and 53 families, of which 28 families were represented by only a single species. Rosaceae alone included as many as 12 species showing the apparent dominance of this family. However, tree species with high-density, basal area coverage and frequency governed the overall physiognomy of the forests.

MANAGEMENT OF NATURAL RESOURCES: AN ASSESSMENT OF THE FOREST CONSERVATION PROGRAMME CONDUCTED BY THE ANNAPURNA CONSERVATION AREA PROJECT IN GHANDRUK VDC, NEPAL

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ABSTRACT

In nature conservation, balancing human needs with conservation priorities has become a growing concern worldwide. In Nepal, the Annapurna Conservation Area Project (ACAP) was born under a new multiple-land-use concept with full local people participation. This study was initiated to make an assessment of the forest conservation programme conducted by ACAP. A stratified inventory was made to estimate the forest resources and their supply potentials. Forest resources use and demands pattern, management and people's perceptions about the program were assessed by a household survey and key informant interviews in three settlement zones (Chomrong, Ghandruk, and Besi) within Ghandruk VDC, the pilot project area of the ACAP.

At present, natural forests are the main suppliers of forest resources in all three zones. Supply of live fuelwood from both the natural and protected forests and timber from the protected forests was banned by the Forest Management Committee (FMC) in 1987; however grazing and fodder collection were not regulated. Although the fuelwood demand by tourist hotels and lodges was offset by the supply of subsidised kerosene by ACAP through tourist entry fees. It was still about 25% of the total fuel demand in Chomrong zone and about 10% in the two other zones. The system of forest protection has increased the time for collection of fuelwood, timber and fodder resources, thereby creating more hardship to the people and increasing the incentives to use more on-farm trees and crop residues for fuelwood and fodder. Alternative technologies such as solar heaters and electricity promoted by ACAP were helpful in reducing fuelwood demand, but their use was limited to the hotels and lodges because of higher investment costs.

Over 200,000 seedlings were distributed by ACAP between 1987 and 1993 under community and private plantation programmes. The most seedlings (59%) were planted by households on their private land. Community plantations were established on 20.2 hectares, distributed with 59% in Ghandruk, 27% in Besi, and 14% in Chomrong. Survival rate in private plantations (70%) was more than double of community plantations (29%). Interest in tree planting was not because of scarcity but because of a perceived need of conservation. In the future, income from plantations and from forest harvesting may well be determinant of economic sustainability.

The people of Ghandruk VDC displayed a very positive perception towards the conservation programme. Ownership feeling of forests was high. They anticipated improved living conditions, increased employment and income opportunities due to the conservation programme. The majority wanted the ACAP to continue rather than change to National Park status. However, local people also felt prepared to manage the area on their own, i.e. ACAP was perceived to be needed only for a few more years. Some problems in building up local technical forestry skills were observed, and this needs special attention by ACAP in the coming years.

The ACAP and the people of Ghandruk have shown remarkable achievement in forest conservation. Improving regeneration of desirable fodder and timber species and at the same time maintaining the large livestock populations sustainably is a major challenge for ecological management. Fuel supply problems in Besi zone should be relieved by alternative energy sources and granting special user rights in the adjacent VC forest, besides exploring other innovative measures for conservation and economic development.

PROBLEM

Various authors have documentated the sustainable management of forests in Nepal under traditional systems as a common property resource from early times. The ACAP recognises the importance of traditional and indigenous conservation practices. The Government's new policy of community forestry has been adopted by ACAP to enable local communities to participate in protection, law enforcement, management and use of forest resources in addition to other nature conservation activities.

In the past, when population density was less, there was a balance between man and nature. Over the last 30 years, however, extensive deforestation, overgrazing, population growth and impacts from tourism have led to depletion and unsustainable resource use in the Annapurna region. In the operational plan of the Annapurna Conservation Area (ACA) it is stated that since there is already pressure on natural resources from local population growth, the increasing tourism in the region is further compounding the problem.

There is a high degree of mutual dependence between tourism and nature conservation. For meeting the needs of local people and tourists, sound planning and management of the area are necessary. Without reliable data, environmental planning is not possible. There is an urgent need to determine the human and ecological resources base and its use pattern in order to develop a sustainable management system for the area.

METHODOLOGY

Both primary and secondary data were used to fulfil the objectives of this study. Primary data were collected during fieldwork through an inventory of forests and plantations, a household survey by questionnaire and key informant interviews. Secondary data sources were the 1:50000 scale LRMP (1984) land utilisation, land system and land capability maps; 1:125000 scale topographical maps; and 1:50000 scale VDC maps from the Topographical Survey Branch, Kathmandu. A detailed land resource use map of the study area was prepared with the help of these maps. Other secondary sources of data relating to Nepal and the study area in particular, in the form of official reports, books, journal articles, theses and dissertations

were extensively used.

The major independent variable in the analysis of the data was the delineation of the three zones. Simple percentage, mean, standard deviation, analysis of variance, t-tests and chi-squared tests were the major statistical tools used. Matrices were used in ranking of preferences.

A preliminary reconnaissance survey of the study area was conducted during September 1993. General information on location of villages, forest areas, socio-economy, and resource use was obtained from the VDC office and local residents. A pilot testing of the questionnaire was performed during this period. A field assistant with junior forestry education (I.Sc. in Forestry) was hired throughout the study period. A local forest guard was hired for the purpose of forest and plantation inventories.

Key informants were identified as persons who were knowledgeable about the forest resource. Members of Forest Management Committees (FMC) and local influential persons, forest watchmen, elderly men and women were selected as key informants. A total of three informants from each settlement zone were randomly selected from the household survey list and asked about their knowledge on traditional resources-use practices and perceived benefits of forest conservation; three forest committee members (whoever was available) from each zone were also separately asked for this information.

FINDINGS

Since the Government has not delegated any authority to the ACAP model, it lacks a legal base for developing regulations and management plans. For instance, regarding illegal cutting of trees, no institution except the Government is authorised to penalise offenders. Some respondents showed dissatisfaction towards the FMC or ACAP for not being able to inflict penalties. If this continues, it may adversely affect the attitudes and support of the local people.

The reconstitution of FMCs and the rules set by them regarding use of forest resources are conservative and restrictive, and members do not like to take into account the silvicultural requirements of the forests. For example, although then forests are protected against free felling, livestock grazing, and lopping, these remain serious problems for regeneration.

Deforestation nearby forests in Ghandruk VDC was induced by extra demand created by tourists, but this was not the sole reason for deforestation in this area. Present data indicate that in the whole VDC hotels and lodges serving tourists account for about 11% of the total demand for fuelwood. In Chomrong, the demand created by tourists is almost 25% of the total and in the other zone it is less than 10%. Although the threat of deforestation due to tourists has subsided since protection rules on use of wood came into force, the large livestock population is still a causal factor of deforestation.

Deforestation was manly confined to the areas close to the settlements, particularly in Besi zone. Statistical evidence also supports the notion that the protected forests in Besi are more degraded than in the other two zones.

In the past, forest resources were collected mainly from nearby forests (now protected), which thereby became more degraded than forests far from the settlements. Due to this, the occurrence of economically important fuelwood and timber species is less in the protected forests.

RECOMMENDATION

Focus should mainly be directed towards the management of the protected forests. Selective felling, lopping, cutting of regeneration and livestock grazing should be regulated in the protected forests as these practices are major causes of regeneration failure. Options are: to endure extra hardship and go further into the natural forest, for forest products and grazing to optimise the use of agricultural residues; to practice rotational grazing and fodder collection from specified patches of protected forests for a number of years until regeneration is established. Since the area of protected forest is large in Ghandruk and Chomrong zones, certain portions of the protected forest should be set aside specifically for livestock grazing and fodder production. Other options are indicated below.

Livestock, particularly goats, are dangerous for seedling establishment in plantations and forests and should be strictly controlled.

Improved breeds of livestock should be introduced for higher milk and meat production.

Rotational and controlled seasonal grazing and stall feeding so that the livestock population is maintained yet forest health is not affected are practices that should be encouraged by FMC and ACAP.

The supply and demand scenarios for fuelwood showed that under the present restrictions imposed by ACAP/FMC there were deficits in all three zones. Regarding timber, the supply was much higher than the demand.

The perceived advantages of forest conservation among local people was very high. A very positive indication was the emergence of a local sense of belongingness that is gradually replacing the lost sense of affiliation towards forests. The positive indicators of change due to conservation are very encouraging for the sustainability of the programme. Moreover, people expected a better standard of living in the future and self-sufficiency in the execution of the conservation programme. However, it was perceived as a drawback that ACAP was handing over management responsibilities of forests to the local people but little technical backup to manage them.

FEMALE PARTICIPATION IN FOREST RESOURCE MANAGEMENT A CASE STUDY OF A WOMEN'S FOREST COMMITTEE IN A NEPALESE VILLAGE

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ABSTRACT

This study to examined how women participated in a women's forest committee's activities and in the implementation of programs designed for the development and management of local forest resource in Nepal. Individual interviews as well as formal and infomal discussions with key informants, direct observations and secondary sources were used to collect data.The collected data were categorised and analysed on the basis of the major activities of the committee, i.e. the decision-making, implementation, benefit-sharing and evaluation phases of the committee's program be, as well as the factors which previous studies had identified as determinants of wowen's participation.

The study showed that the women committee were highly participatory in performing the committees, tasks successfully and that women's involvement in forest committees can definitely help solve the problem of deforestation in the country. What is needed is to allow the factors affecting women' participation to work in their favour. Various recommendations are made as to how the factors affecting women's participation in a forest committee can favour women's group. These recommendations are grouped into three categories: those which apply prior to forming the women's committee, those which apply once the committee is formed, and those which will help sustain the committee in future activities.

PROBLEM

Results of studies conducted in Nepal have shown that Nepalese women participate in activities related to forest resources, such as fuelwood and fodder collection, fetching water, farming, grazing animals and cooking, at least as much as men. These studies have also shown that as primary users of forest resources, Nepalese women can supervise the proper utilisation and conservation of forest resources at least as well as men. It seemed essential, therefore, that forestry programs should involve women from the earliest stages of project design through to the implementation and evaluation phases of the projects as well as give them responsibilities and the right of decision making in all these phases. Accordingly, in 1984 the + (CFDP) initiated the formation of a women's forest committee geared to involving women directly in the design and implementation of a forest resource management plan. Such a committee would be composed of a group of women who were either encouraged to participate by CFDP personnel or showed interest in organising themselves to afforest denuded areas and protect existing forest resources in their community.

The study attempted to find out low the establishment of the women's committee does in fact encourage women to participate actively in a forestry project. By highlighting women's forest-related activities and their implementation of the project, it is hoped to contribute to a better understanding of women's participation in a development project. It is also hoped that such an understanding will contribute to better planning and implementation of similar projects in the future.

OBJECTIVE

The objective of the study was to examine women's participation in the committee's activities and in the implementation of programs designed for the development and management of local forest resources.

METHODOLOGY

Data were collected through (1) individual interviews as well as formal and informal discussion with key informants; (2) observation of he local forestry situation the committee's activities and its working procedures; and (3) secondary data collection in the capital city, Kathmandu, and the regional headquarters of the western development region at Pokhara.

The key informants were of four kinds, namely: panchayat officials, local leaders, committee organisers and committee members. A total of 22 informants were interviewed-8 women committee members; 2 Panchyat officials; 2 group organisers, namely the District Forest Controller (DFC) and the Community Forestry Assistant (CFA) from the District Forest Office (DFO); and 10 other, including 2 forest guards and 8 local leaders.

Two types of data collection instruments were used : (1) a community-level information form to gather data on the physical environment of the site, and (2) an interview guide for key informants to collect information about the committee. The topics covered in an interview depended on the position and knowledge of the informant.

The collected data were first categorised on the basis of the major activities of the women's committee. The data were then analysed, following the definition of participation, i.e., the active involvement of women members in the decision making, implementation, benefit sharing, and evaluation phases of the committee's activities, as well as the factors which previous studies had identified as determinants of women's participation. Frequency and percentage distributions, maps and figures were used whenever appropriate to supplement the analysis.

FINDINGS

The women's committee was found to be highly participatory in performing its tasks successfully. Thus, women's involvement in forest committees can definitely help the Nepalese government to solve the problem of deforestation in the country. What is needed is to allow the factors affecting women's participation to work in their favour.

RECOMMENDATIONS

The recommendations are grouped into three categories, as follows: those which apply prior to forming the women's committee; those which apply once the committee is formed, and those which will help sustain the committee in future activities.

The following recommendations can be followed by the DFO personnel before they form a women's committee:

1. Committee organisers should first motivate the local leaders as well as women who are outspoken and show leadership qualities (except in places where women are capable of organising themselves as a group).

2. Because women tend to feel more confident in groups, the organisers should talk with small groups of women. This helps the women to gain confidence and permit organisers to appreciate the role and situation of women in the community.

3. Organisers should at first stress only the general benefits of forest protection and management. Stress on specific personal benefits should be avoided as this may frustrate committee members if these benefits do not materialise.

4. No major requirements should be expected from women who participate in a forest committee. At the same time, it should be made clear to the women that they can easily launch a forestry program as it deals with activities which are familiar to them.

The following recommendations can be followed once the women are motivated and proceed to form a committee:

5. The group organisers should first hold a meeting of DFO staff, the women interested to join the committee and leaders representing each user group in the community. This meeting should decide how to form the women's forest committee.

6. Women chosen as members of the committee should be selected by concerned villagers in the community. At the same time, only those who are interested should be chosen to join the committee.

7. It will be better if only a small committee is formed at the initial stage. As the committee's effectiveness increases, its size can also expand. In any case, the committee must have proper representation either by geographical location or by user groups in the community.

8. Since illiteracy is high among women, efforts should be made to recruit at least a few members who are literate, as these are necessary for the committee's administrative work. These women should be provided additional support (e.g. training) in this regard because administrative work will be an unfamiliar task to them.

9. The role of the committee needs to be written down in terms of the following: specific activities, the persons or agency responsible for performing each activity, the rights and authority of the committee, the mobilisation of resources, and the role of the committee members and user groups. At the same time, the roles of the DFO and its staff should be

to specify the types of services and assistance that it can provide to the committee.

10. The committee should be given a small area to cover in its initial stage. Once efficiency and effectiveness are achieved for the initial coverage, the program can expand its coverage.

These recommendations can be followed for sustaining committee activities in the future:

11. The committee members should meet at regular intervals so that communication gaps can be checked in time.

12. As the future of the committee depends on local participation, a mechanism should be developed to hold discussions with local people about the tasks, activities and the progress of the committee. Likewise, all major decisions should be made in the presence of the local people, subsequent to minimise community resistance to the committee's actions.

13. As there are several activities that require funds for their implementation, a mechanism should be developed to give the committee a regular source of income. This could be the done by collecting fees from people utilizing forest resources.

14. As many women are illiterate, and in experienced and are also a disadvantaged segment of society, they lack confidence in undertaking a new role. As such, they need support from all sides and at all levels. The DFC is important here, being in a position to motivate and encourage both the women's committee and the local people as well.

FUTURE RESEARCH

The thesis also suggests that more research be carried out to examine women's roles in forest committees, so that definite strategies can be formulated for broader application. The findings of this study confirm previous results. More research, however, would strengthen the present findings and lead to better recommendations for involving women in forest committees designed to protect and develop existing forest resources.

TREE GROWING ON PRIVATE LAND: A SUPPLEMENTARY APPROACH IN THE RURAL DEVELOPMENT FORESTRY PROGRAMMES IN NEPAL

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M.Sc. (1991)
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ABSTRACT

The ever-increasing demand for fuelwood, fodder, bedding material, leaf litter and constructional timber is depleting the forest renounce in Nepal. Community forestry programmes are being implemented in more than two thirds of the 75 districts, but the lack of active participation by the local people in the establishment and management of the community forests has hampered their development. Private planting of trees provides direct benefits to the individual farms. The rural people now realise the need to plant trees on their lands, so tree numbers on most farms have increased. To date farmers have not given due consideration to the management of marginal lands not used for agriculture. These lands need to be developed for the purpose of tree planting. Tree growing for the market should be encouraged where there is a demand for fuelwood and constructional timber. Multi-purpose trees should be more acceptable to the farmers, as they generally do not wish to grow single-purpose species. However it is essential to establish the farmers' needs. The involvement of farmer at all stages is vital for achieving success in private planting program, and a strong extension service can motivate the farmers to participate. Research work on multi-purpose trees which are especially appropriate to the small farmers needs to be done .

PROBLEMS

The ever-increasing population is exerting heavy pressure on the forests of Nepal. It has resulted in a decline in quality as well as quantity of the forests.

The Nepal Government has placed considerable emphasis on education about the deforestation problem, which has contributed so much to the country's environmental degradation since the late 1970s. The government forestry authorities have been unable to manage the country's forest resources properly owing to the lack of active participation of the local people. Realising this, the Government made amendments to the forestry legislation in 1978, which marked a significant change in national policy in that it made provisions for local communities to have responsibility for managing forests.

There are four different programmes under this community-oriented forestry policy. In 1980, the Community Forestry Development Project was initiated in 20 hill districts.

A study has showed that most of the hill farmers grow trees for fodder and fuelwood. Trees on private lands provide about half of the fodder requirements of the livestock. Tree planting in the Terai is mostly for commercial production of timber and fruit.

The private planting of tree farms or farm forests on the private land is attractive. Because the trees belong to individual farmers they would be responsible for maintaining and protecting the trees and forest as they become established. The Government would be received of most of the costs involvement in their management. As in other cases of private ownership, private land is more efficiently managed than that under public or common ownership, owing to the increased motivation of the people responsible for managing it.

This dissertation aims at investigating one of the possible supplementary approaches that can contribute to forestry development in general and to the benefit of small and marginal farmers in particular. The primary objective of the study was to encourage private planting to establish tree farms as one of the strategies of forestry activities for rural development. For creation of private tree farms, individual farmers can be motivated easily. The management of private forestry is far less problematic than that of any other forestry system.

METHODOLOGY

This dissertation is based mainly on a review of literature.

FINDINGS

Untile a few years ago rural people had easy access to forests and did not feel it necessary to grow trees on their farms, even though they need fuelwood, fodder, bedding materials and leaf litter every day. But, the present situation is different because of depletion of the forests and there is a growing interest among the rural people in planting trees on the farms. Every effort should be made by the Government to encourage private planting as it will not only meet the requirements for forest products but also provide extra income from selling those products where a market exists.

With strong extension services, people can be motivated to grow trees on their lands. The people are also realising the importance of trees on their farms.

The rural people are extending the cultivation of marginal lands and it has become necessary to stop this practice. These lands should be put under tree cover to reduce further degradation in the environment. Although subsistence farmers do realise the consequences of using such land for cultivation it will naturally be quite difficult to convince them because main concern is to grow food for their families. Promoting private planting on farms is a complex operation. Because it requires adequate understanding of the socio-economic conditions of farmers. The use of multipurpose trees can motivate to grow more trees on farms. Private planting may most benefit the big farmers, but it must also make small landholders better off.

RECOMMENDATIONS

Indigenous nitrogen-fixing multi-purpose trees, e.g. *Dalbergia sissoo, Acacia catechu, Albizia procera, A. lebbak, Alnus nepalensis, and Sesbania sesban* should be promoted for planting on private lands.

Only good quality seedlings should be distributed, so that survival chances are greater and people do not become disillusioned following failure.

The seedlings of multi-purpose fruit trees such as mango, lichee and lapsi (*Choreospondias auxillaries*) should be raised in greater numbers for distribution .

Research work on multi-purpose trees, both indigenous and exotic and including *Leucaena leucocephala* (which is becoming popular with the farmers) should be carried out regarding suitability of sites and silvicultural techniques such as propagation, coppicing, pruning, and pollarding.

Trials on bare-root planting should be carried out. A nominal fee for each seedling distributed would make the people more conscious of the need to take care of the seedlings.

Monitoring should be established in each district forest office. Feedback from farmers is crucial for such programmes.

More emphasis on social forestry subjects should be given in the curricula of the forestry institutions. The existing technical staff of the Forest Department should be provided with on-the-job training in this regard.

Publicity campaigns regarding tree tenure and subsidies on land tax (when trees are grown on private land) should be carried out, e.g. through Radio Nepal, to motivate people to grow more trees on their own lands.

The Forest Department should approach the agricultural development banks of Nepal to facilitate loans to farmers who wish to grow trees on their lands.

ESTABLISHMENT TECHNIQUES FOR BROAD LEAVED TREE SPECIES IN THE MIDDLE HILLS OF THE CENTRAL REGION OF NEPAL

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ABSTRACT

Broad leaved tree species can be established on poor or nutrient-deficient sites by applying site improvement measures. Three different site amelioration techniques for establishment of broad leaved species in the middle hills of Nepal were studied. The techniques were: fertiliser application, soil working and under-planting. The species used in the experiments were mainly important fodder and fuelwood trees which are suitable for the hills of Nepal. The species were *Brassaiopsis hainla, Ficus auriculata* (Syn. *F. roxburghii*), *F. neriifolia* (var. *nemoralis), F. Semicordata, Litsea cubeba* (syn. *L.* citrata), *Prunus cersoides* and *Sauruia nepaulensis.*

The results have shown significant differences in height growth of the trees after fertiliser application and soil working. The difference in mean height between trees grown with and without applied fertiliser was almost double in some years. Large differences were also found in soil working (pit-size experiments). The difference in height growth between the smallest pit size (15 cm^3) and the largest pit size (50 cm^3) was almost 300%; the difference between the normally used pit size (30 cm^3) and the largest pit size (50 cm^3) was only 60%. Only small differences in survival rates were found with both techniques. Planting broad leaved seedlings under pine also gave positive indications in terms of both survival and height.

From the results obtained it was concluded that fertilization at the time of planting enhances the establishment of broad leaved trees on poor sites. The pit size for planting broadleaved trees must be at least 45 cm^3, or 30 cm × 45 cm × 45 cm in the middle hills. Observation plots to study under-planting of broad leaved trees under pine plantations should be setup in hill-districts.

PROBLEMS

This study was mainly concerned with plantation establishment in the middle hills in the Central Development Region of Nepal, but the problems and constraints of plantation establishment in all physiographic regions are similar. The trials were in response to problems identified by the community Forestry Development Project Conference in 1984.

There is an urgent need for information on nursery and plantation establishment techniques for broad leaved tree species suited to the middle hills region. Research priorities identified were:

1) problems facing practising field foresters.

2) that the techniques developed for solving these problems take account of the constraints imposed by conditions (physiography, soils, climate, erosion and socio-economic conditions of the local people) prevailing in the middle hills.

It has been identified that the following are the most important plantation establishment problems that require research:

- the need to re-evaluate the present planting methods - type of planting tools, the need for pits (planting holes) and how and when these should be prepared;
- bare-root planting problems; and
- protection of plantations from grazing, browsing, fire and cutting.

The most important technical constraint on plantation establishment in the middle hills is site availability and its quality (soils, physiography, climate, erosion). The socio-economic condition of local people is also important.

Lack of good nursery technique and a proper system for collection and storage of seeds, means that most broad-leaved species are difficult to raise. The first problem is to find a good seed tree, especially with fodder species because of severe lopping of these trees and of the fact that many do not set seed or seed very poorly. There is a problem of germination with most of broadleaved tree species, mainly because of lack of trained nursery workers.

OBJECTIVES

The main objective of the trials was to evaluate establishment techniques for broad leaved fodder and fuelwood tree species in a marginal site of the middle hills. Other objectives were:

- to investigate the effect of fertiliser application at the time of planting on survival and growth of the trees;
- to investigate the effects of pine shelter and fertilizer application at the time of planting on survival and growth of the trees.

METHODOLOGY

Short-period trials were set-up using the following four different techniques of tree establishment:

1) fertilizer amelioration (application of fertiliser);
2) under-planting with fertiliser (Pine and fertilizer amelioration);
3) under-planting without fertiliser; and
4) soil working (various pit sizes).

Fertiliser Amelioration

In these trials an inorganic fertiliser containing equal parts of N&P or a compost fertiliser (farm manure) were applied to seedlings. Two rates of complexol, 25g and 50g, and one rate of compost fertiliser were applied The species used were *Ficus neriifolia* and *Prunus cerasoides.*

Under-planting with Fertiliser Technique

In 1985 some demonstration and observation trial plots with pine and fertiliser amelioration techniques were planted at different altitudes and on different soil types in Sindhupalchok, a target district of the Nepal-Australian Forestry Project.

Under-planting without Fertiliser

In this technique, seedlings were planted also under established pine;. In 1985, one demonstration/observation plot was planted under *Pinus roxburghii* planted in 1981 at Tistung. The main species planted were *Ficus* spp. *Litsea cubeba* and *Prunus cerasoides*.

The trial was planted in two blocks, 12 trees line plot planted along the contour.

Soil Working

The standard pit size for afforestation in the hills is 30 × 30 × 30 cm but sometimes 30 cm × 45 cm × 45 cm is also used. In this trial, four different pit sizes were used, viz. (1) 15 cm × 15 cm × 15 cm, (2) 30 cm × 30 cm × 30 cm, (3) 30 cm × 45 cm × 45 cm and (4) 50 cm × 50 cm × 50 cm. A hardy species, *Prunus cerasoides,* was selected for this trial.

FINDINGS

The following findings can be drawn from the experiments.

Since low fertility is a common characteristic of the lands available for afforestation, fertilisation appears to offer possibilities of improving tree growth and survival rates.

Under-planted experimental and observation plots have shown better survival rates than for trees planted on open land.

Since thousands of hectares of pine plantations have been established in the middle hills of Nepal, there is an opportunity now to establish broadleaved species on these sites by under-planting.

RECOMMENDATIONS

Application of fertiliser should be given least priority among the other establishment techniques such as pit size and underplanting techniques. If fertiliser is applied at the time of planting clean weeding should be done at the same time.

Further research is necessary to investigate the appropriate age class of pine for underplanting and canopy opening. Also, suitable species for the consequent microclimates should be evaluated so that mixed forests of conifer and broadleaves can be established to meet the people's needs for all types of tree products.

The Forest Department should carry out some under-planting in pine plantations when thinning has to be done.

Since the depth of planting had a highly significant effect on height growth in the early stages, the planting pit size should be at least 30 × 45 × 45 cm. From the results of the pit size experiments, it can be concluded that broad-leaved species planting should not be targeted towards planting large areas but should aim at maximum success establishment of smaller plantations. Therefore a high degree of supervision should be provided at the time of pit digging and planting.

Further research should take into account the practical problems facing field foresters and the technical and socio-economic constraints prevailing in the middle hills.

A SOCIOLOGICAL STUDY OF BIODIVERSITY CONSERVATION: PERCEPTION, ATTITUDE AND PRACTICES AMONG SELECTED FOREST USER GROUPS IN KABHRE PALANCHOK DISTRICT

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ABSTRACT

This study aimed to gain better understanding of the Forest User Groups who are the main actors in the community forestry program in Nepal. The study, focused on the perceptions and attitudes of FUGs regarding biodiversity conservation, explored the practices of the FUGs which influence biodiversity conservation in their community forests. It also compared tree species diversity between community forests and national forests, and tried to assess the implications of the presence or absence of FUGs, as a social organisation. The study compiled information from seven case-study sites, including two national forests without FUGs and five community forests. Both primary and secondary data were collected by using participatory techniques, questionnaires and reviewing available records and literature.

The perceptions and attitudes of the FUGs towards biodiversity conservation were analysed for their interest and practice in favoring high numbers of both flora and fauna species in their community forests. All the FUGs were found to be positive and highly motivated to increase the number of plant species. FUGs having a single-species forest of pine were attempting to change the composition of their forest to include broad-leaved species. There were also attempts to conserve the faunal diversity in their community forests.

FUG practices which directly influence biodiversity conservation in community forests were identified. These are: protection, management and utilisation of forests, plantation activities and change in the use of forest land. Except for the change in the use of forest land, the practices were found to have positive effects on flora diversity and, therefore, a positive influence on overall biodiversity conservation in community forestry. How positive the effects are however, is directly related to the institutional competence of the FUGs.

The comparative assessment of tree species diversity between community forest and national forest, clearly showed that the FUGs have increased tree species diversity by more than three times since the forests were handed over to them as community forest. On the other hand, one cannot be optimistic about conserving biodiversity in national forests, where tree species diversity has not increased and the forest condition is deteriorating. It can be concluded from this study that the FUGs offer a durable and institutionally capable social organisation for biodiversity conservation in the Mid Hills of Nepal.

PROBLEMS

One of the significant processes responsible for the loss of biodiversity in Nepal is believed to be the excessive deforestation or degradation of forest in recent decades. This represents a big challenge for the conservation of biodiversity in Nepal. A study in eastern region has suggested that active management of community forests by user groups is likely to lead to an increase in biodiversity. This needs further exploration.

The Community Forestry Programme has been recognised as a major strategy for the development and management of forest resources of Nepal. However, despite the vital significance of biodiversity conservation for human existence, the Program does not encompass biodiversity conservation within its objectives. Some studies have shown that there is a tremendous potential for biodiversity conservation in community forestry outside the protected area network system. Some technical aspects of biodiversity conservation in community forestry have already been explored, however, the sociological aspects have so far not been studied. So this study aimed at understanding the attitudes, perceptions, practices and influences of FUGs, as social organisations on biodiversity conservation. The study also explored the status of tree species diversity in national and community forests to compare the situation in the absence and presence of such organised community groups.

At present, some of the questions which need to be answered are:

- What does biodiversity mean to the community ?
- How important is biodiversity for the community ?
- How does the community influence biodiversity conservation ?
- What changes in biodiversity result from handing over a forest to the community as community forest ?
- What are the underlying causes for the changes and what are their impacts on biodiversity conservation in general ?

OBJECTIVES

The study's objectives were:

1) to duscover the perceptions and attitudes of Forest User Groups towards biodiversity conservation in their community forests;
2) to explore the practices and influence of the Forest User Groups regarding biodiversity conservation in community forest and in national forest;
3) to assess the diversity of tree species in the community forests and in national forests investigated.

METHODOLOGY

Kabhre Palanchok District was chosen for this study because it was one of the pioneer districts for initiating community forestry programme in Nepal, and the researcher himself was familiar with the FUGs in the district.

Seven study sites were selected in consultation with the field staff of the Kabhre Palanchok District Forest Office. Of these, five were community forests and two were national forests. The national forest sites were selected with a view to comparing the status of biodiversity in the absence of a social organisation similar to that of the community forests.

Both primary and secondary data were collected for the study.

The questionnaire prepared by Biodiversity Profile Project for Nepal was used, with some changes, to collect basic information for this research. The questionnaire was mostly responded to by previous and present chairmen or secretaries of the FUGs.

Key informant interviews were basically carried out to collect more information on perceptions, attitudes and practices regarding biodiversity conservation in the community forests. A check list was prepared for these interviews. Elderly members of society, forest watchers, women and some members of the FUGs were identified as key informants for the interviews.

The forests were visited to directly observe the regeneration tree species richness, structure, composition and forest condition.

Secondary data sources were records at the District Forest Office, Kabhre Palanchok, the operational plans, the constitutions, and records of the FUGs, and also the relevant literature in form of reports available for forestry and other projects and other published or unpublished material. Both qualitative and quantitative indicators were predetermined for each objective.

FINDINGS

The FUGs have been contributing towards biodiversity conservation in their community forests through enhancing the species diversity in order to derive a greater variety of forest products. They are also capable of providing adequate protection to the wildlife in their community forests. It is worth mentioning that, Gaukhureswor FUG has allocated an undisturbed area specially to provide habitat for deer in their forest.

In case of a community forest, whatever is achieved in forest condition and thereby in species diversity can be attributed to the presence of an authorised and responsible local organisation as a FUG. Thus was found to be a viable and dynamic social organisation that could be trusted for conserving biodiversity in its community forest. In the case of national forest, the resources are under heavy pressure from the local people and have no responsible local institutions yet. Hence the national forests are degrading day by day from the biodiversity conservation point of view.

The FUGs were very conscious of the necessity for protecton measures to conserve the forest resources. They had already adopted protection systems which were found to be effective and sustainable. The national forests had not been adequately protected and the forest condition

was found to be poor.

Management operations were found to be enhancing the tree species diversity in the community forest mainly through natural regeneration. This had been also broadening forest products supplies, a further incentive for managing the community forest in this way.

The FUGs have also been undertaking plantation activity in order to introduce desirable plant species in addition to the ones already growing and to occupy open spaces in their forest. This activity has a positive impact on biodiversity conservation within the community forest through rectification of species composition.

Permanent change from forest to another land-use would have negative impacts on biodiversity conservation.

Regarding the species diversity, community forests and national forests had significant differences. The community forests contained from 21 to 35 tree species while the national forests had from 3 to 13 species only.

CONSERVATION FOR SURVIVAL: A CONSERVATION STRATEGY FOR RESOURCE SELF-SUFFICIENCY IN THE KHUMBU OF NEPAL

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ABSTRACT

The purpose of this study was to develop a strategy for resource self-sufficiency and nature conservation in the Khumbu region of Nepal, and particularly to ensure the prudent management and conservation of the Sagarmatha National Park so that not only the flora and fauna but also the indigenous human population may continue to live in harmony with their environment.

The study examined the historical perspectives of land use, current management strategies for the Park, a theoretical supply and demand assessment of land and labour resources, and prospective problems and opportunities. The methods used in the study includes a review of the published literature and unpublished research articles, internal reports, personal communications with persons knowledgeable in the study area and the author's own observations and experiences.

The study indicated that the Sherpas' spiritual commitment to a system of social and community control of resource management for sustainable use has been disrupted by internal and external political, social and economic factors. Traditional practices of land resource management are no longer in operation in the villages most affected by tourism. But despite the changes that tourism has brought about, Sherpas maintain a strong identification with their culture and religion.

National and international aid agencies are offering strong technical support and solutions for ameliorating the fuelwood crisis and environmental degradation in the Khumbu. However, a broader perspective is required to really solve fuelwood and food shortages; for example, the existing socio-economic realities should be incorporated into project planning. The main problems in achieving sustainable development in the Khumbu region seem to have stemmed from gaps in government legislation and lack of co-ordination between government, aid agencies and local people.

It is recommended that a workable strategy be developed to confront the prevailing problems by increasing productivity of land and labour resources without destroying any aspect of the environment. An informed local body should be set up to co-ordinate development and conservation projects and programmes.

PROBLEM

Deforestation is a serious problem in Nepal, and the Khumbu region is no exception. Since the advent of tourism in the early 1960s, the demand for firewood has increased dramatically. The Sherpas' continued use of timber for house construction and fuel wood for cooking was also contributed to the depletion of once widespread forests. During the lifetime of some of the older villagers the slopes around the villages provided abundant firewood but they are

now either bare or covered by scrub vegetation. Only remnants of the original forests still stand near monasteries in the main villages and in less accessible areas.

The forests close to heavily travelled trails continue to be used as sources of fuelwood. There are signs of erosion resulting from excessive wood-cutting, grazing and trampling. Regeneration of forests is slow due to the high altitude, the cold climate and livestock grazing on the new growth. The traditional methods of cooking and heating are extremely wasteful. An effective way to address the energy problem is required.

The growing recognition of energy conservation and substitution measures to replace fuelwood supply problems needs, however, to be understood in a broader perspective. The Khumbu region is fortunate to have vast natural and cultural resources which could continue to attract tourists and provide supplementary income for the local people and foreign exchange to the nation. However, this depends on proper management of tourism.

A workable strategy to satisfy basic needs must be developed and suitable alternative ways of increasing food, fodder, and labour productivity introduced. Prior to this study, no systematic attempt has been made to develop an overall strategy for confronting the prevailing problems with sensitivity to social, cultural and organisational differences.

METHODOLOGY

The study based of three kinds of sources of information to develop a strategy for resource self-sufficiency and nature conservation in Sagarmatha National Park. Information from anthropological studies, mountaineering books and related publications formed the basis for studying the cultural and historical perspectives of land use.

A review of relevant literature was compiled to determine the present management strategies of the Park and conservation efforts of the Government. Review of the literature was been approached from a number of directions: computer research of literature, personal correspondence, international conventions relating to National Parks, Sagarmatha National Park bibliography, international journals and periodicals.

The calculations for supply and demand of land resources for forestry and grazing land are based on a number of studies undertaken by various workes.

FINDINGS

Conservation of watersheds, soil, forests, and the traditions and cultural identity of the Sherpa people is not only a worthy principle, but is vital to the life-support system of the Khumbu region. There are sound economic and social reasons to protect these resources for future benefit.

The study indicated that the Sherpa's spiritual commitment to a system of social and community control of resource management for sustainable use is disrupted by internal and external political, social and economic factors. The traditional practices of land resource management have broken down in the villages most affected by tourism. However, despite all the changes brought about by this industry, Sherpas have maintained a strong identification with their culture and religion and as only a small percentage of the Khumbu people have

specialised in tourism, their future economic options are still open. However, their options will depend on the patterns of national and international assistance that flows into the region.

There is growing recognition of the fuelwood problem, but a broader perspective is needed to achieve resource self-sufficiency in the region. A committee should be formed at the local level to co-ordinate all development projects in the context of total resource use patterns and to make the funding organisations aware of the problems and prospects.

There is strong local support for reforestation programmes; however, the present technologies to replace fuelwood should be examined in the context of local needs. Local people must be made more aware of the fuelwood crisis through conservation education; it is important that they feel the need for these technologies and that they have the skill and financial resources to absorb them in the long run.

RECOMMENDATIONS

1) In the interests of reducing the pressure on the Khumbu forests, existing stoves should be improved, backboiler heating systems should be introduced, insulation should be encouraged in new buildings, and fuelwood use in activities such as festivities should be reduced.

2) A workable strategy to deal with the problem of long-term energy needs in the Khumbu region should be formulated with the close co-operation of the existing Park Advisory Committee and the funding agencies.

3) Park authorities should not consider any alternative energy projects without assessing environmental and social benefits and costs.

4) Park authorities should develope maximum responsibility for forest management to the local inhabitants.

5) Sagarmatha National Park, while maintaining the present reforestation programme, should seriously consider replanting the Park corridor area between Lukla and Namche.

6) An active environmental education programme should be launched. The strategy for resource self-sufficiency and nature conservation can only be achieved by making people aware of the problems.

7) The potential of the local Park Advisory Committee and honorary forest guards should be recognised and strengthened.

8) A grazing management plan should be formulated and implemented. Since livestock products play a vital role in the diet of the people and provide some income for the farmers, action should be taken to improve animal food supplies and animal productivity. It is strongly recommended that pastureland be managed by a rotational grazing method.

9) The Department of Tourism and other sectors involved in tourism should promote off-peak season tourism in Nepal.

10) Sagarmatha National Park should be designated as a "unique tourist area" for trekking and mountaineering visitors only.

11) The Park authorities should promote alternate viewpoints and tourist routes such as Gokyo Ri to the popular Kalopathar route in order to reduce seasonal overcrowding.

12) Larger scale tourism development should only be undertaken in combination with rational management of renewable natural resources in the region.

13) Research should contribute to the management of specific Park problems. Therefore, research topics should originate from the Park management and planning perspectives, with problems in need of investigation being given priority.

14) The National Park designation should reconsider the inclusion of both permanent and seasonally occupied villages in the Park.

15) High priority should be given to research directed toward establishing the physical and social carrying capacity of the Park with regard to tourism.

16) A Khumbu region co-ordinating committee for development should be established.

17) Park authorities should seek to co-ordinate Park management planning with other departmental agencies, and district and local authorities so that Park management plans can be integrated with other plans for it and the surrounding areas.

18) A strategy aimed at meeting basic needs should be promoted to generate income among poor farmers and thus enable them to buy essential goods and services.

19) The government should provide assistance in the development of small-scale cottage industries based on traditional crafts and skills.

EVALUATION OF A PRIVATE BLOCK PLANTATION PROGRAMME IN MID-HILLS OF EASTERN NEPAL: A CASE STUDY OF PAKHRIBAS AGRICULTURAL CENTRE, DHANKUTA DISTRICT, EASTERN NEPAL

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ABSTRACT

The rapid population growth throughout the middle hills of eastern Nepal has resulted in increased competition for scarce resources, fragmentation of landholdings and the gradual, inevitable erosion of fragile but previously sustainable hill farming systems. Tree planting on private land is widely recognised as an important component of rural resources management and also contributes toward solving many of the interrelated problems of production and conservation of the troubled land use system in the mid-hills of Eastern Nepal.

This report provides a evaluation of private block plantations in five villages covered by Pakhribas Agricultural Centre (PAC) in Dhankuta district. The PAC has placed great emphasis on its private block plantations programme and from 1979 to 1987 distributed more than 300000 seedlings and established more than 1000 fodder and fuelwood blocks on private farmland. The programme ended in 1988 and PAC objectives changed from extension to concentrate to research work. In 1988 the PAC carried out an evaluation of private block plantations with the main aim of finding the degree of failure of trees, the choice of species by different ethnic groups and the natural regeneration of tree species.

The results showed that 42% of the sample farmers had tree survival rates between 75 and 100%, 39% had rates between 50 and 75%. 17% had rates between 25 and 50% and only 2% were below the 25% level. The analysis of results shows that there were highly significant differences between: (a) the average survival rate of trees by age; (b) the total numbers of trees planted and treess surviving, with respect to ethnic groups; and (c) the survival rates of different tree species. Based on the number of seedlings distributed the ten species most preferred by the sample farmers are: *Alnus nepalensis, Ficus auriculata, Sapindus mukorossi, Pinus roxburghii, Ficus semicordata, Dalbergia sissoo, Juglans regia, Pinus wallichiana, Saurauia nepaulensis* and *Ficus lacor.* Among the 43 different types of fodder and fuelwood species distributed, the Brahmin ethnic group planted the most (37) species while the fewest (7) species were planted by the occupational caste and ethnic groups. Livestock and insect damage were often seen as the major problem in private block plantations. Altogether 30 different species were naturally regenerated in private block plantations.

In the light of these findings possible reasons for tree mortality are discussed and possibilities for future improvements in private tree planting programmes in the middle hills of eastern Nepal are suggested.

PROBLEM

Forestry plays an important role in the daily life of Nepalese people, particularly in rural areas. The importance of trees in maintaining the farming system has been widely recognised, and more recently the tree component has emerged as a primary focus for rural development efforts. The main source of energy for rural people is firewood, which meets 87% of the country's total annual energy consumption. Fodder is the second most important forest product used by the villagers. Most families own some livestock, and 75% of the fodder comes from natural forests, trees on the farmland and grassland.

The ever-increasing population is exerting a heavy pressure on the forests of Nepal; this has resulted in a decline in the quality as well as the quantity of the forests.

More land is being put under cultivation as the population pressure increases, and this will further affect the grazing fodder resources. Due to the high intensity of grazing the grasslands have become badly degraded. The manure which a farmer could have received from his animals if kept under stall-feeding conditions, is being lost, which has a further adverse effect on the productivity of farmland.

In the middle hills large tracts of natural vegetation that once protected the steep slopes from monsoonal rain have gradually disappeared as subsistence farmers have cleared the forests to obtain fodder, fuelwood, timber, and land for cultivation. The plight of these Nepalese hill farmers is similar to that of many rural communities around the world i.e. a declining forest resource coupled with smaller farms has led to more intensive and unsustainable agricultural practices which in turn have resulted in lower soil fertility and degraded land.

The Master Plan for the Forestry Sector (1986-2010) places considerable stress upon the encouragement of private tree planting, this being one of the four main components of the community and private forestry programme.

There are many projects attempting to involve the local people in community forestry activities, but very little emphasis has been placed on private tree-planting programmes. PAC is one the very few projects which have emphasised a private tree-planting in a relatively well structured manner. The methods and approaches the PAC has chosen to promote its private tree-planting programme involve more than just distribution of seedlings. The process includes raising and distribution of seedlings in accordance with farmers' preferences; planting of fodder and fuelwood blocks on land that would otherwise be unproductive; and the continued monitoring

of the program. A nominal charge system for tree seedlings was introduced by PAC, so that farmers would take only the necessary number of seedlings for planting and prevent the misuse of seedlings.

OBJECTIVE

This dissertation examines the results of a private block plantations scheme carried out on farms of the eastern hills of Nepal between 1979 and 1987. The main aim of the study was to identify future improvements in this private tree-planting program. The specific objectives within this study were to:

- determine the survival rate of tree seedlings planted by farmers in their plantations;
- identify the reasons for seedling mortality;
- find the number of species naturally regenerating in the block plantation;
- discuss extension and research implications with respect to the tree-planting program and make recommendations for improvements.

METHODOLOGY

An evaluation of private block plantation was carried out in five Village Development Committees (VDCs) of the local target area of PAC. The sample frame was drawn by listing the names of all farmers who had participated in the private block plantation program from 1979 to 1987. One hundred and seventy-four farmers were randomly selected from the five VDCs, representing 17.4% of the total block plantations.

A detailed inventory was carried out in each forest block established by the sample farmers. The quantitative method used for statistical analysis included comparative study between the total number of tree seedlings originally planted by individual farmers and the total number of tree seedlings surviving by age, ethnic groups and individual species. The tree seedlings originating from natural regeneration in the forest blocks were counted. The reasons given by individual farmers for seedling mortality were recorded during the survey.

FINDINGS

The survival rate of seedling is considered to be one of the most important indicators of success in any tree-planting program. The analysis of the survival rate by age by farmers, by ethnic groups and by individual tree species shows that there are differences in all cases. In general survival rate increased with age. Over 80% of the farmers sampled had tree survival rates in excess of 50% and half of those exceeded 75%; 17% had between 25 and 50% survival and only 2% were below the 25% level. Analysis of survival rate by ethnic groups showed significant differences among them.

Brahmin and Chhetri planted 55.8% of the total seedlings distributed to the sample farmers and another 43.8% were planted by five other ethnic groups - Rai, Limbu, Tamang, Newar and Magar. Only 0.4% were planted by the occupational caste/ethnic group. The greatest choice of species was found in the Brahmin and Chhetri groups and the smallest choice in occupational caste/ethnic group.

In the private block evaluation survey the farmers frequently mentioned that damaged by livestock was the major reason for failure of trees planted. Mortality due to pests and disease requires further investigation and research, this being an area which has received very little attention in Nepal. Mortality due to drought or damage from frost could be reduced in a number of ways, including identifying species resistant to such conditions.

Thirty different species regenerated naturally in the private block plantations. Most of the species so regenerating were those used in the planted blocks.

RECOMMENDATIONS

On the basis of this study the following recommendations are made to improve tree planting private on farmland:

1) Intensive research should be undertaken into different tree species and varieties growing in different ecological zones. The knowledge articulated by the farmers in these matters species variation should be taken into account in developing appropriate research strategies for fodder and fuelwood production.

2) The literature review from many countries showed that emphasis on private tree planting can be increased by extension efforts combined with demonstration plots for the farmers. A few successful and highly visible demonstration plots on the land of progressive farmers should be set-up to help to improve tree planting, possible methods of protection, and management of trees on farmland.

3) Effective participation of farmers at all stages of programme formulation and implementation should be encouraged.

4) Time-of-planting trials with appropriate species should be carried out to find which species are suitable for planting before or after the monsoon, so that a planting time convenient to the farmers can be matched with tree species that will establish successfully.

5) Research into winter planting and species establishment by site amelioration should be carried out to identify frost-resistant species and methods of establishing fodder and fuelwood tree species on harsh sites.

6) Research on pests and diseases should be carried out to identify the causes and types of damage and to provide control measures for the farmers.

7) An effective extension programme should be instituted in order to improve seedling survival rates and address the problems of unsuitable sites and improper methods of establishment.

8) Ethnic and occupational/caste groups which are not participating in the private tree planting program should be motivated and educated to encourage them to do so on their farmland.

9) To investigate levels and diversity of natural regeneration within the plantations, an extensive series of experimental plots and necessary control plots should be set-up.

10) Villagers are far more likely to grow trees on their land if they do not adversely affect their crop production. Research emphasis should thus be given to species that provide many products and improve soil fertility.

11) Staff of extension agencies should be well aware of the private forest legislation and should emphasise its provisions to the farmers to avoid confusion about both land and tree tenure.

12) Finally, regular follow-up and technical assistance should be provided for farmers who have planted trees on their farmland.

THE PROSPECTS OF AGROFORESTRY IN NEPAL WITH SPECIFIC REFERENCE TO THE TERAI REGION

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ABSTRACT

Nepal is a small land locked Himalayan country whose economy is based on agriculture production. More than 90% of the population depend on agriculture for their livelihood. The lowland Terai region of the country is well known for its productive agricultural land and tropical/subtropical hardwood forest. However the severe devastation of Nepal's forests over the last three decades has been relatively pronounced in the Terai region.

The rising population, shortage of forest produce and small land holdings have led to the search for sustainable land-use systems. In the study reported here, it is suggested that there is great potential for agroforestry systems in diversified land use, including social forestry, aimed at providing the basic requirements, and hence enhancing the living standards, of the rural people of the region. Experience with large-scale agroforestry activities in a few places in the Terai demonstrate the value of agroforestry for cheap and successful plantation establishment as well as for the production of food and other basic requirements. Similar viable agroforestry initiatives have been developed in small-scale community and taungya plantations at district level.

By devoting some effort to agroforestry, the rural people in the Terai can achieve better crop diversification. Possible benefits are the production of forest produce outside the forest and of food inside the forest, hence providing new possibilities for trade and for small cottage industries. Agroforestry has potential in social forestry to improve the socio-economic level of the people. However, there are some constraints which affect the adoption of the systems. These have been scrutinised and solutions have been recommended.

PROBLEM

In many developing countries trees and shrubs play a vital role in the daily life of the rural poor by providing wood, food, fodder, firewood, etc. Agroforestry being a combination of trees and food production, can therefore, contribute to meeting many of the basic needs of the rural population, specially in Third World countries such as Nepal, so reducing the further deterioration of existing forests.

Tree-planting programs are most effective and most likely to be adopted if local people are involved in the planning and implementation and perceive their own interest in success of the program and if use to made of their existing knowledge and skill. Social forestry is one approach to ensure the application of agroforestry on private lands, community lands, and government forest lands, so as to get optimum productivity from the lands. There also need to be means to ensure the adoption of various agroforestry technical packages more widely on private farms, community lands, and government forest lands through social forestry approach with participation of local people for sustainable adoption of agroforestry.

Past experiences with agroforestry have demonstrated both its potential and the difficulties involved in putting it into practice. They emphasise that there are no simple agroforestry solutions that can be expected to have instant results or be universally applicable. But experience does reinforce the basic relevance of agroforestry as an approach, provided it is viewed in a broad sense and is implemented in ways that are sensitive to the needs and priorities of local people. So the future of agroforestry depends on developing and adopting techniques and approaches which are robust and well-proven and which can be applied under the real-life conditions faced by farmers or local people.

In these regards, the thesis project has tried to explore the possibility of adoption of various agroforestry techniques, various constraints – political, social, technical, finance, organisational, extension and management – associated with the systems, and solutions to the problems so as to arrive at the means for sustainable implementation of such systems.

METHODOLOGY

This study is based mainly on a review of the literature.

FINDINGS

For a country such as Nepal which does not possess any oil or mineral wealth, multiple use of land resources is the only viable option for economic development. Agroforestry is seen to have the potential to improve the socio-economic level of the rural community in the Terai. There are biological and socio-economic constraints which affect the adoption of the system, but if such constraints are eliminated, as recommended in this study, definitely interventions to encourage adoption of agroforestry in social forestry should prove to be a successful multiple land-use strategy in the Terai region.

RECOMMENDATIONS

The Government should be liberal in releasing government land to communities in the Terai for social agroforestry plantations.

The Government should immediately stop all programs of settlement and resettlement on forest lands in the Terai to protect the remaining forests hence to enhance their quality.

The panchayat forest legislation of 1979 should be amended so that agroforestry can be practiced in community plantations more easily.

There should be a separate unit in each District Forest Office to carry out all extension and development work in relation to agroforestry.

The best intercropping tree species should be listed and given emphasis in nurseries supporting agroforestry.

Field extension workers should be given training on various agroforestry technical packages

together with knowledge on agricultural crops and livestock.

The Government should create an environment that enables the field workers from forestry, agriculture and livestock to work jointly in the field, with common objectives in agroforestry extension and motivation work.

The community involved in social forestry activities should be given training in agroforestry practices and extension aspects.

A great understanding needs to be created among forest committees and villagers regarding the distribution of food and forest produce from community agroforestry land as well as the allocation of labour and tasks.

The Forest Department should allocate all possible forest areas for social forestry programs.

Women in the community should be greatly involved in social agroforestry activities since they are responsible for food, fuelwood and other household jobs and so know better what should be grown and what should not.

Research work should continue in this field to develop more practical and supportive technical packages to help communities, individuals and institutions involved in agroforestry.

DEVELOPMENT OF BREEDING STRATEGIES FOR INDIGENOUS SPECIES WITH PARTICULAR REFERENCE TO THE FODDER TREE *(FICUS SEMICORDATA)*

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ABSTRACT

Declining forest and fodder resources in the middle hills of Nepal in the Community and Private Forestry Programme (CPFP) are reviewed. This is followed by an examination of existing agroforestry and farming systems. The main reason for fodder deficit was analysed by personal experience and literature review.

The CPFP has been implemented since 1982, to provide forestry needs in a sustainable manner and in this programme all degraded and accessible Hills Forest is handed over to the Forest User Group for protection, management and utilisation as a Community Forest (CF).

However, excessive use of fodder and grazing had degraded and depleted the handed over CF. This created a fodder problem for the livestock and lack of compost Crop production has been reduced. Thus, for more food production, cultivable lands have been extended on to the stepper slope but lack of manure and vegetation in turn it has increased soil erosion and decreased food production. The current literature review shows that the farmers have more preference for an indigenous fodder tree than an exotic species. Therefore, indigenous fodder species need to be introduced in the current land-use systems for enhancement. This will also restore the ecological balance in the CPFP.

This dissertation investigates and proposes an appropriate intermediate level of breeding strategy for indigenous species with particular reference to the fodder tree *Ficus semicordata*. It will be deployed in Nuwakot District. Nine years after the establishment, it is anticipated that it will produce genetically improved seed. This improved seed can be distributed to community forestry and private forestry for sustainable fodder production and also it can be introduced in the agroforestry systems which will reduce soil erosion and increase crop production. Thus, this programme will ultimately support an increase in the socio-economic condition of the rural people and also it will conserve the ecosystem and genetic resources.

PROBLEMS

Livestock are an essential component of Nepalese farming systems. In the hills almost 75% of the farms are ploughed using animals and they also provide milk, meat and manure.

Palatable green fodder is an important component of livestock feed, composts and manure, particularly in the dry season. Shortage of animal feed in general and green fodder in particular is greatly constraining livestock management and productivity in Nepal.

In a sustainable rural development process, agriculture, livestock and forestry is the baseline for the subsistence farmers. Nonetheless, forest resources are one of the most important components in the development human society. To mitigate the problem of shortage of forest products such as green fodder, a community and private forestry program has been working in the Middle Hills since 1982. However, the demand for fodder many not be adequately fulfilled from the community forests alone, since both livestock population and fodder demand are increasing unusually. This dissertation mainly focuses on developing breeding strategies for indigenous species of fodder trees, with particular reference to *Ficus semicordata,* under the community and private forestry program to improve the fodder supply.

OBJECTIVES

The objectives of the study were within the main context of the Community and Private Forestry Program in the middle hills of Nepal. The specific objectives were:

- to appraise appropriate breeding strategies for the introduction of indigenous multipurpose fodder trees;
- to assess the practicability of introducing fodder trees in agroforestry systems.

METHODOLOGY

Nuwakot District was chosen as the study area for the following reasons:

- In this district the author had worked as a District Forest Officer and was quite familiar with the area.
- This district is representative of most of the middle hills in terms of land-use patterns, socio-economic characteristics, geographical variation, natural vegetation and livestock rearing practices.

The study is mainly based on a review of the literature and personal experience.

FINDINGS

In the Middle Hills, 93% of farmers depend on livestock for draught-power and other purposes. Most of the land is terraced and it is ploughed by the animals. Of the livestock population only about 10% get total digestible nutrient feeds, and the rest are fed just to survive. More than 50% of the required fodder is harvested from the forest. Hence, most of the fodder trees in the forest have been severely lopped, reducing their flowering and coppicing power. As a result, the phenotypic and genetic-base become narrowed. This is one of the main reasons why collecting seed, is difficult.

To improve the CF condition and at the same time meet the needs of the people, private forest plantations have been initiated and seedlings of various species have been distributed freely to the people to plant on farmlands, terraces and terraced banks. However, farmers are reluctant to plant the seedlings supplied by the CPFP because most of the species distributed

were pines or exotic species that were not the people's choices. They also need improved indigenous fodder seedlings from which to increase crop yield and reduce soil loss. This ultimately leads to the inference that farmers are interested to introducing multipurpose indigenous fodder frees in the agroforestry system.

Analysis of current land-use systems showed that there is a lack of improved fodder. The seeds collected from seed-bearing mother trees may not be an improvement either phenotypically or genetically. Hence an intermediate level breeding seedling orchard (BSO) for *Ficus semicordata* is proposed.

Fodder produced from this improved seed may be better in quality and quantity than the unimproved. The improved fodder when given to animals will ultimately increase their draught power, produce more manure and animal products and increase the socio-economic conditions of the rural poor people.

RECOMMENDATION

Research should focus on the following matters relating to *Ficus semicordata* as a fodder tree-species:

- genetic diversity;
- survey of population;
- breeding systems;
- maintaining genetic diversity among breeding populations of tall trees and seed bearing trees;
- intraspecific variation;
- nutritive value and chemical composition.

The improved seeds produced by the BSO may be used in the following ways and programs:

- establishment of a genetic trial to demonstrate gains in quality or productivity;
- launching a nation-wide fodder tree plantation in farming system especially in the terraces and terraced banks of farmlands;
- including the improved trees in agree-silvopastoral and silvopastoral systems;
- extending the knowledge of agroforestry systems in the farming community;
- integrating the national program for pasture, agriculture, forestry, industry etc.;
- assessing food values of tree fodder.

DEFORESTATION AND AGROFORESTRY IN NEPAL

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ABSTRACT

There are many reasons for deforestation in Nepal. Agriculture is perhaps the most important reason but others are: livestock farming, need for fodder, and firewood, low economic status of the people living near forests, and projects with large infrastructures, such as building dams and roads.

Planting trees on agricultural land, or the practice of agroforestry, can protect forests by making tree products such as firewood and fodder easily available on farmers' own farms, can restore fertility of the land by decreasing soil erosion, adding nutrients through decomposition of leaf litter and nitrogen fixation, recycling leached-down nutrients and helping breakdown of nutrients in the subsoil by means of deep roots. The introduction of trees makes it possible to cultivate marginal sites such as saline, acidic or water-logged land or slopes. Careful combination of trees and crops can enable sustainable farming in many parts where long-term cultivation of crops is not possible.

So, agroforestry aims to increase productivity and sustainability in a way which is acceptable in the local context. It depends much upon scientists and technologists to find better tree and crop combinations which are in harmony with the farmers' needs. The practice of agroforestry must benefit from high wisdom of the deep rooted, site-specific, experiences of the rural people and the new advanced technologies. Today, agroforestry is truly a basis for survival.

Much of the former forest area is now are used for non-forestry purposes, mainly development and agriculture, and it is impossible to restore those areas to forest. Hence, today, agroforestry is one of the most effective ways to create new forests and increase tree numbers outside the existing forests and so reduce the global, regional and local effects of deforestation.

PROBLEM

Deforestation is a major problem for which there are many reasons, as also stated above. Agriculture is one of the biggest factors causing deforestation. Other reasons are livestock farming, need for fodder, firewood, low economic status of the people living near forests, projects with large infrastructures like building dams and roads which are contributing to deforestation.

Planting trees on agricultural land, or the practice of agroforestry, can protect forests by making tree products such as firewood, and fodder easily available on farmers' own farms and can restore fertility of the land in various ways.

However, random selection of trees for agroforestry may decrease agricultural yields, because trees can shade the crops, take nutrients and water from the soil and produce phytotoxins. The introduction of agroforestry may also require even more labour from farmers who are already heavily committed.

Agroforestry aims to increase productivity and sustainability in a way which is acceptable in the local context. However, it depends much upon scientists and technologists, to find better tree and crop combinations which are in harmony with the farmers' needs.

METHODOLOGY

The study was based on a review of existing literature.

FINDINGS

There is no doubt that agroforestry can help poor farmers. However, eliminating rural poverty and keeping young people in the villages will still be challenging problems because many people have little land. Alleviating poverty will depend to a large extent on the formulation of the right policies by government to give poor people more access to land and to make them self-reliant.

There are many site specific negative aspects of agroforestry, as discussed in this paper, which project planners should always bear in mind for the success of agroforestry projects. They should not take away the traditional rights of people or decrease the net output of the farm.

In many developing countries, the majority of the population are farmers but because their land cannot sustain agriculture or produce enough food, those who can work often migrate to big cities living the women, children, and older people behind of agroforestry practices. In some circumstances the introduction of agroforestry practices may even increase agricultural crop yields.

Given this situation, agroforestry should not only serve as an alternative to traditional agriculture, but should also act to make rural life productive. If through agroforestry young people can live in their own village and not need to work in the big cities for food, and if village women and children can reduce their burden, agroforestry will deserve to be judged a great succeed.

If agroforestry is to be successful, the most dynamic and advanced technologies, such as biotechnology and genetic engineering, will have to be taking advantage of. The practice of agroforestry must also benefit from the wisdom of the deep-rooted site-specific, experiences of the rural people and the newly advanced technologies.

Much of the former forest area is now used for non-forestry purposes, mainly development and agriculture and would not be restored to for forest. Hence, today, agroforestry is one of the most effective ways to create new forests and increase the number of trees outside the existing forests so as to reduce the global, regional and local effects of deforestation.

RECOMMENDATIONS

The following actions are recommended to reduce deforestation and promote agroforestry in Nepal.

1) Agriculture should be intensified:

2) Because expansion of agricultural land to grow food is the main reason for clearing forests (Bajracharya 1983, Mahat et al. 1987), so agriculture should be intensified (Acharya 1993). But intensification of agriculture without recharging soil nutrients is bound to failure in the longrun. It is impossible to use chemical fertilisers due to poor economic status and accessibility. The only way to intensify agriculture is through the application of organic fertiliser and through agroforestry. These can help agricultural intensification by reducing erosion, nitrogen fixation and nutrient recycling through green manure.

3) There should be intensive as well as extensive on-farm agroforestry research programs, to confirm research outcomes in the farmers' fields.

4) The Government should prepare a practical agroforestry guide dealing with program inputs needed, farming techniques, rotation times, expected outputs etc. and demonstrate this information clearly to the local villagers.

5) At the field level, the agroforestry practice of farmers should be closely monitored so that time, effort and resources are optimised. Poor practices should be corrected before problems emerge.

6) The government should concentrate on creating an environment of incentives in which farm households, community groups and government agents work in the direction of sustainable resource management, production and consumption. Incentives for tree planting should be given to the poor to have them plant more trees under agroforestry. Incentives should be in the form of indirect cash (e.g. buying of the produce at the time of maturity), or long-term loans with low interest rates, along with technical assistance and improvement seeds.

7) Most of the population do not have enough land to grow both food and trees. Many are even landless or do not have enough land to become self sufficient in food. The government should therefore lease lands, for agroforesry only, to the poorest, the landless and those who have too little land.

8) The Government should consider agroforestry to be production forestry and not rehabilitation forestry. Only good-quality land should be leased out for agroforestry practices. If poor-quality land is leased out, people will cultivate agricultural crops, that will further increase erosion and reduce nutrient content, hindering land rehabilitation.

9) In Nepal, the transportation of timber of six species which are found mainly in forests, is normally prohibited, and for transporting the wood of other species, there exists a cumbersome process to get permission from the District Forest Office. The transportation of timber is regulated because the Government cannot guard the trees in the forests. Although government is saving thousands of trees per year by this regulation, it is stopping people planting millions of trees. There should be free transit for the movement of tree products derived from agroforestry on private land.

RESOURCE AND PLANT ECOLOGY OF SHIVAPURI WATERSHED AND WILDLIFE RESERVE, NEPAL

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ABSTRACT

Creating protected areas has been an important strategy for biodiversity conservation. However, the 'forest' approach of conventional protected area management systems has given rise to many cross-boundary problems which threaten the long-term viability of many protected areas in Nepal and elsewhere. In the absence of alternatives, people derive essential resources from the protected areas despite stringent regulations. Such illegal resource use has tremendously increased the human pressure on protected areas. In view of the population growth and depletion of resource base, protected areas now are important maintaining the sustainable supply of survival needs of people and biodiversity conservation. This study in Shivapuri Watershed and Wildlife Reserve, Nepal, which managed by a conventional system, assesses the magnitude of forest resource use by the local people, and its impact on wildlife. Areas near the boundary were found to be extensively degraded and virtually turned into a shrubland. Invasion by *Euptorium adenophorum,* a pantropic weed, was also assessed. Wood-cutting and weed invasion were positively correlated with the elevation while the wildlife distribution was negatively correlated. Suggestions for reducing the pressures on the Reserve are made.

PROBLEM

Nepal has successfully established 14 protected areas (PAs) occupying nearly 11% of the total land area. However cross-boundary issues are threatening the long-term viability of many PAs. Until recently, the sole focus of PA management in Nepal was on the protection of biological resources through the enforcement of strict rules and regulations. Conventional PA management system, based on the western model of national parks, treated people as a threat to conservation and strictly prohibited their use of PA resources without regard to their needs in the face of the rapid depletion of resources outside the PA boundaries. In addition, in the absence of compensation, local people have to bear the costs of crop and property damage from the wildlife. Apparently, all this has resulted in negative attitudes in local people against conservation in general.

It is envisioned that recent 'conservation area' approaches including buffer zones, will incorporate local people and their needs into PA management.

METHODOLOGY

Shivapuri Watershed and Wildlife Reserve, representing the middle hills ecosystem of Nepal, is surrounded by about 50 villages with an estimated total population of 5000. Local people are unable to derive their forest resource needs from the degraded public forest outside the Reserve.

This study was conducted on the northern slope of Shivapuri Watershed, which was reserved in 1975 to maintain the supply of drinking water for Kathmandu. In 1979 it was designated a wildlife reserve to protect the biodiversity of the area. A few settlements within the Reserve boundary were relocated.

The boundary wall surrounding the Reserve was surveyed for evidence of Reserve resources use by the local people. Human-related collapses of the wall were identified from the natural ones and were recorded. A stratified random sampling with plots of size 10 m x 10 m was conducted along contours of the northern aspect of the Shivapuri between 1750 m and 2500 m at elevational intervals of 150 m in early 1992. A total of 140 sample plots were studied along 6 transacts running along the contours. Stratified sampling was done to determine the frequency of evidence of human use of forest resources at different elevations. Frequency of species, their height and diameter at breast height (dbh) were measured for trees and shrubs of height 1.5 m or more. Any evidences of human use in terms of recent lopping, and felling of trees, and of the occurrence of wildlife were recorded for the sample plots. Wildlife pellets, animal bedding and other animal signs were taken as presence of wildlife. Any presence of the invading weed species *Eupatorium adenophorum* in sample plots was taken as indicating human disturbance.

The mean number of plants showing evidence of lopping, wood-cutting evidences, in all the sample plots, was tested with t-test to determine the significance of human use. The resource-use patterns and their relation with the elevation (edge distance) were analysed by chi-square tests. Spearman's rank correlation method was used to determine the relations among deferent observed parameters. Difference in mean number of human use at different elevation levels was determined with Kruskal-Wallis test of ANOVA. Human use intensity of two populations was compared by normal approximation of Mann-Whitney rank test. As the sample size varied at different transacts, the proportions of cut and uncut trees were used for most of the tests to avoid biases due to the difference in vegetation density at different elevations.

FINDINGS

This study suggests that the creation of a boundary wall does not necessarily ensure the protection of an area. Despite many established public entry points for public access made by the Reserve management, several illegal entry points were recorded on the boundary wall. There were 514 damaged sites of which 18% were human related. It appeared that people either break the wall or hasten the process of collapse. Most of such damaged sites were adjacent to farms or houses.

Wild pigs do much damage and trapping them is very difficult. Maintenance of the boundary wall may control the crop raiding intensity, but the maintenance cost of the wall is very high.

The Shivapuri mountaintop is an interesting site for trekkers and visitors. The relative by low frequency of wood cutting and weed invasion at 2050 m. was basically attributed to the topography (predominant cliffs and rugged physiography). However, the distribution of wildlife was also surprisingly low. Except at the edges, the current level of human use in the study area was not a serious threat to the wildlife population. Nevertheless, measures to sustain the local needs without jeopardising the wildlife resources showed to be considered to check further deterioration of the reserve.

RECOMMENDATIONS

The main source of conflict between local people and the PA management in Nepal is the restriction on resource use without adequate alternatives, Wildlife damage to crops and depredation of livestock causing hardship to the subsistence farmers, and no direct benefit from the PA.

Strengthening community-based resource management systems, entrusting management responsibility and authority to local institutions and introducing a variety of rights and land tenure arrangements help to bring local people into active participation in planning, management, and decision making. This is likely to develop confidence and a trustful environment between the local people and the management. Creation and management of buffer zones or multiple-use zones would greatly cut back the pressure on PAS. Community plantations in public lands and their management should be encouraged as an alternative to meeting the resource needs.

Improving the economic standards of the surrounding communities is vital for changing the behaviour and dependency on resource use. Developing the skills and resources needed to enable local people to increase their income through the promotion of cottage industries and tourism can bring positive results. Local people should be trained to enter the tourism business so that the benefits go to them and not to city-based entrepreneurs. Control measures for wildlife damage to crops and livestock are necessary to develop on existing situations, can help promote conservation of biological resource at the community level.

Conservation education is the backbone for the success of PA management. This should include school programmes and curriculum development, mobile audio-visual and extension programmes, public campaigns, study for of the community leaders, income-generating activities for the youth and home visits. Apparently, for successful conservation and management of a PA, it is necessary to address the areas beyond PA boundaries and co-operate with local people in creating ecologically sustainable system of land and resource use practices.

The new approach of 'conservation area' and recent enactment of creating buffer zone around the PAs in Nepal are likely to bring back the local people into mainstream conservation.

AN ASSESSMENT OF BIOMASS PRODUCTION AND UTILIZATION IN THE RAUGHAT KHOLA WATERSHED OF THE MYAGDI DISTRICT NEPAL

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M.Sc. (1995)
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ABSTRACT

Deforestation problems of Nepal are being reduced by creating community forests like Panchayat Forests and Panchayat Protected Forests to reduce problems caused by open access to the natural common forest and by establishing local responsibility through people's participation in forest protection and utilisation. The objective of this study was to determine if the area allocated to community forest is sufficient to meet the biomass demand of selected panchayats in the Rahughat watershed of 32658 ha in Myagdi District. A model was designed to compare 1:1 fodder and fuelwood plantation, and fodder plantation only. Variables included different categories of forests of different sizes, yield per hectare per year of fodder and wood, and annual demand for biomass. The model projected demand and supply from 1981 to 2011 in 5-year intervals. The results showed that there is insufficient biomass production to meet local needs without intensive management of all forests. Community forests are quite inadequate and all national forests are needed for local utilisation. Wood production exceeds the demand only with intensive management of the existing forest, but fodder is still in deficit even after plantation of fodder species. Local production of livestock and agricultural crops, as well as the socio-economic characteristics of the watershed were also analysed. This study showed that there are many social problems to be solved before the ecological problem can be solved. The resource scarcity problems cannot be solved by external inputs unless is an accompanying decline of the population. The watershed needs more fodder plantations without fuelwood, along with private plantations and farm forestry. Also, all the national forests should be managed locally through community involvement instead of through centrally planned management plans. This study should be of value in formulating the resource policies and management objectives for comparable watersheds.

PROBLEMS

Deforestation is the one of the major problems of Nepal. Lack of participation by the people in solutions is one of the causes of the high rate of deforestation after the Forest Nationalisation Act (1956). Rapidly increasing human and livestock populations also contribute to deforestation.

A number of initiaties e.g., afforestation, soil conservation, forestry extension and management have been implemented to reverse the present trend of deteriorating ecosystems but the major production-oriented activity is through community involvement.

According to regulations under the Forest Act 2018 BS (1962 AD), the following two categories of forest can be owned by the panchayats: Panchayat Forest (PF) and Panchayat Protected Forest (PPF).

OBJECTIVE

The objectives of this study were: (I) to assess the allocation of barren land for plantation of PF and existing forest for immediate use as PPF to determine if the total area in forest is sufficient to meet fuelwood, timber, and fodder demands of the panchayats in the study area; and (ii) to estimate the minimum forest area needed to meet the demand for wood and fodder allocating community forests (PF and PPF) as the first priority and national forest and reforestation as second and third priorities.

METHODOLOGY

The Raughat Khola watershed area of 32658 ha which was part of the Resource Conservation and Utilisation Project (RCUP) was the focus of the study. This project covered the Daraundi watershed of Gorkha District and the upper Kali Gandaki watershed area of Myagdi and Mustan Districts, one of several severely deteriorating ecological systems.

Various types of data and analysis models were used in the study including maps, flowcharts, graphs and linear equations. Linear programming was the primary model used. In the model the production of biomass can be optimised subject to the constraints of yield and availability of the land.

FINDINGS

This study showed clearly that the supply of fodder in the entire watershed is far below the demand projected for the period 1981 to 2011. It has been suggested that all the forest under 10000 feet would have to be utilised eventually.

Community involvement is essential not only in the community-owned forests, but also in the management of national forests. This study showed that there are many social problems to solve which are closely connected to ecological problems. The present resource scarcity problems of this watershed cannot be solved by the RCUP if there is not an accompanying decline of population levels. To meet local demand, the project must emphasise fodder production on national forests, PF, private plantation, and farm forests. Also, all the national forests in the area should be managed locally through community involvement instead of through central planning.

Policies are needed to encourage people to migrate out of this area. Alternatively food should be brought in to meet the demand, so that further cultivation of the marginal lands can be avoided. The present livestock population should be replaced by improved breeds, and alternate income should be generated so that the livestock population could be reduced. Daphne collection for paper manufacture is one possibility for additional employment generation of the local people. Other jobs through cottage industries should be promoted. Family planning is needed to reduce population growth. Intensive management of cultivation should be carried out on suitable agricultural lands with inputs such as irrigation and improved seeds. The introduction of improved stoves has had encouraging results.

WOMEN'S PARTICIPATION IN COMMUNITY FORESTRY: A CASE STUDY OF TWO VILLAGE PANCHAYATS IN KASKI DISTRICT OF NEPAL

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ABSTRACT

The objective of this study was to assess women's participation and to determine the factors affecting women's participation and the extent of community participation in two community forestry projects in Nepal. Lekhnath and Sisuwa, two village panchayats in Kaski District were selected for study. In addition to a formal survey including 120 households and 10 forestry professionals, other sources of data were informal discussions with local leaders and forestry officers, and review of published and unpublished information from various concerned agencies.

The extent of women's participation in community forestry in general, was quite low in both panchayats. Their participation in implementation was limited to filling polypots and sowing seeds and they were not involved in any of the on-going management activities.

In general the village-level participation in community forestry was politically motivated rather than by conscious, voluntary decisions of the villagers. Even the forestry professionals themselves were found to have only a vague concept of community forestry. Most of the household factors considered, namely: family size, fuelwood requirement, livestock ownership, contact with extension workers, perception of the value of the forest and ways of conserving the resources, and the respondents' attitude towards forest committee, forest officers and government regulations were found to be positively related to participation. Farm size, however, was related inversely. Among the different cultural groups, Gurungs and Newars, respectively, showed the highest and lowest participation levels.

Major problems associated with community forestry projects as perceived by the forestry professionals were the relatively inflexible targets, delayed release of funds, flexibility of panchayat boundaries, people's indifference, and lack of motivation among the forestry professionals and para-professionals.

PROBLEM

Forest is of the oldest, most diverse and most stable of ecosystems and is self-perpetuating and protective of the environment. It is an integral part of the agro-ecosystem of a developing country like Nepal. But a lack of understanding of the fragile nature of the forest ecosystem exists. A significant proportion of the forested land -- both government and privately owned -- is either being used suboptimally or being over-used, leading to severe ecological imbalances which threaten the continued viability of the agro-ecosystem and may also contribute to major ecological disaster. A possible solution to this problem is the adoption of a community forestry system, which may promote not only the socio-economic improvement of the rural populace but also the maintenance of environmental stability and harmony. However, the system can be effective only when the intended beneficiaries accept and adopt

it.

The intended beneficiaries of community forestry should be women because they are the primary consumers of forest products, know about better tree species to grow, suffer most from forest degradation, are overwhelmingly disadvantaged and are consistently overlooked and under-valued. Thus, efforts have to be made to determine whether women are being targeted or not and what problems they are facing.

METHODOLOGY

The study covered two village panchayats of the Kaski District namely Lekhnath and Sisuwa in central western Nepal. Both primary and secondary data were collected. A formal survey of 120 households (70 from Sisuwa and 50 from Lekhnath), 10 forestry professionals, one Community Forestry Assistant (CFA) and four forestry paraprofessionals, informal discussions with local leaders, forestry officers and villagers; and a review of previous studies regarding community forestry in Nepal were conducted.

The analysis and discussions were primarily done at the household, forestry organisation and community levels. However, special emphasis was placed on the participation on non-participation of women and how the household, forestry organisation and community characteristics have enhanced or limited these.

FINDINGS

Participation in community forestry activities both at the community and household level were significantly affected by the community characteristics, forestry organisation and household characteristics.

In addition to the paraprofessional foresters, other forestry staff including community forestry assistants, forest watchers, nursery foreman etc., play an important role in implementing the community forestry projects.

To a large extent the low morale or motivation of forestry paraprofessionals and other forestry staff to perform their jobs was because of the insecurity of their jobs, low salaries (which were also almost always late) and lack of awareness of their responsibilities and the roles they should play in programme implementation.

Participation in community forestry had been all the less effective because the local people were not consulted during project design and planning. Similarly, the extension programme was designed without involving the field officers and local forest committees.

In addition to fuelwood and fodder collection, the women were responsible for major farm operations.

In general the extent of women's participation in community forestry, was quite low in both the panchayats.

RECOMMENDATIONS

A similar study should be conducted in other villages under different circumstances to confirm or reject some of the findings of this study.

The forestry paraprofessionals should be given training and proper orientation regarding their jobs and the goals of community forestry itself.

Forestry extension activities should also pay particular attention to changing the value orientations of people towards the forest, its resources and the forestry-related institutions as well.

The forest organisations should consider involving women in all cadres of forestry services. If possible, the Community Forestry and Afforestation Division (CFAD) should hire a woman co-ordinator at the central level and women motivators at the field level.

Women should be involved in project planning and decision-making so that they do not have difficulty in conceptualising project ideas or expressing their own needs.

Women's availability to join in community forestry activities should be considered with reference to the demands of their farm work.

THE FODDER TREE SITUATION AND ITS MANAGEMENT IN THE MID-HILLS OF NEPAL

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ABSTRACT

This study of mountain ecosystems indicates that huge numbers of animals have progressively led to a natural resources deficit. Overgrazing and inadequate resource management practices have resulted in degradation and severe erosion in the region. However, livestock are an integral part of the hills farming systems and provide a good deal of economic support to the local communities. But overall production and performance are low, considering the animal numbers, due to feeding deficits. Generating nutritive animal feed is seen as one of the best way of increasing productivity. Fodder trees offer potential for improving livestock forage production at times when crop residue, along with cereal production, is declining and pure grassland improvement is not possible. Furthermore, fodder trees produce nutritive green forage during the dry season when substitute feeding is not available, and simultaneously help to prevent soil erosion.

There is great potential for increasing the number of fodder trees on private and communal or public land since most of the middle hills land-use categories can support forest shrub or grassland and the land is mostly accessible. If these land units were planted with multipurpose or fodder trees and managed properly, the hills could well produce more than five million additional total digestive nutrient (TDN) annually. making the region more then self-sufficient in fodder. In addition, however, improved management practices to maximise tree fodder production would need to be adopted and all fodder sources to be under integrated complementary management.

PROBLEM

The middle hills of Nepal contain more than half the country's population and of these about 90% derive their livelihood from agriculture. In this region mixed farming-livestock husbandry, forestry and crops - is practised. Accordingly, every farmer keeps a herd of animals which help the farming system to run smoothly as well as to support the large population. The nutrient deficiency resulting from severe overgrazing and mismanagement of natural resources is an important factor in limiting stock production.

Since the hills farming system is now unable to support its human population in the traditional way, the current trend is for mass migration of the hills population to the already overcrowded Terai. There is an urgent need to reverse this trend by maintaining and intensifing farming in the hills.

Attention is focused on tree fodder as the key to progress on this issue. Features which appeal are the opportunities to combine fodder production with effective soil conservation measures and enrichment of soil fertility, which are facilitated by retention of trees and enhanced nutritional value of browse material. Apart from this, tree foliage is the only available source of green fodder during the dry period of the year, including more than 35% of the total animal feed when most other feeds are exhausted. In these alarming circumstances, tree fodder can help greatly to keep the present hills farming system in balance without further deterioration of the fragile ecosystem. The existing complex farming system of the middle hills would collapse without tree fodder.

OBJECTIVES

In this study potential areas for planting fodder trees were identified and appropriate management and silvicultural strategies for maximal fodder production from the existing fodder trees were analysed, with the primary aim of enabling farmers to harvest a sustainable yield of green fodder throughout the dry period of the year.

METHODOLOGY

Various approaches to data assembly and appraisal were adopted in the processes of selecting the best fodder or multipurpose tree species, identifying potential areas for planting, describing traditional fodder-tree management options, determinating lopping and management practices for fodder trees, and assessing the place of fodder's-trees in agroforestry.

All the three species studied are indigenous, have some history of domestication and have wide ecological ranges. Each occurs commonly on private and communal land and is in demand by the local community.

FINDINGS

The complex farming systems of the middle hills face a questionable future, in the absence of sufficient fodder production. Tree fodder is vital for dry season feeding and should simultaneously play a role in soil conservation. The greatest threat is free grazing by excessive numbers of live-stock. However, the traditional agricultural system still continues to be heavily dependent on animals and cannot be divorced from the farmers' general economic system. The issue is one of sustainability, and the first consideration must be the regional potential to generate the fodder necessary to feed the stock.

Arable land in the region almost always is terraced and terrace risers on walls, regarded as potential fodder-tree growing sites, constitute 24% of the total cultivated land. The majority of these lands are accessible and are in desperate need of planting to protect adjacent arable lands from further spread of erosion. Trees planted close to arable land should be widely spaced to reduce shading effects on crops. Candidates should be managed under coppice systems to ensure ground coverage with the minimum number of trees.

Arable land often suffers from the failure of terrace risers and walls. Planting trees (fodder/multipurpose) along these benches could significantly help to control erosion and offer additional tree-fodder production. In these lands small trees and shrubs (e.g. *Albizia, Buddleja, Erythrina, Gliciridia, Leucaena, Morus, Saurauia, and Sesbania*) should be planted with high-yielding forage grass and legumes. The tree spacing should be 1-3 m, and management should be on the basis of lopping, once to three times a year according to species, to limit the plants' size. Pollarding is advocated as the technique producing plants of the most suitable form.

Shrub lands yield far below their potential, but with proper protection, enrichment and gap planting could produce at rates comparable with those of the forested land after 3 to 5 years of such management.

Most of the potential areas could produce more than the assumed yields as the trees become older. The total annual fodder demand of the region is about 5.71 million TDN. The present fodder shortfall could be resolved within a period of 5 to 10 years.

The marginal land and terrace risers and walls are under farmers' ownership. These lands would, therefore need to be planted by individual farmers as private planting.

RECOMMENDATION

For more efficient tree-fodder production there is an urgent need for more vigorous applied research, the results of which should be transferred to farmers. At the same time, extension geared to people's needs should be promoted. The big hurdle in fodder development remains administrative lack of co-ordination and co-operation between the departments of forest, livestock and agriculture. If this gap can be bridged the way is open to apply the expanding understanding of how fodder systems can successfully operate to the most advantageous effect.

THE RELATIONSHIP BETWEEN THE FOREST AND THE FARMING SYSTEM IN CHAUTARA, NEPAL, WITH SPECIAL REFERENCE TO LIVESTOCK PRODUCTION

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ABSTRACT

Livestock raising is an important activity in the hill farming systems of Nepal. The high dependency of farmers on the forest for raising livestock and meeting domestic needs is considered to be one of the major reasons for deforestation and soil erosion.

In this thesis an attempt is made to discover the reasons why Nepalese farmers attach such great importance to livestock. This involved examining the role of the livestock in the farming systems. The interaction of the farming systems with the forest is then examined to discover if there are grounds for believing that rural people contribute significantly to deforestation. The analysis is based on cross-sectional data which was collected in a survey of 40 families in Chautara Panchayat of the Sindhu-Palchok District of Nepal. Chautara Panchayat was selected mainly because it is the centre of field operations for the Nepal-Australia Forestry Project.

The data show that households spend a considerable portion of their time looking after livestock. Reasons were examined and it was concluded that livestock raising is profitable from the farmer's viewpoint. The data also reveal that families depend heavily on the forest but collect greater quantities of fodder for their animals than firewood.

Farm families could therefore, be contributing to deforestation. Policies to alleviate the problem are suggested. They involve trying either to reduce animal number or to provide more fodder. However it is possible that these policies could be contradictory, in that providing more fodder would encourage farmers to keep more livestock.

The second part of the thesis examines this possibility. Regression analysis was conducted in order to determine the effect on livestock units of the number of privately owned fodder trees and the time taken by a family member to collect a load of fodder, factors likely to be affected by reforestation.

The analysis reveals that an increase in the number of fodder trees might result in an increase in the number of buffaloes. Similarly reduction in the time involved in collecting fodder might increase the nimber of goats. However no relationship can be found between these variabls and the number of cattle.

PROBLEM

Recently there has been a growing concern in Nepal about the rapid rate of deforestation and the problems which have resulted. Explanations have focused on the heavy dependence rural people have on the forest. They use it for fodder to feed their livestock, for fuelwood, timber and for litter which is used as flooring in animal sheds. The first two uses are by far the most important.

The average hill family requires about 3.5 ha of forest to provide fodder for its animals, but only between 0.3 and 0.6 ha for fuelwood. This implies that the agricultural system and the forest could maintain themselves if each family had access to about 4 ha of forest. However there is only sufficient forest to allow each family less than 2 ha. It is estimated that 25% of Nepal's forest area has been destroyed between 1964 and 1975.

The most obvious effect of deforestation is erosion. There is already a great deal of natural erosion in Nepal because of the very heavy monsoons and the steep terrain. Yet it has been suggested that half of the erosion which occurs is man-made. Part of this is due to the high rate of population growth, which means that marginal land is being brought into cultivation, much of it on steep slopes. Part is due to the overgrazing of pastures and part is attributable to the excessive use of the forest for fodder and fuelwood.

METHODOLOGY

Local forest officials helped to indentify four communities within a two-hour walk from Chautara market area. All of these were visited and a list of households owning livestock was obtained. From the list 40 households were selected randomly for interview. The aim of the survey was to get as much information as possible from as many farmers as possible.

Questionnaires had been prepared beforehand and necessary adjustments and improvements were made after some trial interviews in the field. Different types of questionnaires were designed for different visits. For the first visit, a preliminary questionnaire was prepared seeking information about basic socio-economic variables such as family, religion and farm details, and also about livestock and staff feeding.

It was decided to visit each household in the sample every alternate day. At subsequent visits, an intensive questionnaire was completed, giving details of the activities of all household members on the day immediately before the visit. During this stage four other questionnaires were also asked. Three of these concerned human and animal labour requirements for paddy, maize and millet production during the previous year. The fourth covered a number of miscellaneous and subjective questions.

OBJECTIVE

The aim of the study was to examine the relationship between farm families and the forest, in particular the interaction between livestock the forest.

FINDINGS

Livestock ranked second only to crop production in terms of the average household's allocation of labour. Women, in particular, devoted a great deal of time to livestock. Much of this involved collecting fodder. In fact families took more from the forest for fodder than for fuelwood.

Livestock are kept neither for purely social reasons not for purely traditional ones. Livestock raising seems to be profitable from the farmer's point of view, and attempts to change attitudes independent of the economics of livestock rearing, are unlikely to reduce livestock numbers significantly.

An increase in the number of privately owned fodder trees may result in an increase in the number of buffaloes. A reduction in the time involved in collecting fodder may increase the number of goats. However no relationship between these variables and the numbers of cattle could be discovered , perhaps because of the importance of religious restrictions, which meant that farmers could not limit the number of unproductive cattle they owned.

RECOMMENDATIONS

Attempts should be made on the one hand to reduce the number of livestock by affecting the economics of livestock raising and on the other to increase the availability of fodder. The agriculture and forestry ministries should work closely together on such matters.

The same importance should be given to policies designed to reduce the number of livestock as to those designed to increase the available fodder.

AN ANALYSIS OF HOUSEHOLD DEMAND FOR FUELWOOD DURING THE WINTER SEASON IN THE KATHMANDU DISTRICT OF NEPAL

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ABSTRACT

This study was conducted to analyse the determinants of household demand for fuelwood and to estimate price, household size and income + elasticities of fuelwood demand. A sample of 154 respondents were personally interviewed using a pre-tested questionnaire in selected rural and urban areas of Kathmandu District.

Estimation of parameters was accomplished by fitting several multiple regression functions to cross-section data. Both linear and double – log forms were used in the estimation of fluelwood demand equations, and were compared on the basis of economic and statistical criteria. The explanatory variables included in the estimation of the fuelwood demand equation were; price of fuelwood, price of electricity, price of kerosene, price of rice husk and sawdust, price of shrubs and branches, frequency of cooking foods, household weekly income, household size, distance of the house from the forest area, and dummy variables for urban or rural location, type of stove and type of fuelwood.

The linear function was selected as the best household fuelwood demand model because of its higher coefficient of determination (R^2), higher number of significant explanatory variables and the conformity of the signs of the regression coefficients of all the explanatory variables to economic expectations .

There result of the demand analysis showed that the price of fuelwood, the price of electricity, frequency of cooking foods, household weekly income, household size and urban or rural location had significant effects on weekly household fuelwood demand. On the other hand, the prices of kerosene, shrubs and branches, the type of stove and the type of fuelwood did not have significant effect.

The own-price elasticity of per capita fuelwood demand was higher (-.20) than that of the per household demand (-.16). With the exception of the price of electricity, the prices of other fuel sources had insignificant effects on household fuelwood demand. The cross-price elasticity of household fuelwood demand with respect to the price of electricity was .20. The income and household size elasticities were .13 and .32, respectively.

PROBLEM

The simplest form of forest energy is fuelwood. The importance of fuelwood as a primary source of energy varies widely among different parts of the world. In Nepal, approximately 92% of the total energy consumption comes from fuelwood. Fuelwood in this country has been used mainly for domestic, industrial and commercial purposes. The domestic sector

consumed the greatest proportion of the total fuelwood consumption. About 99% of the whole population of this country uses fuelwood. Despite the availability of alternative fuels such as dung, biogas, kerosene and electricity, there has been a strong preference for fuelwood, primarily because of its low cost. For this reason, forests in various parts of Nepal have been exploited beyond their capacity to provide sustained yield. Presently, forests are in various stages of degradation in the major ecological zones of Nepal. Hence, in this era of world energy crisis mountainous developing countries like Nepal need to carefully develop strategies which would meet their minimum domestic energy requirements without impairing the vulnerable forest ecology.

OBJECTIVES

The general objective of this study was to analyze the household demand for fuelwood in winter in the Kathmandu district. Specifically, the objectives of this study were:

1) to analyse the determinants of household fuelwood demand; and

2) to estimate own-price, cross-price, household size and income clasticities of the fuelwood demand .

METHODOLOGY

The three sample panchayats which were purposively selected for this particular study were: (1) Kathmandu Town, representing an urban panchayat and non-forest area; (2) Jorpati, representing a rural panchayat with community or reserved forest area; and (3) Dakshinkali, representing a rural panchayat located near a free-access forest. The sample sizes for the rural and unban sample panchayat were determined through equal allocation method. A total of 154 households, which were randomly selected with replacement were personally interviewed using a pre-tested questionnaire.

Both descriptive and regression analyses were employed in the study. To estimate the household and per capita demand equations for fuelwood in the winter season, both linear and double-log functions were fitted to the data. The ordinary least squares method was utilized in the estimation of the fuelwood demand models. The explanatory variables included in the estimation of these models were: price of fuelwood, price of electricity, price of kerosene, price rice husk and sawdust, price of shrubs and branches, frequency of cooking meals and livestock feed, household weekly income, household size, distance of the house from the forest area, and dummy variables for urban/ rural location, type of stove, and type of fuelwood. The two functional models were compared on the basis of statistical and economic criteria.

FINDINGS

The results of the study showed that the majority of the sample households used only, hardwood (43%) while 40% used both hardwood and conifers and 17% only used conifers or softwood. Traditional stoves were commonly used in all three sample panchayats (88%).

The sample households generally preferred to use fuelwood for cooking (76%) compared to other energy sources. This was followed by electricity (11%), gas (8%) and kerosene (4%). The major reasons for their preference for fuelwood were as follows: its lower cost and its availability. They also mentioned that the use of fuelwood requires simple stoves whereas the commercial energy sources need special stoves which are not locally manufactured and are, therefore, more expensive.

In the rural panchayats, the use of agricultural wastes and cowdung as fuelwood substitutes was commonly practiced because of their abundant supply in these areas. However this was not possible in the urban panchayat because of unavailability.

The results of the study also showed that the majority of the sample households bought fuelwood (78%) while the remainder did not. The rural panchyats had higher collection of fuelwood per capita than the urban panchayat because of their accessibility to forest areas. The sample households which purchased fuelwood generally had a higher average weekly household income than those who did not buy fuelwood.

Most sample households (71%). reported that they consume more fuelwood during the winter season because, it takes longer to cook food and boil water during this period and more is needed for heating and for producing wine.

Results of the demand analysis shòwed that the linear model is the best household fuelwood demand equation because of its better fit (higher coefficient of determination), higher number of significant explanatory variables and the conformity of the signs of the regression coefficients of all the explanatory variables to economic expectations.

COMPARISON OF DIFFERENT SAMPLING TECHNIQUES IN FOREST INVENTORY IN SOUTHERN NEPAL

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ABSTRACT

This study aimed at improving techniques for developing inventories of the forests of the *terai* belt of Nepal using aerial photographs and satellite imageries.

The scientific management of the forest resources is not feasible without efficient inventory results. Furthermore, adequate reliable data is indispensable for planning as well as decision making in proper utilization of the forest resources. The valuable forests especially in the *Terai* ought to be scientifically managed for the production of construction-wood, fuel-wood and fodder. As it has been noticed that the present inventory system followed at present needs some improvement, this study has been carried out in order to find out a best suitable sampling design in terms of precision. In this context, several sampling designs were tested using a simulated model forest. A systematic triangular three-plot clustre design proved to be the best in terms of sampling error case of mixed forests. Similarly, a linear two-plot clustre design gave best results in case of *sal* forests. Both the designs could be used for collecting more reliable data from the respective forests of *terai* for their better scientific management as well as for proper decision making.

PROBLEMS

The forest inventory systems available at present need some improvement as those have not been statistically tested so far.

METHODOLOGY

The study was carried out using a simulated model forest which was created with the help of sample plot data, satellite image and digitized map of the study area. The procedure consisted of the following four steps:

step one:	modeling of the stand volume
step two:	generation of a simulated model forest
step three:	simulation (testing) of different sampling techniques in the simulated model forest; and
step four:	computation of the precision of a single inventory using boot-strap method.

Various systematic as well as random point (single plot clustre), linear (two-plot clustre, three-plot clustre and four-plot clustre), triangular (three-plot clustre) and square (four-plot clustre and eight-plot clustre) sampling designs were tested.

FINDINGS

In case of mixed forest, the following model gave the best results:

$$\ln(v+10) = a_0 + a_1 sv - a_2 Ch_4 - a_3 Ch_7$$

where, v = pixelwise volume of all species (m^3/ha);
sv = the mean stratum volume of all species (m^3/ha);

Ch_4 and Ch_7 are the radiation intensities of the TM (Thematic Mapper) image pixels with the 4^{th} and 7^{th} channels; and
a_0, a_1, a_2, ... are coefficients.

The coefficient of determination (R^2) and the standard error of estimate (s_e) of the model fitted were 57.1% and 51.6% respectibly; the F-ratio being 74.8.

Similarly, the best (so far) model for *sal* forest was:

$$\ln(v+10) = a_0 + a_1 sv - a_2 Ch_3 - a_3 Ch_5 + a_4 Ch_7 + a_5(Ch_3 * Ch_5) - a_6(Ch_3 * Ch_7)$$

where, v = pixelwise volume of *sal* (m^3/ha);

sv = the mean stratum volume of all species (m^3/ha);
Ch_3, Ch_4, Ch_5 and Ch_7 are the radiation intensities of the TM image pixels with the 3^{rd}, 4^{th}, 5^{th} and 7^{th} channels; and
a_0, a_1, a_2, ... are coefficients.

The R^2 and the s_e of the model were 42.7% and 84.4% respectibly; the F-ratio being 21.6. The predicted pixel volumes of all species were, more or less, found to be quite high which could be due to poor digitization of the forest strata boundaries and very small size of the study area compared to the whole *terai* as the error increases with the decrease in the area.

Out of the different sampling techniques tested, the sampling errors of estimate were found to be smaller with the systematic triangular three-plot clustre design. A systematic triangular three-plot clustre design with the plots spaced at 275m from the plot centre proved to be the best in case of mixed forest in terms of sampling error of estimate (6.8 m^3/ha). Similarly, a linear two-plot clustre design with the plots spaced at 50m apart from each other design came to be the best with least sampling error (7.1 m^3/ha) in case of *sal* forest. The sampling ratio used was 0.02% in all designs tested.

RECOMMENDATIONS

A systematic triangular three-plot clustre design with the plots spaced at 275m apart from the clustre centre in case of mixed forest and a linear two-plot clustre design with the plots spaced at 50m apart from each other in case of *sal* forest could be used for collecting more reliable data from the forests of *terai* for their scientific management as well as proper decision making.

PERCEPTIONS OF AND ATTITUDES TOWARDS THE ADOPTION OF COMMUNITY FORESTRY PRACTICES IN PALPA, NEPAL: A CASE ANALYSIS

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ABSTRACT

The study aimed at ascertaining: (1) farmers' and extension agents' perceptions and attitudes about of the community forestry programme; (2) the extent of adoption of community forestry activities; (3) relationships between selected characteristics of the farmers and the extension agents and their perceptions of and attitudes towards some aspects of the community forestry programme; and (4) the relationships between farmers' and extension agents' perceptions and attitudes and their perceived adoption of community forestry activities.

The data were gathered from 100 farmers of Madanpokhara and Bandipokhara village panchayats in Palpa District, Nepal, and 21 extension agents working in the Palpa District Forest Office, with the use of semi-structured interview schedules.

The results showed that the majority of the farmers have high perceptions of and favourable attitudes towards the community forestry programme. Most extension agents, on the other hand, have high perceptions of but unfavourable attitudes towards extension work.

Education, contact with extension agents and participation affect farmers' perceptions of the community forestry legislation, community forestry and extension agents. Similarly, experience, training and job satisfaction of extension agents affect their perceptions of extension work. Education determines the extension agents' attitudes towards extension work and farmers. Farmers' perceptions and attitudes were significantly related, which implied that the community forestry aspects highly perceived were also most favoured.

Although farmers with high perceptions of and favourable attitude towards community forestry and extension workers had higher adoption rates, only 40% of the farmers had, so far, adopted community forestry practices.

The level of adoption of community forestry activities was found to be significantly related to the farmers' level of education, caste, income, farm size, contact with extension agents and the participation in community forestry activities.

The extension services being provided by the change agents were found to be inefficient in relating to the people and thereby promoting participation.

PROBLEM

The community forestry programme has been in train in Nepal for the last years with the aim of benefiting rural communities. It can be said, however, that forestry for rural communities will seldom succeed unless the people concerned are persuaded of its usefulness. The political and legislative support for people's participation has provided the basis for adopting the community forestry programme and thus, to some extent, contribute to halting the environmental deterioration of the Nepalese hills and mountains. However, despite this, local peoples' attitudes of apprehension and mistrust of government based on past experiences have not abated. The major problem is people's participation at panchayat level. This may be due to the present legislation, which could be ineffective or inappropriate in itself, or to still unfavourable views of communities and extension workers. Some communities even regard protection of panchayat forest plantation sites as the sole responsibility of the Forest Department, which is quite contrary to the essence of community forestry program. This behaviour reflects indifferent perceptions and attitudes of people as well as extension wooers towards community forestry.

OBJECTIVES

The concern of this study was to find out the farmers and extension agents' perceptions of and attitudes towards the adoption of community forestry activities in Palpa, Nepal.

This study aimed at answering the following pertinent questions:

1) How do farmers and extension workers perceive the community forestry programs in the context of meeting forestry basic needs ?
2) What are their attitudes towards the community forestry programme ?
3) What is the extent of adoption of community forestry in the district studied?
4) What are the relationships between farmers' and extension workers' characteristics and their perceptions and attitudes regarding certain aspects of community forestry activities?
5) What are the relationships between farmers' and extension workers' characteristics and their adoption of community forestry activities ?

METHODOLOGY

The study was conducted in Madanpokhara and Bandipokhara village panchayats in Palpa District, Nepal. From each panchayat 50 farmers were selected proportionately from three caste categories, using a stratified random sampling technique. Similarly, 21 extension agents were also included in the study. Semi-structured interviews were used to gather primary data.

Relevant secondary data were obtained through various government and non-government agencies in the district. Statistical tools like frequency counts, percentage mean, standard deviation, chi-square test, Fisher's test and Spearman Rank Coefficient of Correlation were used in the data analysis. The level of significance to determine the relationship was set at 5%.

FINDINGS

Farmers had high awareness and perceptions of the community forestry programme but not of community forestry legislation and extension agents. Extension agents had higher perceptions of extension work than of farmers.

Farmers had favourable attitudes towards the community forestry programme but not towards extension agents. On the other hand, extension agents had unfavourable attitudes towards farmers.

Farmers' perceptions of and attitudes towards of the community forestry program had significant relationships, which implied that the aspects most highly perceived were also most favoured. On the other hand, extension agent perceptions of and attitudes towards extension work and farmers were not significants related which implied that the extension agents could not distinguish perception from attitude.

Education, contact with extension agents, and participation directly affected farmers' perceptions of community forestry legislation, community forestry and extension agents under the community forestry programme; farmers with higher incomes and those who stall-fed their animals had better perceptions of community forestry legislation and extension agents; farmers who were self-sufficient in fuelwood from their farm trees had better perceptions of community forestry and extension agents; and family size directly affected farmer's perceptions of community forestry.

Similarly, extension agents who had more experience, had training and were satisfied with their jobs had better perceptions of extension work. However, extension agents with higher education had a better perceptions of the farmers.

Contact with extension agents directly affect farmers' attitudes towards community forestry and extension agents. Also, the farmers' education and participation directly influenced their attitudes towards community forestry.

Similarly, the higher the level of education of the extension agent, the more favourable were their attitudes towards extension work and farmers.

Farmers with low perceptions of community forestry and extension agents had unfavourable attitudes towards the community forestry program.

Farmers with higher perceptions of community forestry legislation, community forestry and extension agents had higher adoption rates of community forestry activities.

Similarly, extension agents with higher perceptions of extension work had higher adoption rates of community forestry activities.

Farmers with favourable attitudes towards community forestry and extension agents had higher adoption rates of community forestry.
However, extension agents' attitudes towards extension work and farmers had no bearing on adoption of community forestry activities.

Certain variables such as caste, education, income, farm size, contact with extension agents and participation directly affected the farmers' adoption of community forestry activities.

However, variables such as education, experience, training, and job satisfaction had no bearing on extension agents' adoption of community forestry activities.

RECOMMENDATIONS

Communication and Extension to Farmers

Community forestry extension programs designed for farmers should be more comprehensive so as to encompass and emphasise all relevant aspects of the community forestry program. The extension programme must be sustained, must try to inform and, more importantly, educate the people and try to reach as many farmers as possible.

Efforts to educate farmers should put more stress not only on the poorly perceived aspects of community forestry but also on the least favoured areas. Illiterate farmers should be provided with the facilities and access to learn by means of social education and adult education, along with audio-visual aids about various community forestry activities.

Continuing Education and Adequate Support of Programme Staff

It may be necessary to make a clear distinction between the protector and promoter functions of extension agents and assign different personnel to each of these two functions. The area to be covered by personnel should be realistic.

Participatory Approach

The community forestry programme should provide venues for discussion and consultation with the farmers before any implementation is done in the field. Amendments should be made in community forestry legislation to redefine the ownership of panchayat forest and panchayat protected Forest. Communities which actually provide protection to nearby forests should be given its tenure rather than institutions, which are more often than not motivated politically.

Further Research

The following areas are suggested for further research:

1) People's participation in community forestry program should be studied indepth, with more emphasis on women's participation, as they are the real users of forest products.
2) As the reasons for farmers' and extension workers' perceptions and attitudes towards the adoption of community forestry activities varied greatly, indepth study of the specific factors which are responsible for such variations should be conducted, with a view to redesigning extension teaching and providing feedback to the planners and decision makers engaged in developing suitable strategies for implementation.
3) An expanded study with larger samples should be considered for future research.
4) A study on the role of community forestry in soil conservation, and improving productivity, incomes and the standard of living of the farmers should be conducted.

PEOPLE AND GRASSES A CASE STUDY FROM THE ROYAL BARDIA NATIONAL PARK, NEPAL

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ABSTRACT

In recent years the idea of integrating local people's needs into the management of protected areas in Third World countries has increasingly gained ground. This approach attempts to provide for the cultural and subsistence needs of local people in addition to preserving natural and cultural resources. The grass resources inside the Royal Bardia National Park (RBNP) in Nepal were traditionally used by the local people for a number of different purposes before the area was established as a protected area in the late 1970s. Recognising this, the Department of National Parks and Wildlife Conservation (DNPWC) has initiated a programme of controlled harvesting of grasses from the Park. Permits are issued for a small fee and allow villagers to collect grass during a 2-week period early in the dry season. In recent years, some 30 to 40 thousand permits have been issued annually.

This study focused on areas near the south-west corner and along the southern border of the RBNP. Data were collected from households in selected wards through questionnaire surveys, structured interviews and more informal surveys based on rapid appraisal techniques. An extensive survey covered most of the area along the southern boundary of the Park, and a more in-depth survey concentrated on households within three Village Development Committees near the Park headquarters, where most of the grass is collected. In all, 181 households were interviewed in the in-depth study and, 113 in the extensive survey.

The results are discussed with reference to integrating local people's needs into conservation management. The RBNP provides the villagers with more than 14,000 tons of grasses worth 312,000 dollars a year, a sum equivalent to three times the Park budget. The Park is the only source for these grasses, contributing an essential part of the livelihood of the local people. Grasses are integral to their way of life and are used for a wide range of products and activities. The indigenous Tharu population has the widest range of knowledge and uses of the grasses. The villagers themselves find it would be impossible to cope without the inputs from the Park. It is not only those who live in the immediate vicinity of the Park who benefits. Substantial resources are harvested by people who live as far away as 20 kilometres.

There is a need for increased funding for the Park and for measures aimed at bridging the gap between conservation and development.

PROBLEM

National parks, wildlife reserves and other types of protected areas are at the forefront in efforts to maintain biological diversity. Conflicts between protected areas and the people living in their vicinity are escalating in many parts of the world. In response to such conflicts and recognising local people's rights to utilise sustainably their own resources, a new and more people-oriented approach to conservation is gaining ground. This is based on the

proposal that national parks in Third World countries cannot exist as isolated entities separate from the social realities around them. The fortress' approach to conservation is gradually being replaced by designs that take the people living near protected areas into consideration

A variety of grasses inside the RBNP in south-western Nepal were traditionally used by the local people for a number of different purposes before the area was established as a protected area in the late 1970s. Recognising this, the national parks authority (DNPWC) has initiated a programme of controlled harvesting of grasses from the Park. Permits are issued for a small fee and allow villagers to collect grass during a 2-week period early in the dry season. In recent years, some 30 to 40 thousand permits have been issued annually.

The Park is the only source of these grasses, which are used for house building, roofs and a variety of other purposes. Only a small minority can afford substitutes like brick houses or roofs covered with tiles or corrugated iron in the place of reed and thatch grasses. The programme can be seen as an attempt to provide essential resources to local people without disturbing the ecological balance of the Park area. It is a good example of trying to take local peoples needs into consideration and bridge the gap between conservation and development.

The purpose of this study was to try to establish whether the 2-week grasscutting period in the Park is supplying essential resources to its neighbours, and if this contributes to workable relations between the park and people.

OBJECTIVES

1) to estimate the amounts of different grass types that are harvested by different ethnic and socio-economic groups;

2) to investigate the uses of different grass types in individual households and establish whether there are differences in forms of utilisation between different ethnic and socio-economic groups;

3) to establish how the Park's grasslands are contributing to the local economy and the well-being of individual households;

4) to establish whether the grasscutting programme is meeting its objective of offering compensation to people in the impact zone, i.e. those living relatively near the Park and which have been adversely affected by its creation, or if the programme has been dispersed to benefit outsiders in a major way.

METHODOLOGY

Three Village Development Committees (VDCs) located from Amreni on the new highway in the north to the Indian border in the south, along the south-western border of the Park were chosen as the areas for extensive study. These were Thankurdwana, Shivapur and Suryapatuwa. This is the area where most of the grasses are collected. Smaller in-depth surveys were also carried out along the road to Gulariya on the Indian border and across the Geruwa river in Gola and Manau.

Information was gathered through informal discussions with key informants. Samples of the different grass-tyupes were collected from areas inside and outside the Park. The grasses were identified in the field with the help of local farmers and a Nepali botanist. Samples were brought back to the Agricultural University of Norway for verification. Informal household surveys were conducted to identify end uses of the grasses.

About 10% of the heads of the 2100 households in the three VDCs were surveyed. Questionnaires, structured interviews, and more informal interviews based on rapid appraisal techniques were used.

FINDINGS

Relations between Park and people around the RBNP have so far been quite favourable.

This study has shown that the RBNP provides the villagers with more than 14,000 tons of grasses worth $ 312,000 a year. This sum is equivalent to three times the Park budget. The park is the only source for these grasses, contributing an essential part of the livelihood of the local people. Grasses are integral to their way of life and are used for a wide range purposes. The Tharu population has the widest range of knowledge and uses of the grasses.

FOREST UTILIZATION AND MANAGEMENT PRACTICES OF A NEPALESE HILL COMMUNITY

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ABSTRACT

A case-study of local people's practices in forest utilisation and management was made in Naldung Panchayat in Kabhre Palanchok District. The main emphasis was given to the utilisation of two forest products, fodder and litter. Generally, the research had a reiterative character through which new information obtained in one round of interviews could be included in the following round of more detailed questioning. In addition a gradual shift from random to purposive sampling was utilised.

Besides the five forests areas that lie within Naldung's Panchayat's borders, its inhabitants heavily rely on tree vegetation which forms an internal part of the subsistence agricultural system. Forestry products originate from private lands as well as common wastelands situated outside the forest areas.

Timber, fuelwood, fodder and litter have gradually become scarce but fodder is felt to be in shortest supply, directly followed by litter and timber. Fuelwood, although becoming scarcer was considered to be still relatively available.

All indigenous forestry management systems are initiated at lower levels. The only system that was supported by the total community had disappeared some 20 to 40 years ago.

Various recommendations are made in order to get active participation of people in different forestry activities.

PROBLEM

On the one hand it is stated by many authors that due to the nationalisation Act of 1957 the forest resources of Nepal have declined tremendously as the farmers in the hills did not feel responsible for them any more. On the other hand it was not and still is often not realised that traditional systems of forest resource management in the hills of Nepal were sometimes highly social and well organised as part of the total local agricultural system.

It therefore is not surprising that many management studies have been undertaken and management plans drawn-up without considering indigenous knowledge and management systems already existing in the areas concerned. But this attitude has slowly changed during recent years with the introduction of community forestry. It was recognised that in order to formulate sound projects and/or promote new forestry techniques and concepts it is essential to understand local practices (related to both social structures and forest resources) and real needs first.

Also the planning of efficient and sustainable use of the forest resource can only be done in an effective way when issues like customs and users rights are seriously taken into consideration and incorporated. This only can be done when the local communities are actively involved. Lately community forestry in Nepal has received much attention from both the Nepalese Government and foreign organisations. Just recently the Forestry Action Master Plan has been finalised in which the term Community Forestry is one of the main items.

But it is necessary to consider such questions as: Is all the attention given at policy level to community forestry and self-determination of rural communities appropriate? Is it crystallised and in accordance with the rural people's perceptions on forest utilisation and management? Is it workable? Is it still a top-down approach even though the intentions might be the other way around?

OBJECTIVES

Specifically the study sought to answer the following questions:

- What kind of forest products are used and what are the relations between the quality and quantity of these forest products and the demand for them?
- How are the forest resources managed?

METHODOLOGY

The research site was Naldung, a rather large hill panchayat of about 2200 ha not far from Kathmandu.

The research conducted tends towards a participatory research model. For the collection of field data various interview rounds were made. The interviews were designed in such a way that optimal qualitative information on the various aspects of local practices and perceptions in respect to forest utilisation and management could be obtained.

Generally the interviews were a reiterative, so that information obtained in one round of interviews could be included in the following round of more detailed questioning. In addition a gradual shift from random to purposive sampling was utilised.

The major elements of the research methodology used were the following:

a) orientation and integration phase;
b) general interviews;
c) detailed interviews;
d) an '80-species' questionnaire;
e) discussions with key-informants; and
f) literature study.

Generally, data obtained during the interviews were cross-checked during field visits. In case of unclear or conflicting information respondents were sometimes revisited for further investigation. Such cross-checking was facilitated by the open and informal character of the interviews.

FINDINGS

Notwithstanding Naldung's close vicinity to the urban centres of the Kathmandu valley, it can be considered a more or less average rural panchayat. Its infrastructure and mixture of different ethnical groups is comparable with many more remote hill panchayats.

Besides the five forests areas that lay within Naldung's panchayat borders, its inhabitants rely heavily on the tree vegetation which forms an internal part of the subsistence agricultural system. Forestry products originate from private lands as well as common wastelands situated outside the forest areas.

Timber, fuelwood, fodder and litter have gradually become scarce, but fodder is felt to be in shortest supply, directly followed by litter and timber. Fuelwood, although becoming scarcer was considered to be still relatively available.

Local people have quite a good knowledge of tree species and their possible utilisation. Nonetheless, due to scarcity of specific species people may utilise other trees than the ones most preferred, and their perceptions about the availability of certain species often seems to be based on old conceptions rather than on the actual situations.

Indigenous forestry management systems occur at various levels. All management systems are initiated at lower levels (hamlets or other units of the community). The only system that was supported by the total community had disappeared some 20 to 40 years ago. This system concerned Raniban, which was a public grazing ground for cows and the source of timber for public buildings. With the change in livestock keeping from cow to buffalo this system came to an end.

In most of the hamlet systems observed the forest watchers had a key role in ensuring proper forest management practices. They were supported by groups of households from which each watcher received a specific quantity of grains. In return the forest watchers had to control the forest by surveillance. This system had a symbolic function and stimulated people to self-discipline in collecting forest products.

None of the existing management systems is backed up by an official organisation, be it a project or the government structure. Each was launched on the initiative from within one or two hamlets only. The forests concerned are treated as the hamlets' own property but at the same time it is realised that outsiders cannot be rejected completely, as the forest is actually state or panchayat property. Owner rights are a difficult but important topic in this respect. Customs, habits and user rights are often stronger than official rules and regulations.

Religion plays an important role within forest management. But the function of religion has changed tremendously over time. People tend to adjust their culture to suit their living conditions.

RECOMMENDATIONS

Active participation in forestry activities is most likely to occur if the activities show results in the short-term, even though forestry in itself is in principle a long-term discipline. In order to achieve this the following recommendations can be made:

- to employ more field-workers from the Naldung area. There are some really good and motivated people available in Naldung who are knowledgeable on both vegetation and social structures. These people should act as initiators and motivators and might be more successful than better educated outsiders.

- to set up trial plots according to the Baalban, model in Dubagaunban, Raniban and possibly, Chiteban and to organise twice-a-year demonstration days when actual users should make (as far as possible) the decisions themselves as to what is to be harvested.

- to set up two plantations, one small (± ½ ha) and one large (±2½ ha), the first at Chiteban and the second between Dadagaun and Lamagaun. The smaller one should be planted and managed by a part of a single ward and the bigger one by a larger unit. These plantations should have several function such as:

  a) soil conservation and reforestation;

  b) extension, as they can be seen by many people (demonstration effect);

  c) research in terms of what kind of social problems arise and how should they be solved.

A LAND USE-LAND CAPABILITY CLASSIFICATION SYSTEM FOR NEPAL : A CASE STUDY IN PHEWA LAKE WATERSHED

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ABSTRACT

Because of rapidly expanding population, the efficient utilisation of land resources to produce food, fodder and fuel is a critical need in Nepal. A scientific integrated approach to land capability classification is needed to support efficient land use.

This study developed land capability classes based on the overlay interpretation of maps of the main land charateristics of landform, soils and vegetation and existing land use. Nine land classes were delineated on the basis of levels of productive capacity, limitations, risk of soil damage, erosion hazard and need for conservation measures.

The extensive system of terraces and manual cultivation of steep-sloped terrace land plays a significant role in land capability in Nepal. The upgrading of classes by terracing and downgrading of classes by soil limitations, excess wetness and inundation are considered over the classes determined by slope, soil depth, and stoniness.

The system was tested in the Phewa Lake watershed in central-western Nepal.

PROBLEM

The use of land resources without proper management and without regard to their capability can result in soil erosion on the slopes, floods in the plains, and degradation of the productive capacity of the land. Proper land-use based on the land's capability and utilisation of conservation measures to preserve that capability requires careful planning, for which it is important to have a land capability classification system that is based on the land's capability, conservation measures required, limitations for certain uses, and risks of soil damage and erosion. Such a system is imperative in an agriculture-based country like Nepal.

OBJECTIVES

a) to develop a land capability classification system relevant to land-use in Nepal, based on (1) the inherent capability of the land for agriculture, pasture or forestry, (2) conservation measures needed to control erosion and (3) limitations, risks of soil damage and erosion hazard for certain land uses; and

b) to develop soil, landform and land-use mapping legends for Nepal, which are necessary for using the system.

METHODOLOGY

The following maps were first prepared:

a) soil maps including soil depth, stoniness and rockiness;

b) landform maps including slope; and

c) vegetation and/or land-use maps.

Land capability maps were then prepared by overlaying of the above three kinds of maps.

Three levels of generalisation of mapping system were prepared. The Level I generalisation is for use on 1:250000 or small scale Landsat or high altitude aerial photographs with minimum ground checking. This level of generalisation is designed for broad reconnaissance inventory or for deriving general information on an area. Level I cannot be used for land capability classification, because it is too general for the purpose.

The Level II generalisation is for use on aerial photographs of 1:50000 to 1:100000 scale with moderate ground checking. The Level III generalisation is for use on 1:12000 scale aerial photographs with intensive ground checking. Level II and III mapping is very detailed and is designed for land capability classification.

The recognisability and mapping of an object is determined by its size, shape and nature and the resolution of the photographs. Therefore, the level of generalisation and scale of aerial photographs are not restricted to each other.

At present, Nepal has almost complete coverage by aerial photographs of scale of about 1:50000.

FINDINGS

The efficient utilisation of land resources can be achieved by proper planning of land not based on a reliable land capability classification. The land capability classification system can:

1) classify the land on the basis of (a) the inherent capability of the land for agriculture, pasture or forestry utilisation; (b) conservation measures needed to control erosion; and (c) limitations, risks of soil damage and erosion hazard for certain landuses;

2) guide landowners in choosing the most appropriate use for the land;

3) provide guidance to land-use planners;

4) facilitate effective planning of research on land management and assist in applying the results in extension programme; and

5) enable the compilation of soil, landform, vegetation and existing land-use maps, that can be used in interpretation for other purposes such as urban development, and wildlife

management.

One of the major problems of the system is it requires considerable amount of time and labour.

RECOMMENDATIONS

The system developed here should be tested for other parts of Nepal and should be further refined before being extensively used.

Further work to develop the system should stress:

1) quantification of productive capacity, erosion hazards, limitations, risks of soil damage and need for conservation measures.

2) consideration of micro-climate such as aspect, rainfall patterns, growing seasons and frost.

3) consideration of local socio-economic conditions.

4) consideration of irrigability of land.

The classification system reflects present needs and socio-economic conditions and should be amended, taking advantage of improved technology to reflect future changes so as to continue to satisfy the objectives set out for land-use classification.

ENVIRONMENTAL EDUCATION PROBLEMS AND OPPORTUNITIES IN THE ROYAL CHITWAN NATIONAL PARK, NEPAL

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ABSTRACT

The various types of forest land provide habitats for diversity of animals, especially in the Terai, the southern part of Nepal, which was renowned for its indigenous wildlife. This part of Nepal can still boast a rich and varied fauna, although because of development, settlement encroachment in the forest land, poaching and over exploitation, the forest has been disappearing rapidly during the last couple of decades, and as a result, wildlife populations are now very depleted and most species are threatened with extinction. Management of such areas to conserve the indigenous fauna and flora is of the utmost importance both ecologically and economically. The fast-growing tourist industry in Nepal has also placed tremendous pressure on forests and reserves in the mountains, where then needs for firewood and leaf litter are now serious problems. Therefore, steps towards visitor education needs to be taken by providing sufficient information and enforcing park rules and regulation. The study also found out that the most difficult issue is the need to maintain good public relations in the area. Various recommendations were made based on the findings.

PROBLEMS

The Royal Chitwan National Park was legally established in 1973 with an area of 210 sq. miles, and in 1976 was extended both east and west to an area of 360 sq. miles.

As the Park is less than a decade old, it has completed only the basic development. Much remains to be done. A major problem is dealing with the local people who have objected to the prohibitation of their accesss to the Park. Before the establishment of the Park, villagers were using the area for their daily needs of firewood, grasses and all kinds of forest products. One can understand how difficult it was to maintain good relations with people without an alternative resource to meet their needs.

METHODOLOGY

This is based mainly on a literature review and the experience of the author.

FINDINGS

Deforestation threatenes not only wildlife but also human well-being in the Terai region owing to insufficient food and energy for the communities living there.

Management of such areas to conserve the indigenous fauna and flora is of the utmost importance both ecologically and economically.

Recreation in the forests or parks for most Nepalese has hardly begun, owing to lack of roads and transport systems.

The fast-growing tourist industry in Nepal has also placed tremendous pressure on forests and reserves in the mountains, where then needs for firewood and leaf litter are now serious problems. Therefore, steps towards visitor education needs to be taken by providing sufficient information and enforcing park rules and regulation.

The most difficult issue is the need to maintain good public relations at the Royal Chitwan National Park.

RECOMMENDATIONS

The following recommendations are made for the development of the Park:

1. a The visitor centre in the Park should be staffed regularly.

   b. Detailed information on the Park should made available in Kathmandu, before tourists go to the Park. To this end co-ordination between the tourism information service and the Park office is highly desirable. Brochures or information bulletins could be produced jointly.

   c. Slide shows should be organised in the visitor centre to interpret more about Park.

   d. Park staff in the field should be provided with cameras and other photographic equipment and encourased to take photographs for education programs.

   e. As the Gharial Project at Kasara is an important attraction, the present visitor centre should improved and additional pictures and information should be placed on display.

2. A short trail up to a machan (watch tower) and a trail along the Rapti River should be provided for educational tours. A trail should also be provided for trekkers who can spend several days in the back country. Possible routes are:

   a. Sauraha-Hasta Khola-Dharang Khola-Amuwa-Surah.

   b. Boating down between the Narayani and the Park headquarters and trek back. Transportation may be required in this case.

3. Camp sites should be provided in order to reduce the pressure in Saurah area. These should include basic facilities including toilet, kitchen and water.

4. Because of the difficult access to the area, some accommodation should be made available for visiting school groups.

5. (a) Whare possible, the Park should provide more job opportunities for the local people.

   (b) The Park should take the necessary steps urgently to minimise crop damage by wildlife. Electric fencing might help in this regard.

6. The wildlife population of the Park should be determined.

7. (a) Staff should be trained appropriately for the tasks assigned to them.

   (b) a training course for the Park guards should be conducted every three months.

   (c) Army staff and civil staff such as rangers, foresters, senior game scouts and others also require an understanding of the conservation programme and should be given education on the conservation programme of the Park.

COMMENTS ON THE TRADITIONAL PATTERN OF FOREST USE IN THE HILLS OF NEPAL

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ABSTRACT

Nationalisation of Nepal's forests in 1957 was an unsuccessful attempt to conserve and protect the forest resource. Malaria eradication in 1960s had enabled a huge migration from the hills to the Terai, and technical advice supplied by the international organisations policy-makers then suggested the clearance of forest for food for the people. The huge population growth, clearance of the forests for settlement of the migrants in the Terai and production of food for the hills people and extreme presssure on the remaining forests presented a great danger of environmental degradation in the country. This probable environmental degradation and fuelwood crisis in Nepal, received world-wide attention in the 1970s. The blame was largely placed on the peasants for this destruction.

Community Forestry, implemented from 1978 aims to meet the basic forestry products requirements of the rural people. To facilitate this, panchayat forests and panchayat protected forest rules were formulated, under these rules state owned forests were handed over to the local communities with a management plan. The objectives of the management plans were formulated for community woodlots improvement, but the local community hardly knew about the management plans made by community forestry assistants (CFA).

It is suggested that these management plans be simplified so that they could assist in the determination of the community's way of managing their forests. Traditionally existing indigenous utilisation patterns of the forests, seen even today in the hills of Nepal, may provide vital clews for the solution of the problem of forests resource depletion and to meet the basic needs of the people through proper management and protection by the local people themselves. This would assist in fighting back the degradation of the environment of the country.

PROBLEMS

In developing as well as developed countries forests and trees contribute in various ways to the daily life of the people. Forestry plays a significant role in the the rural development process. However, Nepal, like most other developing countries, suffers due to the problem of the disappearance of the forest resource.

In order to achieve planned development and scientific management of the natural forest resources, all the private forests were nationalised in Nepal. New policies were introduced and organisational reforms were taken to us in order to implement the policies. These policies and strategies usually ignored or gave a low priority to the needs of the people living in or adjacent to the forest for firewood, fodder, timber, fibre, medicine etc. It was realised that the forests needed to be managed to ensure the fullest possible participation and involvement of

the local people because they know best what they want and what is needed where they live.

OBJECTIVES

This study aimed at identifying approaches to community forest management that might be effective in Nepal. It is no use preparing forest management plans only. The criterion of success should not be the preparation of the management plan only. A management plan should have a definite objective. It should employ a strategy that is practicable, and above all it should be understood by the local people if they are the ones to use it.

The indigenous knowledge or the 'folk knowledge' which is the practical knowledge the local people have may be of great value. The traditional system of forest management can provide important lessons that should not be ignored.

Community management of forest resources is indigenous and not an imported or borrowed technology. Local knowledge on which the indigenous system of natural resource management is based holds great importance for the sustainable management of the environment. Loss of traditional system of resource management at any place should not be merely a concern over loss of the physical resource but also as a loss of the potential for good management. The forestry technicians in Nepal must study the the traditional practices of forest management and see how best they can be improved and best used for the development and conservation of the forest resources of the country.

METHODOLOGY

This study is based on a literature review and the on going experience of the anther.

FINDINGS

Destruction of the forests, whether in the Terai or in the hills, is not due to the management practices of local poeple. The concept of community involvement in forestry to manage production on a sustainable basis is not new to the hills. Searches throughout the country showed that sustained yield management often existed, and continuations of such management systems are still found in one form or another, showing the capability of the communities to jointly protect, manage, and utilise the forest to meet their needs in the long-term. The traditional patterns of forest management varied from place to place. All these seem to show that rural communities often knew better than foresters what was needed and suited to local situations.

Traditional systems of forest management integrated all aspects of need and availability of resources, and times for harvesting during the year. In the pursuit of better management and conservation of the forest, government policy changed and the forests were nationalised in 1957. The existing traditional management systems were by-passed or ignored, and people's requirements were not considered as important. This was a big defect of the new system.

Shortage of trained staff, funds and lack of a stable policy also led to failure in the implementation of management plans and of efforts to educate local people on the part of government. This was partly because the management and education plans drawn up

although depended on a reasonably sound technical skills, proved unsuited for their execution to meet the local communities requirements.

Successful forest management must be a combination of understanding and acceptance of a sound management system by the local community and reflection of social needs. Drawing on options which can be readily understood by the village people simplifies the whole process.

Placing forest management decisions with local communities is a radical departure from conventional forest management and one that will take a good deal of patience and perseverance to implement. However, there are leads that can be taken from traditional ways in which local communities have utilised forest resources of the country, in providing systems which may be socially acceptable.

THE POTENTIAL OF AGROFORESTRY IN THE MIDDLE HILLS OF NEPAL

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ABSTRACT

The problems of environmental degradation arising from existing land-use practices and their impact on agro-ecosystems and the rural economy in the Middle Hills of Nepal are discussed. Analysis of available information indicates that extreme human population pressures, along with social and economic constraints, have created severe land-use problems.

Exponential population growth and high livestock numbers, bring extension of cultivated land on to unsuitable slopes, overgrazing of both forest and rangeland and increasing demand for forest products to meet the basic needs of the growing population have degraded the environment considerably. The deteriorating conditions are reflected in declining crop yields, severe soil erosion and increasing scarcity of forest produce , especially fodder and fuelwood.

The nature of these problems suggests that there is an urgent need for an alternative land-use system capable of meeting the basic needs of the people on a sustainable basis and capable of halting environmental deterioration. Information from elsewhere reveals that agroforestry systems which integrate crops, livestock and trees have potential to achieve both objectives. Studies from different countries are reviewed to determine the applicability of agroforestry land use systems in the Middle Hills. Three main systems-agro-silvicultural, silvopastoral and agrosivopastoral-are considered.

Alley cropping, introduction of multipurpose tree species on farmlands as shelterbelts or windbreaks, tree interplanting (agrosilvicultural systems); controlled grazing in afforested areas, restoration of rangelands, establishment of fodder trees orchards on private land and stall feeding of livestock (silvopastoral systems), and relay cropping or ley farming and the introduction of grasses and legumes on terrace risers (agrosilvopastoral systems) are proposed as alternatives to present land-use systems. Appropriate fodder grass, legume and tree species for each system are suggested, and management practical application and implementation of these systems at community level is postulated.

PROBLEMS

The farmers of the hills region of Nepal generally pursue a mixed farming system in which three main components -- crop production, livestock husbandry and forestry -- are closely and inseparably integrated. To be sustainable, hills farming systems primarily require a net transfer of fertility from the forest, through fodder and leaf-litter, to stall-fed animals. Forest is an integral part of the farming system, just as much as arable land and livestock.

Recently, rapid population growth throughout the hills region has resulted in increased competition for scarce resources, the fragmentation of land-holdings and the gradual but

inevitable breakdown of the fragile but previously sustainable hills farming systems.

Various estimates indicate that the demand for forest products such as fodder, fuelwood and timber far exceeds supply. The situation in the Middle Hills is the most serious. This has resulted in serious problems of soil erosion, mass wastage and loss of arable land through landslides. Abandoned terraces are common in many areas, indicating the inability of farmers to maintain ecological stability and productivity at acceptable levels.

Considering the situation described above, all future means of solving the mountain land-use problem have to be directed towards the main point of overcoming the deficit in biomass and human nutrition in these areas.

Although agroforestry systems predate the coining of the term and are a part of traditional farming wisdom, it is only recently that their importance and potential has been recognised. They have a special role to play in the management of marginal lands, which become more and more degraded by continuous agriculture and where the main source of fertility is organic matter.

It is in this context that agroforestry assumes considerable significance for the hills farming systems of Nepal.

OBJECTIES

This study examined the current land-use practices and the impacts of subsistence agriculture on agro-ecosystems and rural economy in the hills of Nepal. The status of traditional agroforestry in the hills of Nepal is reviewed and attempts are made to analyse the natural and socio-economic conditions for possible future agroforestry production systems at the community level in these areas. Particular emphasis is given to existing systems as a basis for improvement offering wide scope for meeting community needs.

METHODOLOGY

This study is based mainly on review of literature.

FINDINGS

The deteriorating environmental conditions in the Middle Hills of Nepal are reflected in declining agricultural production, severe soil erosion and an increasing scarcity of forest produce, particularly fodder and fuelwood.

Agroforestry systems -- agro-sivicultural, silvopastoral and agrosilvopastoral -- have considerable potential for improving existing land use in the Middle Hills, particularly the weakest link in the farming chain -- the supply of fodder.

Potential agrisilvicultural systems identified for the Middle Hills are alley cropping, introduction of multipurpose tree species on farmlands for shelterbelts, windbreaks and tree interplanting.

The silvopastoral systems offer the greatest potential for solving to fodder supply problems in the Middle Hills. Controlled grazing in afforested areas, restoration of rangelands, establishment of fodder tree orchards on private land and stall feeding of livestock are systems with high potential.

Among agrosilvopastoral systems, relay cropping or ley farming and the introduction of fodder grasses and legumes on terrace risers deserve special attention.

RECOMMENDATIONS

The various agroforestry systems discussed above should be vigorously pursued since a successful implementation would certainly increase overall productivity and enable a satisfactory ratio of agricultural to forestry land to be attained to sustain the present farming system and the existing area of agricultural land.

The Panchayat Forest and the Panchayat Protected Forest Rules of 1978 and the currently operating Community Forestry Development Programmes are promising organisational frameworks and should be responsible for implementing agroforestry programmes at field level.

With present staff and logistic constraints, District Forest Offices alone will not be able to implement the programmes effectively. Support manpower from the related disciplines of agriculture and livestock should be made available.

Extension services should be made available by the Department of Forests as well as by the Department of Agriculture and Livestock. The combination of these services is essential.

More emphasis should be given to local involvement in the programmes. To encourage local initiatives, leader farmer training programmes at pancayat level with regular follow-up visits should form a permanent feature of agroforestry extension.

Regular in-service training programmes for field staff, preferably at intervals of six months, should be organised. Seed orchards for suitable tree species should be established in various environmental zones.

Future Research

A number of research programmes should be undertaken to faciliate success of any massive programme of agroforestry. The immediate needs are:

- Tree and shrub species will need to be selected for their wider genetic variation and adaptability to suit different marginal or low nutrient soils. The selection should be for species with multiple uses sauch as fodder, fuel, timber and fertiliser and high regenerative or coppicing ability. Nitrogen-fixing ability would be an additional advantage.

- Agro-techonological packages of cultural practices for individual species and specific habitats should to be worked out in combination with appropriate fodder gasses/legumes.

- research on optimum combinations of spacing between agricultural and tree crops for sustained combined productivity.

- research on pollarding of fodder tree to maximise leaf production. Raising trees at a close spacing followed by pollarding would provide more foliage per unit area.

- research into ways of improving the quality of nursery stock and hence operational efficiency and survival in the field.

- research to define appropriate stocking levels for rotational grazing systems.

All this research will require an integrated and multidisciplinary approach. Relevant disciplines should pool their expertise to find solutions to problems arising in various areas.

DISSEMINATION OF FORESTRY INFORMATION AMONG RESEARCH WORKERS, WITH SPECIAL REFERENCE TO NEPAL

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ABSTRACT

Different kinds of research scientists are categorised as different levels of users. Information needs of users of forestry information in Nepal are examined, identified and discussed in this thesis. Information seeking behaviour of the users is characterised.

Publications of forestry information inside and outside the country are mentioned. Bibliographies of literature are considered an important feature for forestry information services. The communication of such information from producers to users are identified. Libraries are shown as intermediaries in disseminating forestry information. The present situation of forestry in Nepal, the availability of information for forestry research and user satisfaction levels are examined and identified.

Primary, secondary and tertiary information services are discussed. The study also aimed to identify the present situation of the forestry libraries and existing services available in the forestry libraries, including networking of forestry libraries in Nepal and their resource capabilities.

A COMPARISON OF GROWTH RATES AND DEVELOPMENT OF BIOMASS TABLES OF SOME FUELWOOD TREE SPECIES IN THE EASTERN TERAI OF NEPAL

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ABSTRACT

Trial plots of 0.735 ha of six fast-growing fuelwood species (*Acacia auriculiformis, Acacia catechu, Dalbergia sissoo, Eucalyptus camaldulensis, Eucalyptus tereticornis* and *Leucaena leucocephala*) were established in July 1985 at Tarahara in the eastern Terai of Nepal to compare their growth rates and biomass production on short rotations.The *L. leucocephala* plot was heavily damaged so it was excluded from analysis. Statistical analyses were performed on height, diameter, basal area, survival (%), green biomass of tree components and above-ground wood after 5.5 years growth. *E. camaldulensis* and *A. catechu* were not significantly different from one another in diameter (10.1 cm and 11.3 cm respectively) or in the height (10.9 m and 12.5 m respectively). *E. tereticornis* has both lowest diameter (9.4 cm) and lowest height(8.2 m).

Basal area varied from 12.544 m^2/ha for *A. catechu* and 11.468 m^2 / ha for *E. camaldulensis* down to 3.382m^2/ha for *E. tereticornis*. The four species except *E. tereticornis* did not differ significantly in basal area. Close relationships were found between the green and oven-dry biomass of branches (including twigs without leaves), stem wood (including bark) and total above-ground wood respectively and the breast height diameter (logarithmic transformed) for all the species, including *E. tereticornis*.

Oven dry biomass of above-ground wood (kg/tree) was highest for *A. catechu* (35.97 kg/tree) and lowest (17.25 kg/tree) for *Acacia auriculiformis*. Dry biomass production per unit area for four species except *E. tereticornis* was the highest (42.59 t/ha) for *A. catechu* and lowest (25.01 t/ha) for *D. sissoo*. Green above-ground biomass was highest (100.35 t/ha) for *E. camaldulensis* and the lowest (19.27 t/ha) for *E. tereticornis*. The species did not differ significantly in green above-ground wood biomass production except for *E. tereticornis*.

After 5.5 years the growth and biomass production of *A. catechu* was found to be surprisingly similar to *E. camaldulensis* restricted to pit cultivation. There were no statistical differences between the four species excluding *E. tereticornis* in green above-ground wood biomass production. However, it was observed that *A. catechu* and *E. camaldulensis* showed better performance in diameter, height, basal area and biomass production than the others.

PROBLEM

In Nepal biomass provides 95% of total energy consumption, whereas fuelwood accounts for more than 87%. Increasing attention is now being paid to large-scale afforestation programmes to meet the severe crisis created due to the shortage of timber, firewood, etc. A number of multipurpose fast-growing species are therefore, being raised by forestry projects. However, short rotation plantations in the Terai region are still in their infancy. The Forestry Research and Sagarnath Forestry Development projects have identified the most promising species for plantations and smaller community woodlots but only in the central Terai/Bhabar region.

Biomass yield estimates are an important tool in the management of forests both for large scale plantations and small village woodlot. Sound management of the plantation with good planning requires accurate estimates of growth and yield to facilitate decisions about the site for species, growth rates timing of harvesting etc. Thus, biomass tables for established short rotation plantations have increasingly become vital, particularly for forest managers for the estimation of fuelwood yield in the Terai.

So far, biomass studies on the above mentioned fast growing fuelwood species have not been carried out in the eastern Terai. It is expected to fill this gap to some extent by providing information on the growth and above-ground biomass of these species managed on short rotations.

Oven-dry weights are generally used for the development of biomass prediction equations. In addition to this, the use of oven-dry weights provides a standard reference by which measurements at different sites can be compared. However, fuelwood in Nepal is sold on a green weight basis. Forest managers need to know the yield of the crop on the basis of both green and air dry weight because of the practical problems of sale units. Therefore, green weight tables are essential and will be presented in addition to the oven-dry tables. The biomass equations (based on oven-dry as well as green weights) developed on the above mentioned species are initial steps to provide yield estimates in the eastern Terai.

METHODOLOGY

The study site, Tarahara lies in the Susari District in the eastern Terai region of Nepal. A forest area of about four hectares was provided by the District Forest Office. The trial was set up in July 1985 on 0.735 ha. Five out of six species. The experimental design was randomised complete block of four replications with six treatments. Each plot size consisted of 49 plants of each of the species and only the inner 5 x 5 plants were used for assessment leaving one outer line as buffer. Spot cultivation was done at 0.5 m radios around each plant twice a year for the first three growing seasons.

Assessments were done in January-February each year during the slowest growing period. All surviving trees within each effective plot size were measured. Heights were measured using a Sunnto clinometer on the inner core of 5 x 5 trees of each of the species in January 1990 and 1991 and diameters at breast height were also recorded during that assessment.

Four to seven trees of each species in each plot of each block were selected as having diameter at breas height (dbh) covering the entire range of variation of dbh in the population and were destructively sampled to compute biomass tables for bolewood, branchwood and total above-ground wood (plus branches). Representative sub-samples of each component were collected for the determinations for moisture content and dry matter percent. These sub-samples were taken to the laboratory and oven dried.

Altogether, 20 trees of *Acacia auriculiformis* and *Dalbergia sissoo,* 22 of *Acacia catechu,* 21 of *Eucalyptus camaldulensis,* and 17 of *Eucalyptus tereticornis* were felled for the estimation of biomass from the four blocks.

FINDINGS

The predictive biomass equations developed from these results are an early attempt to help generate the biomass table for these species in the eastern Terai of Nepal. These tables can provide reliable estimates for existing plantations of these species.

RECOMMENDATIONS

Information on nutrient cycling in Nepal forests of the species studied is almost non-existent. Research on this master should therefore be undertaken to help in selecting of the best species and management practices.

Fourther research should be carried out to supplement existing knowledge on the biomass of these species at different spacings.

Of the five shortcut methods used for biomass estimation, basal area proportion, stratified mean tree technique, and mean tree technique using tree of mean basal area could be used for in cases where there are no biomass equations developed for a particular site.

WATERSHED MODELLING: ESTIMATION OF SURFACE RUNOFF AND SOIL EROSION RATES: A CASE STUDY OF NAKKHU KHOLA WATERSHED, NEPAL

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ABSTRACT

How can the conditions of the people living in degraded mountain watersheds of Nepal improved without further degradation of the watershed ecosystem? The technical solutions derived from qualitative assessments of watershed conditions in the past has not helped much to solve the issue raised by this question. It calls for a methodology, based on a quantitative approach, for better understanding of the local environment. This must be supported by the local farmers responses in order to develop recommendations for watershed management strategies and to implement the program through the farmers participation.

This study demonstrates a methodology to quantify two key physical indicators of watershed conditions and identify the causes for the change in surface runoff and high soil erosion rates. The findings from the physical modelling are supported by field data.

The study carried out on Nakkhu Khola watershed indictated that surface runoff increased over time. Soil erosion rate from the watershed area is very high. Mass wasting dominate total sediment load in the river downstream. The major physical and socio-economic factors causing degradation were analysed. These were increase in population, high susceptibility of mountain ecosystem to landslide frequency. The present management strategy has to be changed because, the objective is very narrow, the scale of activities is quite low, and the program does not provide initiative to the farmers for launching conservation management activities. Resource management actions are recommended to improve the condition of the watershed by increasing local farmer participation.

PROBLEM

Mountain watersheds in Nepal occupy a prominent place in the geographical and economic setting of the country. They account for 68% of the total area and serve as a homeland for 60% of the total population. Natural resources provided by the watershed ecosystem are the main sources of livelihood of the majority of the rural population. More than 90% of the population living in these watersheds are dependent on agriculture .

This over-dependency on the primary resources has a negative impact on both the productivity and stability of the hills ecosystem. Their fragility, the high intensity of rainfall and increased human activities keep these watersheds in a continuous process of change. Within the past fourty years, these watersheds have experienced major changes in: i) land use (e.g. deforestation, extension of cultivated lands), ii) natural calamities (e.g. greater frequency of landslides) iii) hydrologic regimes (e.g. increased surface runoff and flood frequency), iv) surface soil conditions (e.g. soil erosion and loss of soil productivity), and v)

food sufficiency (e.g. increasing demand for food, fuelwood and fodder with decreasing supply etc.)

At national level, a series of conservation policies and programs have been introduced and a national level co-ordination council has been recently set up to address the problems of environmental degradation. The lack of success in the current strategies, however, points to the need for new strategies. A sound watershed management strategy requires the assessment of local/ regional physical and socio-economic conditions. It is necessary to clearly understand:

i) The physical and socio-economic causes, nature and dynamics of watershed degradation;

ii) The indicators of degradation such as increased run-off and soil erosion.

This thesis attempts to demonstrate a methodology which can contribute the understandings to solve some of these problems through the estimation of rainfall runoff and soil erosion rates and analyses of the causes.

METHODOLOGY

This study used the questionnaire administration method , the official documents, and personal observation techniques in collecting socio-economic data. The physical data were collected from various relevant organisations and personal observations. The following stepwise procedures were adopted to meet the objectives of the study.

i) **Aerial photo Interpretation**:

After the site selection, aerial photos for 1954 (scale 1:32,000) and for 1986 (scale 1:10,000) were obtained. The topographic map 1956 and land use map (1978) were also obtained. The topographic maps was taken as the base map to prepare the final map. The land use map (1986) was also taken as a base map. Finally field verification was carried out to prepare a 1986 general land use map, and crop and vegetation maps.

ii) **Soil Sample Tests**:

Laboratory tests for soil texture, nutrition status and pH values were conducted, taking soil samples at 10 different locations. The soil map was prepared using topography and land capability map prepared by the Land Resource Mapping Project (LRMP) as the base maps.

iii) **Questionnaire Administration**:

Sixty nine numbers of households (approximately 5% of the total population) were interviewed to determine the perceptions of the local people regarding on the existing environmental conditions in the area, causes of floods and landslides, the effectiveness of the BWP and the responses to the crop diversification and local needs.

iv) **Digitization of Maps**:

All the maps prepared including geology, land degradation and 1978 land use maps were

digitized in IBM micro computer with the use of the Geographical Information System (GIS) ARC/INFO package to prepare the data bases for the physical modelling and further analyses. .

v) **Physical Modelling, and Results Analysis:**

With application of the GIS ARC/INFO according to package recommendations, the estimation of surface runoff potential, and soil erosion rates were performed. The estimated surface runoff results of 1954, 1978 and 1986 are also compared.

FINDINGS

1) The multidisciplinary approach combining physical, socio-economic and political aspects provided a better understanding of the issues related to environmental degradations than a study of physical aspects alone.

2) The use of a GIS application though is time consuming and costly, helps in physical modelling and land use change analyses which otherwise, would be much difficult to carry out.

3) The erosion rates estimated are within the range specified in other studies in Nepal. The application of USLE can be made for conservation planning in mountain watersheds but with some caution.

4) The surface runoff has increased over period studied due to changes in land use patterns and forest/shrub cover. The runoff rates are increasing.

5) The mass wasting contribution to the total sediment load is very high to the surface soil erosion.. Though minimal in comparison, surface erosion is continuous and need to be controlled.

6) The farming systems being practised by farmers is below subsistence level. The decreasing soil fertility and increasing cost of cultivations are other major reasons for low conservation activities in addition to subsistence level farming. Though farmers were found to be conscious of the cause of environmental degradation, its causes and effects, they were to poor to practice conservation.

7) The scale of activities of the Bagmati Watershed Project aimed at reducing the soil erosion rates and increase the quality of life of the people is quite low in comparison to the intensity of the problem. The project also failed to introduce productivity measures to increase the resource supply and reduce the pressure on these resources.

RECOMMENDATIONS

1) A Central Database Management Network Systems(CDMNS) in co-ordination with the present watershed management and rural development projects should be established. Air photos at 1:10,000 scale should be taken at regular intervals and data should be feed into CDMNS to aid in conservation planning and monitoring of watershed management

projects.

2) As International Centre for Integrated Mountain Development (ICIMOD), will have micro computer supported GIS, a wing in Soil and Water Conservation Department should be created and works should be carried out in co-ordination with ICIMOD. The present Remote Sensing Centre should be made active toward this.

3) Experimental runoff plots should be established in all watershed project representing different kinds of slopes and land use patterns.

4) The application of GIS should be confined at regional scale and for medium level watersheds. The use of GIS for watersheds less than 25 sq.km. can be costly and time consuming. Instead a field based "quick design" approach in consultation with the farmers can be applied for small watersheds.

5) Software packages for indetifying key environmental indicators should be developed for mountain regions. This can help for making timely monitoring of the projects and take quick decisions

6) The objective of the BWP should not be only protection of the watershed as it is now and it should not concentrate its activities only on the structural aspects but should also deal with productivity aspects.

7) **Planning Approach:**

Present planning, design and implementation approach should be changed toward;

i) collecting of essential data for soil conservation measures e.g. soils, climate, land use, topography, infrastructures, crop management, farming systems, hydrology, soil erosion, surface runoff, geology etc. and establishment of a sound data base management purposes;

ii) introducing land use policies to provide a basis for developing systematic planning guide lines on a micro watershed basis or on the basis of political units;

iii) changing of existing legislation and financial procedures to give local communities (not the local political organisations) appropriate power to manage and utilise the natural resources and the financial benefits of the projects;

iv) developing and strengthening community organisation in area where these are inadequate; and

v) planning and design of the programs and budget with focus to the physical environment and farmers need in consultation with the farmers in the field.

8) Scale and Duration of the Program:

The scale of the program should depend on the intensity of the problem and financial and institutional capability of the project. The duration of the project should be fixed for duration of 5 to 6 years and after that the policy should be toward handing over the

management responsibility to the farmer themselves.

9) Technological Choice:

It is not always desirable to adopt the technology such as the cropping practices that is only preferred by the farmers. In steep terraces, present practices of maize farming can not be allowed to continue. A technological package that suite to the local ago-climatic conditions should be developed.

The second point of the consideration is that the type of technology adopted should bring down the soil loss within physical carrying capacity limits. Evaluation criteria to measure the soil loss against the soil loss tolerance values and for productivity measures before and after the project must be developed and carried out for the selection of appropriate technology in the future.

10. Structural Measures:

The structural measures followed by BWP sounds quite appropriate, though not sufficient. Agronomic measures should follow along with these structural measures, An experimental surface runoff plot should be established and research on developing agronomic package suitable for steep slopes should be conducted in one watershed and the outcome should be tried in similar locations. Other structural measures such as construction of ponds, runoff diversion structures, land reclamation, terrace improvements etc. should be continued but with local peoples involvement.

11. Farmer-based Solutions:

a) changing of existing legislation and financial procedures to give local communities appropriate power to manage and use the natural resources and financial benefits from the project themselves;

b) communicate the causes and possible effects of increased surface runoff and soil erosion on soil fertility, crop productivity, cost of cultivation and possible measures to be adopted by farmers.

c) letting the farmers organise and demand for the assistance from farmer themselves.

d) employing catalysts or Non Governmental organisations (NGO's) to strengthen the local communities' organisation and to train the people. Employ field supervisors from among these trained people and local teachers.

e) introduce technical program after settng up of local institutional infrastructures and providing financial and technical support with minimal interventions.

f) carry out timely monitoring and evaluation, with people participation and suggestions for improvement in conservation practices.

g) carryout farmers to farmers' training to initiate more people in conservation management.

FUTURE RESEARCH

1) establishment of rainfall recording stations and use of the SCS Curve Number model with consideration of rainfall intensity and slope aspects, applying GIS,

2) studies on other biophysical aspects which the present study has not touched but which are of immense importance in providing knowledge on soil and water conservation. This include: study of species types, total biomass available, soil quality and fertility, research on tree species and crops suitaed to local agro-climatic conditions which may help in reducing soil loss, maintaining soil fertility and increasing productivity.

COMMUNITY FORESTRY IN THE HILLS OF NEPAL: A PROPERTY RIGHTS APPROACH TO RESOURCE MANAGEMENT

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ABSTRACT

Establishing property rights over resources is vital for the efficient and equitable exploitation of resources in developing countries such as Nepal. Nepal's economy is based on subsistence agriculture, with forestry as an integral part. The hills communities of Nepal, being dependent on forests, have always protected their forests on the basis of mutually recognised access and use rights. In the past, however, the institutional changes imposed by the state have often tended to disrupt the existing local common property systems. This, eventually, resulted in deforestation and degradation of forests. The present community forestry policy, implemented as an on-going programme since 1978, acts to return the ownership of the forests to their relevant user communities for use and management.

This study analysed the community forestry sector of Nepal from a property rights point of view. The focus of the study was to assess how community forestry in Nepal acts to formalise the rural community's rights over the forests.

PROBLEM

Community forestry was first formally implemented in Nepal in 1978, with the aim of combating deforestation and mobilising forest resources for economic development. Since the early stages of its inception, community forestry has aimed at returning the ownership of the forest resources to the people. However, it took almost a decade to realise how this could truly be achieved. The transfer of ownership started after the adoption of a clear-cut community forestry policy in 1988. The essence of community forestry in Nepal is the transfer of control over the forest, and responsibility for its management, from government to the local communities.

The literature during the late 1970s highlighted the existence of continual massive deforestation in the Himalayas, leading to an ecological crisis in the hills of Nepal.

Authors have used various economic, social and anthropological theories to explain the deforestation in the hills of Nepal in the past.

However, these theories have been frequently questioned, and no single theory alone is considered efficient to fully explain the deforestation in the past. It has been suggested that: "because Nepali villagers view the forest as a common property resource, they misuse it. They inefficiently consume forest products and inefficiently invest in the forest resources ... These inefficient actions are the result of the common property character of the forest, and they impose welfare losses to the society". However, the contention in this thesis is that the forest resources could never be better protected and conserved than by those whose survival depends on the existence of the forest itself. The people in the hills of Nepal have always

depended on the forests for subsistence, and therefore they have had a common motive to use and sustain the forest.

It is argued that the disruption of the community-level institutional arrangements caused by the shift of property rights over the resources has remained the root cause of deforestation in the past. The community forestry programme currently being implemented is an approach towards the legal and formal establishment of the people's property rights over the forest resources.

METHODOLOGY

This study is based mainly on a review of the literature.

FINDINGS

Community forestry has proved to be an effective tool for both the protection and the efficient use of forests as common property resource in the hills of Nepal. Community forestry as a property rights approach to resource management in the case of the Hills of Nepal thus ensures:

- increased protection of the resource base;
- efficient, equitable and sustainable management of forests; and
- improved social welfare.

FURTHER RESEARCH

Some areas of further research are:

- study on patterns of interaction amongst individuals and different interest groups involved in community forestry. This study should be instrumental in solving the problems related to the involvement of the poor and socially marginalised, enforcement of rules and violation from outside the users' group.

- study on the effect of size, shape, ethnicity and the socio-economic conditions of the forest users' groups on effectiveness of community forestry. This study should be helpful in formulating alternative approaches as intervention to successfully involve the people in common property forest management.

YIELD AND OPTIMUM STRUCTURE OF UNEVEN-AGED SAL FORESTS IN SOUTHERN NEPAL

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ABSTRACT

Sal (*Shorea robusta*) is a very important timber species in Nepal. This study presents a transition matrix model of sal, applied to a selection forest growth under Nepalese condition. The objectives of the study were to develop a growth model for an uneven-aged stand of sal forest and to optimise stand structure by using the growth model and linear programming software. The empirical parameters were estimated for the transition matrix model. The transition probabilities were based on a one-hectare permanent sample plot established recently in commercial forest. Adding a separate waiting class for small seedlings further developed the transition matrix model to describe the dynamics of theses. Empirical data was limited and the transition probabilities do not depend on the stand density. The in-growth parameter for the growth model was taken as constant.

A computer programme of FORTRAN prepared by Professor Timo Pukkala was used for making simulations. According to simulations the transition probabilities were quite high for one year. The annual growth rate was 11 to 23 m^3 ha^{-1}. The simulation gave removals between 90 and 100 m^3 over 5 years cycles with thinning intensity of 25% constant proportion from all diameter class. The in-growth (C) parameter and a_1 - elements of the matrix affected the simulation results. The stand basal area was sensitive to both these parameters. There were plenty of small trees in lower diameter classes during simulation, most likely due to the limited empirical data. Linear programming software Lindo was used to find the optimum stand structure and optimum cutting rates. This led to constant production of 20 to 32 m^3 ha^{-1} when the objective was to maximise volume production. When cutting cycles were increased to two years, the maximum constant production was 49 m^3 ha^{-1}. If the objective was to maximise timber production then the maximum constant production was 25 m^3 h^{a-1}. The extension of the cutting cycle slightly reduced the maximum constant production in optimisation.

PROBLEM

The most valuable forests of Nepal for wood production are in the lowland Terai and the Siwalik (Churia) hills. The dominant species is sal (*Shorea robusta*), which accounts for almost half the total wood volume. In the Terai the sal foresst is being continuously reduced by conversion to agriculture, legally or illegally, and little is being done to ensure regeneration. In the hills, lopping and over cutting for fuelwood has reduced sal forests to degraded scrub wood and other forest products needed by the households were taken from the forests.

The absence of systematic and active management planning system creates a vacuum.

Decline of the forests has in turn created environmental problems such as accelerated soil erosion, downstream sedimentation, and losses in agricultural productivity.

Forestry planning, whether for long-term macro-level programming or short-term operations, require a good information base. This should cover the nature, extent, productivity, and other aspects of the forest resources of the country and localities.

Prediction of growth and yield of forest stands is a central issue in forestry. The need for reliable determination of forest growth in the sal forest today is more critical than ever, as timber exploitation in most areas is exceeding the rate of regeneration or growth and the safety margin for error in planning is rapidly diminishing. Yet the development of growth and yield models and simulators of even-aged and uneven-aged sal forest is almost non-existent.

Uneven-aged management leads to a forest with a more natural aspect than its even-aged counterpart and regeneration is mostly natural in an uneven-aged forest.

OBJECTIVES

This study had the following objectives:

1. to develop a model for uneven-aged stand management of sal forest, parameters of the model being;

    - transition of trees between diameter classes;
    - ingrowth of new tress

2. optimisation of stand structure by using the growth model and linear programming.

METHODOLOGY

Data for this study were obtained from a one hecatare sample are a located in the Terai. After harvesting the area was divided into four plots each 50 m square for treatments trials. In each plot a cluster consisting of six 10 m^2 in area sub-plot was established. All twenty-eight plots were measured in December 1993, approximately nine months after harvesting and again in December 1994. The forest in the area is mainly mature, heterogeneous forest. The main species are sal and asna (*Terminalia tomentosa*). Each tree was measured. The following information was collected from each cluster plot.

1) stems per plot: number and height of seedlings and coppices of all species, minimum height 50 cm; only one coppice per stump was counted.
2) sal per plot: Number and height of sal seedlings or coppices of all sizes; only one coppice per stump was counted.
3) most dominant species, by visual estimate based on the percentage of green biomass of species in the plot.
4) mean height of the seedlings and coppice.

The two measurements of the sample plot were used to compute the transition and staying probabilities for the diameter classes, as required in the transition matrix model.

The validity of the simulation system was tested in two ways:

a) effect of thinning method on stand growth;
b) simulating conversion of an initially even aged stand to an unevenaged stand by appropriate managements

FINDINGS

According to this study, the annual production of a selection forest is between 11 and 23 m^3 ha^{-1} per annum. The sample area represents only one type of sal forest in the Inner Terai. With different soil and ground vegetation the reaction of seedlings to weeds may differ from the results of this study. Therefore it is important to get more information from sal forests in different locations, and under different growing conditions.

The results in this paper are still preliminary, and more reliable conclusions could be drawn if further inventory results are incorporated in the model, after survival, height growth and diameter growth are more accurately assessed.

There is a great need for information on selection management. Unfortunately, at present there are no data on uneven-aged stands of sal for Nepal. The present study should therefore be taken as a preliminary attempt to throw light on the questions connected with managing uneven-aged sal stands in Nepal.

More accurate growth estimates will be available in coming years from a re-measured permanent sample plot and we might then be able to predict future growth more accurately. The most important part of the future work is to consider these study and to develop more reliable and accurate growth and yield models for sal.

COMMON PROPERTY FOREST MANAGEMENT AND PRODUCTS DISTRIBUTION (PEOPLE'S PERCEPTION AND ROLE IN GORKHA, NEPAL)

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ABSTRACT

This study attempted to ascertain the socio-economic and demographic situation of the Nareswor Village Panchayat in Gorkha District, to assess perceptions, roles and, views on distribution of common property forest (CPF) products and to assess the socio-economic factors influencing these perceptions of the respondents and to determine the factors influencing the role of respondents regarding the CPF.

The study was carried out in Nareswor Village Panchayat in Gorkha by interviewing 106 household heads, 10 women and 47 local leaders, using an interview schedule to collect primary data. Required secondary data were collected from concerned agencies and departments in Nepal.

The findings of the study showed that respondents had varied socio-economic characteristics. Most had many livestock, goats being the most popular. Very few respondents had private trees or forest for their use. The most preferred forest land tenure was private ownership, to ensure the security of benefits coming from the forest.

Socio-economic factors such as age, income, caste and education of the household heads, education and age of women, and income and education of local leaders significantly affected their perceptions of CPF management and product distribution. Factors such as income and caste of household heads and caste of local leaders had a significant influence on their roles in CPF management and product distribution.

The income, caste and education of household heads and education and caste of local leaders were found to affect their views regarding CPF management and forestry products. Caste and education of household heads, income of local leaders and age of women were significantly related to their views regarding equitable distribution of CPF products. On the basis of the findings of this study, various recommendations are made.

PROBLEMS

In the past, Nepalese forests were overused, consumed very fast, and consumed with the wrong mix of products. In many parts of Nepal, people used inefficient forest harvesting techniques and did not even invest in the renewal of resources nor the collection of information regarding the forest and its management techniques. Consequently the basic forest products- fodder, fuel, poles, grazing land etc.- needed for the survival of the Nepalese rural people become scarce. Even then the people did not stop exploiting the forest, thus creating a severe deforestation problem. Clearing forests was just a short-term solution to food and other forest product shortages. It has compounded what has been called the poor

man's energy crisis. As the forest cover decreased, the soil erosion rate increased and has now created environmental problems which threatene the lives of people in both hills and Terai. The demand for forest products now exceeds the supply and the growth rate of the Nepalese forest. Hence, the decreasing quality of stock, diminishing area and declining growth rate of forest need some attention.

In many parts of Nepal, including Gorkha, the newly created CPFs are now in a position to provide some benefits (thinning products, grasses, fodder, poles etc.). However it is not clear who is going to get what from this newly created forest resource. Planners and forest managers have not come up with a suitable strategy to solve this problem. The people retain their past attitudes of apprehension and mistrust government effort to increase the people's involvement in such activities and are still reluctant to be involved directly in the newly created resource management and distribution programme. This has created an attitude of indifference among many people in Nepal as regards working in the people-oriented forestry program. These problems cannot be solved in one study.

OBJECTIVES

This study tried to describe a suitable CFP management and product distribution scheme, considering the people's perceptions, roles, views on equity, and views regarding the distribution of various products. It considered the following questions:

1) What socio-economic factors affect the household heads' perceptions regarding CPF management and products distribution?

2) What socio-economic factors affect the local leaders' perceptions regarding CPF management and products distribution?

3) What socio-economic factors affect the household heads' roles in CPF management and products distribution ?

4) What socio-economic factors affect the local leaders' roles in CPF management and products distribution ?

5) What socio-economic factors affect the household heads' and local leaders' views about the distributional aspects of CPF products ?

METHODOLOGY

The study was carried out in Nareswor village panchayat in Gorkha by interviewing 106 selected household heads, 10 women and 47 local leaders using an interview schedule to collect primary data. The number of households was calculated by using the following formula:

$$n = \frac{N}{1 + Ne^2}$$

Where,

n = sample size
N = number of total households in the panchayat
e = desired margin of error

The full list of household heads was stratified into four major caste-ethinic groups which were randomly sampled in proportion to the numbers in the groups. Required secondary data were collected from the concerned agencies and departments in Nepal.

The employed data analysis was descriptive, using frequency, means, percentages, range, standard deviation. The X^2-test was used to test the relationship between socio-economic factors and respondents perceptions, roles, views on equitable distribution and views regarding distribution of CPF products. The Fisher exact probability test was used to find the relationship between women's socio-economic factors and their perception, role, view on product distribution and equitable distribution of CPF products.

FINDINGS

The findings of the study, showed that respondents in Nareswor Panchayat in Gorkha District had varied socio-economic characteristics.

Most of the respondents reported that the forest products from the existing forest system are insufficient for the people in the area because of the limited area and very young stands.

Forest professionals and technicians exercised decision-making power regarding forest management in the area, but most respondents preferred a decision-making body composed of local leaders and the local people. Most also revealed that the forestry professionals and technicians were uncooperative in working with the local people.

Most respondents - household heads, women and local leaders, had highly perceptions of CPF management and product distribution. The reasons given were that the newly introduced CPF management scheme in the area improved the forest products supply and reduced environmental degradation.

Most respondents said that the forest products should be distributed among the people according to their contributions to CPF management so that they are fully rewarded for their involvement.

Socio-economic factors - age, income, caste and education of the household heads and women, and income and education of local leaders-significantly affected their perceptions of CPF management and product distribution.

Income and caste of household heads and caste of local leaders had a significant influence on their role performance in CPF management and product distribution.

The income, caste and education of household heads and education and caste of local leaders were found to affect their views regarding CPF management and distribution of products.

Caste and education of household heads, income of local leaders and age of women were significantly related to their views regarding equitable distribution of CPF products.

RECOMMENDATIONS

Innovations in CPF management and products distribution in Nepal should never be considered as replacement for the existing indigenous systems of forest management and conservation. Conservation of the natural forest ecosystem and improved management in modified natural forest system and plantation should work as appropriate means of building up local strengths and capabilities. Effective introduction of forestry innovation will ultimately require an understanding of activities that fall within the spectrum of people's spontaneous responses to scarcity. This will only be possible through direct two-way communications between rural people, professionals and planners, and efforts to devise collaborative methods of CPF management which can be effective until the people become self-reliant.

Considering the diversity in socio-economic characteristics and backgrounds of the people in the study area, the Government should introduce holistic approaches to CPF management that will maintain productivity, stability and sustainability in all aspects of rural development.

It is important that the number of livestock per household be reduced by introducing improved breeds. However, the introduction of new breeds should not contradict the right of the independent group to maintain their religious integrity.

The limitations on forest landholdings of panchayats in Nepal should be removed to help make the products supply sufficient for the local area and reduce total dependency on government subsidies.

An active extension programme convincing people to use forest resources wisely, use a good mix of products, conserve energy by using an improved stoves, and conserve natural forest ecosystems should be implemented.

Since respondents preferred private forest landownership it would be socially acceptable to transfer land rights at ward level to people who have permanent boundaries. This would enhance people's involvement, investment in forest management at ward level, and the supply of forest products, and reduce government involvement. Individually owned forest would be suited only to the Terai, which is ideal for growing commercial timber. This will also increase the local leaders' participation in the local decision-making.

The Government should transfer its product distribution power to local leaders and people as soon as possible, to increase the trust of the people in the Government and help the people become self reliant in decision making.

Since forest professionals and technicians were uncooperative in working with the people in the area, the Government should train such staff to work more closely with the people.

FURTHER RESEARCH

The following topies for further study are:

1) more extensive studies along the lines of the present study, with increased sample size to confirm the present results.

2) the effectiveness of government involvement and subsidies in CPF management and products distribution both in Nareswor and in other panchayats in the district so that strategies for encouraging people can be improved.

3) effects of other factors, such distance from forest area, government subsidies in other rural development activities, and other support services for resource creation and conservation.

CONTOUR TRENCHING AS A STRATEGY IN WATERSHED REHABILITATION: APPLICATION TO NEPALESE CONDITION

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ABSTRACT

The disastrous soil erosion problems and the uncontrolled movement of water in Nepal's mountains caused by human and livestock activities call for the identification of simple, cheap, and effective rehabilitation techniques. This report analyses contour trenching as a rehabilitation technique in the United States and examines the applicability and transferability of the techniques to Nepal.

The details of contour trench systems as applied by the U.S. Forest Service were analysed by reviewing available research papers, handbooks, official records, personal communication, and actual field visits. The results and observations have been delineated for the physical and cultural aspects of the Nepalese watershed systems.

Contour trench systems in the United States are designed to hold overland runoff resulting from high-intensity short-duration rainfall events. The idea is to store overland flow on site and allow it to percolate slowly into the soil. Trenches are an interim measure and are no substitute for rehabilitation measures designed to reduce runoff and erosion in the long-term. Quantitative evaluation of trenching effects is lacking and few quantitative studies report the combined effects of trenching, grazing and fire control. There are examples of tremendous success and disastrous failure. Contour trenches are delicate structures. Evaluation by experienced personnel reveals that contour trenching has a definite role in the rehabilitation of impaired watersheds if carried out systematically and precisely.

Contour trenches have questionable benefits in areas where large-volume, long-duration and possibly high-intensity rains occur (such as the monsoon areas). Thus, this control method may have only a limited role in the overall strategy of rehabilitation planning in Nepal. The primary limitation as seen from the analysis is the huge amount of long-duration rainfall and direct runoff produced. However, there is some potential in the semi-arid parts of Nepal where frequent floodings are caused by short-duration high-intensity rainfall. Watershed rehabilitation techniques developed in U.S. can be applied in Nepal in certain cases. However, site specific research support is essential in designing control structures. Nepal needs to develop research projects to identify and apply alternative rehabilitation techniques which can handle large volumes of uncontrolled water in impaired watersheds.

PROBLEM

The highly populated mid-Himalayan mountains and valleys of Nepal are in a process of desertification because of the intensive use and abuse of the land. Torrential floods, mass movements, and mudflows are common and are increasing every year. Many slopes are devoid of vegetation. Fire, uncontrolled grazing, indiscriminate liquidation of forests, and cultivation of steep slopes are moving the region towards unpredictable disasters which may cause loss of life and properties for the mountain dwellers as well as valley farmers.

Realising this alarming situation, His Majesty's Government of Nepal established the Department of Soil and Water Conservation to formulate directions in resource conservation programmes.

In the past, no conservation measures had been taken, but now attempts are being made to rehabilitate the exposed watersheds. This new conservation movement is gaining in popularity both within and outside Nepal. But the leaders in this field are in a dilemma as to how to use the substantial amouns of taxpayer's money, international loans and co-operation from other countries which could become available because of lack of past experience, technical knowledge, research results and simple guides to the technicalities of the rehabilitation.

There has been a tremendous wastage of limited resources, skilled manpower and time in most developing countries in trying to transfer prototypes of research and technology from developed nations, especially in the field of agriculture and natural resources. The primary reasons for failures are the absence of prior analysis of transferability of the technology, and lack of the understanding of the socio-economic structure.

However the great experience and research of a developed nation may be not a curse but a boon for today's Third world if transferability of the developed technology is intensively analysed and then adapted to suit the local conditions. The United States, a world leader in the conservation movement, has done much work in watershed rehabilitation in the past. This paper aims at the modest goal of reviewing past work on contour trenching in the United States and their application in Nepalese condition. However, a comprehentive strategy of watershed rehabilitation involves a network of techniques and a tremendous amount of work is required to cover all the aspects of the problem.

METHODOLOGY

This study was based on a review of the literature.

FINDINGS

While the principle of terracing as a soil conservation measure is very old and extensively used, the use of contour trenching for controlling soil erosion and floods on forest and range lands is new and its application is limited. Only a few qualitative and quantitative evaluations have been made to determine the effectiveness of contour trenching.

It is indicated that contour trenching is of most benefit when high-intensity short-duration rainstorms cause runoff on areas of depleted vegetative cover. The surface runoff, in this case, results when the rainfall exceeds the infiltration rates. The trenches allow the water to slowly infiltrate into the soil rather than run overland and cause erosion. For this to occur, there must be ordered flow. In addition to ponding of the overland flow, contour trenches must also intercept shallow subsurface flow. Thus, in some situations, where soils are deep and infiltration is high, they will not solve the purpose of reducing floods. Contour trenches have questionable benefits in areas where large-volume, long-duration, and possibly high-intensity rainfall occurs (such as monsoon areas). In such cases, trenches may have a detrimental rather than a beneficial effect since in this type of climatic event, in addition to large volumes of overland flow, subsurface flows will continuously contribute large volumes of water to the trench system. If the interception rate of subsurface flow in trenches exceeds the infiltration rate of the impounded overland flow, overtopping of the trenches is unavoidable. This will cause a chain reaction to successive trenches down the slope, such as mass erosion hazards increase greatly as the zone of soil saturation approaches the surface. These observations emphasise the need for great care in designing contour trenches.

RECOMMENDATIONS

The following recommendations are made for future watershed rehabilitation in general:

1) For finding reliable curve numbers, gauged watersheds, where values of precipitation and discharge for different storms, are available should be used. Any set of measured values of P and Q will define a Curve Number.

2) In ungauged watersheds actual field plots to determine the direct runoff under different storm patterns should be established. Though infiltration studies on small plots may not be truly representative of the area, the infiltration data for different cover types and soil types should neverthless be obtained. Such studies when delineated over the adjectoral description of the SCS Handbook should help in estimating appropriate Curve Numbers. In essence, the design of contour trench systems depends on knowing the expected runoff as a fraction of the precipitation. Any method which results in reliable runoff volumes will minimize the risks of fauly design.

FUTURE RESEARCH

Four categories of basic research support should be emphasised. They are:

1) fundamental studies on the various parts of the hydrologic cycle.

2) development of more efficient ways of measuring hydrologic phenomena.

3) inventories to define better the characteristics and problems of natural resource management.

4) development of analytical methods to permit more rational and efficient use and integration of available data.

WILDLIFE CONSERVATION IN NEPAL: AN APPROPRIATE PHILOSOPHY FOR THE PRESENT AND THE FUTURE

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ABSTRACT

This thesis gives a description of the current institutions and organisations and some of the issues prevailing in wildlife management in Nepal. Given the growing economic and ecological significance of wildlife for the country, any constraint to conserving and benefiting from them should be removed quickly and effectively.

Rural dependence on forest resources, aggravated by rises in human and livestock populations, makes wildlife conservation a difficult task. Methods by which such dependence could be reduced or shifted would have positive implications for wildlife conservation. The issues outlined indicate the multidimensional nature of the enterprise, which therefore requires a collaborative approach for resolution. Institutional collaboration with sectors having potential impact on wildlife conservation (agriculture, livestock, forestry and tourism in particular) is the primary need. Apart from inter-sectorial links, the Department of National Parks and Wildlife Conservation (DNPWC) itself needs timely modifications to its structure and functional pattern. The appointment of middle-level managers (both at headquarters and field levels) and delegation of responsibilities are areas needing attention. Existing legal inadequacies also need to be rectified by relevant legislation. In view of fast-degrading habitats, bio-ecological management of wild species (with emphasis on threatened and endangered ones) should be the ultimate aim of conservation.

PROBLEM

The recorded history of conservation measures dates back to the third century BC. However the principle of nature conservation, as a religious instinct, has always been part of tradition in Nepal, and the essential components of nature (animal, plant, water, soil) all have prominent places in people's spiritual life.

Until a hundred years ago, wildlife in Nepal was plentiful. Hunting of tiger, rhinoceros, deer etc. was an important hobby and sport, not only of the elites but of the ordinary people as well and there was no immediate danger of extinction of such species. The habitats supporting them were extensive and human population pressure was minimal, particularly in the Terai. In recent times, rapid population growth has resulted in increased demand for natural resources. Vast areas of dense natural forest including crucial habitats for wildlife have been destroyed to meet growing demands for food, fuel and fodder. The lowland Terai, being the most fertile and economically prosperous region of Nepal, was especially severely affected due to mass migrations of settlers from the hills.

Rapidly growing developmental activities also have considerable impacts on wildlife populations. All these, together with poaching, have led to endangering the status of many mammalian and avian wildlife species, including rhinoceros (*Rhinoceros unicornis*), tiger (*Panthera tigris*), snow leopard (*Panthera uncia*) and wild elephant (*Elephas maximus*).

METHODOLOGY

This study is based mainly on a literature review.

FINDINGS

During the last two decades the Government of Nepal has addressed the new realities, recognising the need of conservation of natural resources for the sustained development of the country and a better quality of life for its people. This has been the basis of the national conservation strategy, prepared in 1983 under IUCN guidelines. Wildlife, being part of the natural heritage, represents a valuable link with the environmental. In a moral sense, wildlife conservation could be important for a country like Nepal where, for the majority, the only source of inspiration is their religion, which, in turn, regards the natural components as divine.

To achieve the objective of wildlife conservation as a socio-economic enterprise, stress has been laid on its proper management. Various international organisations have provided expert and material assistance to help achieve this goal. Nepal has introduced legislation for the protection of the resource.

Despite government efforts, wildlife over the past two and three decades has suffered severely through extensive destruction of habitat, expansion of agricultural settlements and poaching. It has often generated people-park conflicts, which tend to be more intense in the Terai parks and reserves than in those of the Himalaya. Nepal also faces ecological problems arising from destruction of habitats. Wildlife, particularly species with narrow geographical ranges are seriously threatened by this. Legal and administrative inadequacies add to the social and ecological constraints on management.

It is from this perspective that wildlife conservation in Nepal calls for careful and regular evaluation of actions taken. The social, ecological and legal aspects of wildlife conservation are areas needing regular appraisal. When resource management works to accommodate local communities in conservation activities and demonstrates that it can bring sustainable and immediate benefits, conflicts can be minimised. Under minimum conflict situations wildlife resources can play an important role in a country's long-term economic development. Nepal is no exception.

The present thesis attempts to portray a picture of the protected area system of Nepal, with special reference to its current institutional organisations. In addition, specific management issues (social, ecological and legal) facing wildlife conservation, towards which increased awareness and intensive research has to be directed, were subject to evaluation.

RECOMMENDATIONS

Large areas of natural forests including some crucial wildlife habitat have been altered during the last few decades in Nepal. Since expansion of agriculture, demands for forest products and development activities in response to the rapidly rising population are the main reason for

this situation, it is recommended that community forest management programs be encouraged in the areas surrounding national parks and reserves. Attempts should also be made to gain public support and participation in these through 'show-by-result' and a conservation education campaign.

Wildlife conservation programmes should not be in isolation from other rural development activities. It is therefore recommended that there be collaboration between the wildlife and the agricultural sectors to increase rural crop production through the application of improved technology (e.g. agroforestry, silvopastoral and agro-sivopastoral systems), and to encourage less land-demanding agricultural enterprises which would help reduce the pressure on the remaining natural forests.

There should be similar collaboration with the forestry and livestock sectors to reduce fodder demand currently met by exploiting natural forests, and with energy related sectors to develop alternative sources of energy and improve efficiency of traditional energy-use systems.

Regarding the DNPWC, it should: (i) try to meet the increasing demand for trained manpower, and (ii) to adopt the principle of strengthening middle-level management by delegating responsibility. The present structure of the large centralized protection unit should be changed to small and more mobile units better able to meet the requirements of individual parks or reserves.

Present legislation in Nepal fails to provide for the changing national and global attitudes towards wildlife. It is therefore recommended that particular attention be given to matters such as extension of the list of protected species, rules and regulations for individual parks and reserves and legal co-ordination with other sectors. Stricter penalties for offences are recommended, particularly against poaching.

Improved ecological knowledge about wildlife indicates that the bio-ecological requirements of wildlife species are not adequately met by the protected area infrastructure in its present form, particularly where rare and endangered species are concerned. It is therefore recommended that physical links between protected areas (through corridors and buffer areas) should be instituted. Translocation or reintroduction of endangered species should also be explored.

Nepal requires regional and international support and co-operation in the form of technical and financial assistance. It is recommended that such support and co-operation should be actively sought by the Government.

TOWARDS COMMUNAL FOREST MANAGEMENT: SOME CASE STUDIES FROM BEGANS VDC, NEPAL

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ABSTRACT

In Nepal, forests were nationalised in 1957. The Government saw itself as the professional manager of the forests and aimed at large-scale development. The Forestry Act of 1961 made it clear that virtually every form of access to the state forest resources was prohibited unless specifically authorised. In 1978, the legislation changed and the Government started a process of handing over control and management of local forests to the panchayats (the local administrative units).

Forestry development work in the hills has been strongly influenced by the 1978 legislation and much of the efforts of government and aid agencies have been focused on the creation of Panchayat Forests and Panchayat Protected Forests. With the end of the Panchayat system in April 1990, both titles were abandoned and replaced by the term Community Forest. Recent government forestry sector policy is in favour of managing all the accessible hills forests through the local beneficiaries themselves. This policy is termed Community Forestry, and the local users form Forest User Groups. Implementation of this new policy is a slow and time-consuming process. It starts with reorientation of Forest Department staff and rapport building with the communities. This is followed by user identification and assisting the users to write their own management plans that reflect the feelings and aspirations of all. Then handover of the forest to the user group takes place.

Parallel to these initiatives taken by the Government, local systems developed: indigenous systems, generated by initiatives from within local communities themselves. There is now a growing recognition that indigenous systems of forest management are common in many parts of the hills. Often these indigenous management organisations have existed already for many years. These systems operate on land that may technically be government land, but in effect is perceived by the communities as their property.

Two types of forest management systems can be distinguished: externally sponsored and indigenous systems. A problem in this classification however, is that an externally sponsored management system can be initiated, and even actively adopted, yet be completely incorporated into local social systems and relations.

PEOBLEM

Although forest committees exist in some indigenous systems, they are not always present. Furthermore, indigenous committees in Nepal often bear little resemblance to the Western model of committee (i.e. of a sub-group of a population with delegated decision-making powers). In Nepal decision making often takes place in an irregular assembly (sabha) of all interested group members, or all who are available. Such an assembly is sometimes referred to as a samiti.

Another irony in indigenous systems in Nepal, is that they are often protection-oriented rather than use oriented. From the above it is not surprising that during recent years many conflicting ideas have developed in respect of the significance and development scope of indigenous forest management systems, which can at least partly be explained by the variety of indigenous management systems present.

METHODOLOGY

A review of indigenous forest management systems in Nepal concluded that the store of existing knowledge is limited and needs building up through more primary studies. Consequently it was decided to carry out an exploratory survey of a qualitative nature. By making case studies of three different forest areas it was hoped to elucidate the major factors influencing the functioning of communal forest management systems. The case studies were carried out in Begnas VDC from October to December 1991. This is one of the seven VDCs in the Begnas Tal/Rupa Tal Watershed Management Project (BTRT) of the Department of Soil Conservation and Watershed Management.

The study involved:

- literature review in various offices and libraries;
- interviews with scientists who have done research on a similar subject and/or worked in the BTRT area; and
- direct observation

The author attended meetings of forest committees and CDCs in different areas, to cross-check the information given, in order to get information about how different kinds of people interact, their way of conducting meetings, motivation of people, role and degree of involvement of women, decision-making processes, and dispute resolution, and to get clues to possible solutions to problems, etc. Questions that were virtually impossible to include in semi-structured interviews (decision-making processes, conduct of meetings, group motivation etc.) were covered by this kind of direct observation.

FINDINGS

The case studies showed that before the forests were nationalised in 1957 the forest management system was dominated by an ownership pattern that had come into existence during the Talukdar system under which the forests were owned and managed by mainly Brahmin families or clans. The owners took turns in guarding their forest and made their own

rules concerning the species, condition and amount of products to be harvested. Other members of society were dependent on them for forest products.

In noni of the cases studied did nationalisation have any influence. In this context, it is appropriate to mention that the often quoted hypothesis that after nationalisation, the farmers in the hills of Nepal did not feel responsible for the forest, seems not to hold there any more.

Resource scarcity was the main reason for previous forest owners to try to establish a communal forest management system together with the other users. The system can be qualified as indigenous, as it is an outcome of indigenous initiatives. It is indeed a dynamic response to a changing situation.

In Bhirepani and Dopare/ Kahare, besides resource scarcity and changes in government policy another factor played a role: the possibility of some people getting the forest legally handed over to them (possibly, in the eyes of some former owners, to regain ownership and/or control).

As a basis for indigenous use rights, residence (proximity to the forest) rather than membership of a kin or caste group should play a role. When the communal forest management systems were established as responses to changing situations new user groups were formed in three cases. In Bherepani-Dopare/Kahare, this was done top-down by the main committee on basis of residence and whether a household had access to forests elsewhere or not. In Kalomuda/Daregaunda use rights were not established instantly, but developed through a process of negotiation.

Compared to the other two cases, the forest in one case was very heavily degraded when the management system started, and restoring the reproductive capacity of the forest was a clear goal from the start. As in the other two cases however, the villagers ignore seedling regeneration, other than through natural seeding.

RECOMMENDATIONS

It seems better not to talk about handovers to user groups too quickly: time is needed to see how their co-operation develops. Trust needs to grow within the organisations, and rules, use rights and rule enforcement need to be negotiated and accepted first.

Some strategies to facilitate handovers, might be:

- to clarify what is going to be handed over to whom, so that committee members could then consider whether they are still interested in communal forest management or not;
- to get all users involved to agree that equal investment in forest management (shared protection responsibilities) will lead to an equitable distribution of forest benefits.
- to simplify rule enforcement. What would make rule enforcement much easier is demarcation of the areas of forest around the pieces of agricultural land that are officially registered as belonging to the Lalpurja (land ownership certificate) holders.
- instructions on low to conduct meetings, rule enforcement, etc. and study tours to other areas where forest management committees are functioning.

- suitable changes in committee composition.

Regarding this last strategy, one possibility to improve communication between the main committee and sub-committees might be the inclusion of one member of each sub-committee in the main committee.

As women are most involved in forest product collection, adding female members to the committees might be useful to increase women involvement. The disadvantage of this however, is that women often do not say much during male-dominated committee meetings. An alternative might be to form separate women's sub-committees in the different sub-areas, and have these meet separately, but once a month together with the male sub-committee.

Another improvement in the committee composition would be to have a proportional representation of the previous non-owners of forest in the main-and sub-committees, so that distrust can decrease.

THE ROLE OF FORESTRY ORGANISATION IN CONFLICT RESOLUTION IN COMMUNITY FORESTRY MANAGEMENT IN NEPAL

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ABSTRACT

Conventional methods of forest management are not suitable for rural people as they ignore their needs for forest products. To enable the rural people to meet the needs for these forest products, people centred emphasis is necessary in forestry development activities.

The Government of Nepal has brought tremendous changes in forest policy. The new policy and its implementation tools, such as the Forest Act 1993 and Regulations 1995, reflect the fact that the state forests have been handed over to local forest user group (FUGs), and management and utilisation responsibilities have been shifted from the Forest Department to the FUGs. However local communities are culturally and economically heterogeneous. Powerful and elite people basically still control the situation, and women and the underprivileged, who are the main stakeholders in community forestry, have not benefited very much yet. Hence, sources of great conflict have emerged out of the different interests and needs of the stakeholders.

The causes of conflict can be thought of as tangible or intangible, needs of beliefs. The consequences of conflicts in forestry management are often negative. Nonetheless, when there is informed participation by all the stakeholders involved there are frequently positive consequences. The local people living in groups or clusters near or in the forests have the greatest desire for sustainable utilisation and management of their forest resources.

Having the forestry organisations involved in the processes of conciliation, negotiation, mediation and co-ordination has been one of the best approaches to conflict resolution.These approaches are found useful in the major categories of conflict such as inter-FUGs, intra-FUGs, between outsiders and insiders, and institutional. The goal of the organisation working in conflict resolution should not be to avoid the conflict but rather to focus on the skills needed to help both the organisation and users to find out the differences and solve the conflict on the basis of people participation according to their needs and social system. The participatory approach in resolving conflicts is significant because it is based on the indigenous knowledge and skills of local people.

Both forestry personnel and community people can begin to learn the necessary social skills through the participatory diagnostic method. Nevertheless, giving training to the both would improve their conflict-managing abilities.

PROBLEM

The importance of forest and tree resources with regard to biodiversity and sustainable rural development is widely recognised. Conventional methods of forest management have emphasised timber production to collect government revenue, but in the international forestry arena there has been growing recognition and acceptance that maximising the exporting of timber for large industries frequently causes gross degradation of forest resources. A different strategy is needed if these limited resources are to be exploited sustainably. More enlightened management of the forest resources is already making very great contributions to the well being of the rural people who depend on forests for their livelihood and to achieving biodiversity and conservation as well as other developments in rural society.

Considering the importance of forest resources and the lack of government funds for managing them it seemed necessary to solve the problems by involving the local people in proper management and utilisation of forests- a new forestry paradigm that can be described as the "people- centred forestry approach".

However, in "people-centred forestry" corrosive conflicts have emerged in the distribution of products and sharing of benefits and responsibilities. The issues of forest product distribution include the question of rights: who should and who should not get a share of the products and why? How are decisions on management of forests to be made? How are the boundaries of forests for FUGs to be defined? Are the forests being managed effectively? If yes, then how? If not, then why not? Is everyone within the FUGs benefiting from the community forests? If yes, then how? If not, then why not? How are any conflicts and disputes being resolved? Who are involved in the resolution of conflicts and why? What has been the role of the Forest Department in resolving conflicts? What kinds of preparation do mediators and negotiators need? What are the best ways to negotiate agreements? What are the options for the resolution of a conflict that could be presented on the negotiation table?

There is very limited information available on these aspects of community forestry. This dissertation makes an attempt to address some of the questions and issues raised above.

METHODOLOGY

The study was based on secondary sources of information and the author's own field experiences in over 12 years in community forestry, partly at national level in the United Mission to Nepal.

FINDINGS

The new forest policy and legislation state that the public forests should be handed over to FUGs as community forests. In community forestry people are paramount and should have

control over the forest resources and their distribution. However, in sharing the benefits of the forest products conflicts often emerge because there are different interests and needs among the local people. Such conflicts can lead to negative consequences and misuse of the resources, even to the extent of its serious decline.

Positive consequences, such as collaboration and compromise, are usually achieved if local people are involved and forestry organisations play a catalyic role in the resolution of conflicts in a holistic way. The processes needed in this participatory approach are mediation and conciliation, negotiation, facilitation, co-ordination, networking and information systems. To perform their respective roles both forestry personnel and community people need to learn participatory diagnostic social skills in order to acquire the capability for conflict resolution.

There are two main elements that are always ignored by forestry organisations. The first is the art of learning from the local people regarding their indigenous knowledge and skills for conflict resolution. The second is the analysis of conflicts to show how one conflict is related to another and what policy defects hinder the forestry organisation from working in favour of the main stakeholders.

FUTURE RESEARCH

Empirical field research is needed to refine the theory of the origins, sources and categories of conflicts and their resolution. Some important questions for future study are:

- the role of negotiation and conciliation in conflicts involving ethnic groups where the culture and gender issues are different;
- "power" issues related to communication and literacy skills, gender and the imbalance of power between the indigenous social institutions and the large forestry organisations.
- how to develop practical strategies for resolving conflict.
- approaches to improving traditionally weak groups especially regarding the skills needed at the discussion table;
- the social skills forestry personnel need to develop supportive forest policies and organisation: which can promote community forestry and minimise conflicts.

AGROFORESTRY IN THE HILLS OF NEPAL

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ABSTRACT

The problems of deforestation and environmental degradation in the Hills of Nepal and their impact on agricultural systems and rural economy have been discussed. The nature of problems suggests that there is an urgent need for an alternative land use system which is both productive and sustainable. Agroforestry has potential to achieve both of these objectives. Tree intercropping with shade-tolerant cash crops such as tea and cardamon, silvo-pastoral system and horti-pastoral system have been proposed as alternatives to present land use system for marginal land in the Hills. Alley cropping is proposed for main crop land. Actions have been suggested for the practical application of these systems at community level.

PROBLEM

Forest is an integral part of the farming system, just as much as arable land and livestock. The stability of the system depends on the balance betwen the arable land, livestock population and forest land. The increased human and livestock population pressure on land and high rate of both human and livestock population growth have increased the demands on the forests for farming land, animal fodder, fuelwood, timber and other basic needs. More and more forest areas have been cleared for farming and erosion-prone steeper slopes have been brought under cultivation. Over-exploitation of forest trees for fodder and fuelwood and overgrazing of the pasture and rangelands are not uncommon. Consequently, Nepal is facing the most accute problems of deforestation and soil erosion. Landslides that destroy lives, homes and crops occur more and more frequently throughout the Nepalese hills.

The productivity of land is declining. In many areas, firewood is so scarce that dung must be burnt for fuel thus further depriving the land of desperately needed manure. Abandoned terraces are common in many steep areas indicating the inability of farmers to maintain ecological stability so that productivity falls to unacceptable levels and so forces abandonment. Thus, the increasing population is destroying the very resources which are required to sustain it.

Considering the situation described above, all future means of solving the mountain land use problems have to be directed towards the main point of overcoming the deficit in biomass and human nutrition in these areas. This dissertation elaborates the inter-relationship of crop production, livestock and forestry and identifies the causes of deforestation and its consequences on the agroecosystem, agricultural production and human life in the hills of Nepal. Finally, it aims to put forward possible solutions to the problems of environmental degradation through the application of appropriate agroforestry practices on a community level in the Hills of Nepal.

METHODOLOGY

Since the basic data necessary for agroforestry planning are not available for Nepal, an attempt is made to collect information from other countries, and to examine whether and how it might be adapted to this area. Hence this study is based mainly on the literature review.

FINDINGS

Agroforestry systems have huge potential for the Hills of Nepal where population density is extremely high, landholdings are small, organic manure is the main source of soil fertility, marginal lands with steep slopes are prone to severe soil erosion, productivity is declining, traditional agricultural systems and dwindling forest resources have failed to keep pace with increasing demands for food, fuelwood, fodder and other basic needs of people and consequently environmental deterioration has reached a stage of crisis. Under these circumstances, there seems little scope for modern monocultural capital-intensive technology to play a significant role.

There is an urgent need for a land use system which will meet the increasing demands for food, fuelwood, fodder and other basic needs of people on a sustained basis and halt environmental deterioration at the same time. The only valid alternative to the existing land use system is to integrate agriculture, animal husbandry and forestry which will not only make the system productive and self-sustainable but will also contribute to environmental conserevation. Though agroforestry systems have been already in existence in some limited areas in the Hills, they have to be improved to a marked extent and expanded through entire hill region.

RECOMMENDATIONS

Tree intercropping with shade-tolerant cash crops such as tea and cardemon, silvo-pastoral system and horti-pastoral system are suggested as alternatives to present land use system for marginal lands in the hills of Nepal. Alley cropping is proposed for main crop land.

For successful implementation of these agroforestry systems, active participation of government, researchers, development workers and farmers is essential. In this regard, it is essential for the government to take immediate actions for the institutionalisation of agroforestry, promotion of agroforestry research, extension, training and education programmes, development of infrastructure and provision of incentives and credits.

Involvement of aid-donor international agencies like World Bank, FAO may be essential for the successful implementation of the agroforestry systems. In addition, international agencies involved in agroforestry activities can help by providing guidance for agroforestry research and training facilities to develop suitable manpower. Their help might be useful for devising appropriate curriculum for agroforestry course at the university level.

Abstracts:

Nepalese Scholars' Theses Related to Topics Outside Nepal.

AN INTEGRATED APPROACH TO MODELLING THE IMPACT OF TIMBER HARVEST ON STREAM FLOW: A GIS-BASED YDROLOGIC MODEL

Achet, Shiva Hari.
Ph.D. (1997)
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ABSTRACT

An integrated modelling approach to assess the impact of timber harvest on peak flows, mean daily flow, and timing of streamflow was developed using GIS, C Programming and Utools visualisation. The model embraces the newly evolving focus on landscape level management. The model was used to test hypotheses that timber-harvesting patterns impact peak, volume and timing of streamflow. The model deals with three watershed levels, two modelling approaches and four timber-harvest scenarios. The model was calibrated and validated using two separate sets of precipitation events using ASCE recommendation.

This study in Hoh watershed revealed that timber harvesting significantly impacts peak and mean daily streamflows at watershed, sub-basin and basin level in descending order. The difference in results of the impact of timber harvesting on streamflow is also attributable to difference in methodology. If about 27% of the basin were harvested (extracting 46.9 million m3 of timber) the peak flow would increase by 44 to 51% at basin, 34 to 41% at sub-basin and 55 to 141% at watershed level in medium and high hydrologic conditions. By reducing the timber harvest by 26%, the corresponding reductions in peak flow at the basin level, sub-basin level and watershed level were 9 to 10%, 7 to 9% and 16 to 18% respectively. Regarding mean daily flow, harvesting 27% of the basin would increase the mean daily flow by 30 to 47% at basin, 22 to 36% at sub-basin and 77 to 137% at watershed level in medium and high hydrologic conditions.

If the timber harvest was 34.6 million m^3 the corresponding reduction in mean daily flow at basin, sub-basin and watershed level would be 7 to 10%, 5 to 8% and 14 to 20% respectively. Reforestation reduced impacts on Peak and mean daily flows in medium and high hydrologic conditions. The impact on timing to peak flow was governed by modelling approach and hydrologic condition more than by timber harvest option. UTOOLS visualisation was useful in identifying additional harvest criteria and communicating model results.

ECONOMICS OF FOREST POLICIES AND PLANS IN INDIA WITH SPECIAL REFERENCE TO UTTAR PRADESH

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ABSTRACT

This thesis examines economic aspects of the use and management of forests in India, with special reference to Uttar Pradesh. In spite of the two explicit economic goals of the country, namely, (a) to raise the living standards of the people, and (b) to open up economic opportunity for all, the public forests management policies and plans are oriented to achieve neither economic efficiency nor equity except in a marginal manner. Instead, the national forest policies aim at ad hoc goals based on classical forestry tenets, the sectoral plans to continue to meet the wood requirements of the country, primarily for industries, and the forest management or working plans to the sustained yield of wood in perpetuity.

What would have been more logical for a forward-looking post- independence India would have been to use and manage the public forest resource primarily for its economic potentialities including economic efficiency, fairer income distribution and for inducing socio-economic changes in backward communities and regions. Apparently three major obstacles-ideological, organisational and institutional- are inhibiting the economic use and management of forests in India. The ideological inhibitions include myths and folklore of classical-forestry; the organisational obstacles include rigid class and status hierarchy and dysfunctional bureaucracy; and the institutional bottlenecks include external stresses on the government forest offices and officers.

In order to enhance the forestry contributions to the economic betterment and welfare of India, the thesis recommends ways and means to induce changes in ideological, organisational and institutional structures and processes. Such measuires taken here and now in gradual steps would enable India to foster the forestry potentiality for winning the war against poverty, hunger, disease, illiteracy and inequality.

RELATIONSHIP BETWEEN FOREST REGENERATIN AND GROUNT FLORA DIVERSITY IN DEFORESTED GAPS IN DOI SUTHEP-PUI NATIONAL PARK

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M.Sc. (1996)
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ABSTRACT

Interactions between tree seedlings and herbaceous vegetation are widely assumed to be important factors affecting the growth and performance of trees. However, few experimental studies have been conducted to investigate the importance of such phenomena. This study was carried out to determine if the herbaceous ground flora in deforested areas can be used to indicate the suitability of sites for the natual establishment or planting of various trees seedling species. It examined recruitment (density, relative growth rate, mortality), species composition, diversity and richness of the natural tree seedling community and their association with the herbaceous ground flora vagetation communities on deforested sites. Three major types of dominant ground flora communities were selected for the quantitative investigation (*Eupatorium adenophorum.* Spreng. (Compositae), *Imperata cyclindrica* (L.) P. Beauv. var. major (Nees) C.E. Hubb. ex Hubb. and Vaugh. (Gramineae); *Pteridium aqilinum* (L.) Kuhn ssp. *aquilinum* var. *wightianum* (Ag.) Try. (Dennstaedtiaceae), and two additional sites were selected for qualitative study - an *Imperata cylindrica* dominated site, and mixed ground flora species [*Pennisetum pedicellatum* schumach.; *Setaria paviflora* (Poir.) Kerg.; *Microstegium vaganas* (Nees ex Steud.] and *Eupatorium adenophorum* dominated site. A total of 48 quardrats of 2 x 2 m. were laid down in 50 x 50 m. permanet plots. The quadrats were inspected every 2 months over 10 months.

Tree seedling diversity was highest in the *Eupatorium*-dominated site (10.23) followed by the *Imperata*-dominated site (7.52) and the *Pteridium*-dominated site (5.59). Moreover, the Eupatorium site had the lowest seedling mortality (21.7%) over 10 months) followed by *Pteridium* site (25.7%) and the *Imperata* site (30%). For most tree seedlings species, growth rates were highest in the *Eupatorium* site and lowest in the *Pteridium* site. There were no significant associtions between any of the tree seedling species found in the *Imperata* and *Pteridium*-dominated sites with the dominant herbaceous ground flora species and in the *Eupatorium*-dominted site, only three tree seedling species [*Castanopsis diversifolia* King ex Hk. f. (Fagaceae), *Leea indica* (Burm. f.) Merr. (Leeaceae) and *Phoebe lanceolata* (Nees) Nees (Lauraceae)] showed significant association. There were no significant differences among sites in soil parameters. Out of the four vegetation types, *Eupatorium adenophorum* seems to provide the best conditions for tree seedling establishment and growth and provides a reliable indicator for success of *C. diversifolia*, L. indica and *P. lanceolata* seedlings. In general, however, domonant groundflora did not provide a reliable indication of the tree seedling community or the soil conditions, since few positive associations were found and the soil conditions were very similar at all three sites.

THE POTENTIAL OF COMMUNITY FORESTRY AND AGRO-FORESTRY IN RELOCATED VILLAGE: KHAO ANG UE NAI WILDLIFE SANCTUARY, EASTERN THAILAND

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ABSTRACT

The focus of this study is to assess the acceptance of community forestry and agroforestry in the relocated villages, Ban Siyad-1 and Ban Siyad-2, of the Khao Ang Rue Nai Wildlife Sanctuary. Field findings were analyzed to draw the conclusions and to make recommendations for developing community forestry and agroforestry for the sustainable development of the relocated villages.

The study showed that the villagers of the study area are excessively poor, are much anxious for their better livelihood. Villagers are trying their best through diverse approaches of farming systems, for example, growing combination of agricultural crop species in the same piece of land, practising agroforestry, based on their own experiences and knowledge, it was also known that, same piece of land is providing more income through agroforestry practices. Community forestry does not exist in the field. However, a 100 rai natural forest is separated for the villagers management by the concern Government authority.

Community forestry, as (C.F.) understood by the villagers, is for the betterment of the villagers to get fuelwood, fodder, timber and minor forest products such as mushroom, bamboo, rattan, honey, and medicinal plants etc. C.F. is being misused and overused by the villagers. Lack of community forestry organisation is the root cause of overuse and misuse of the forest. People do not have the idea about the procedures of community forestry organisatons, assurance of their rights and benefits from the community forests.

Villagers of the relocated area exhibited much interest towards having community forstry and they have also suggested that the community forests should be managed through the active participation of the users.

Based on the field findings and analysis of the results, recommendations were proposed for the development of community forestry, agroforestry, and for further research.

CURRENT SITUATION OF FOREST RESOURCES IN ASIA AND SCOPE FOR IMPROVEMENT

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ABSTRACT

Forests are the greatest achievement of ecological evolution and it is in forests that natural regulatory processes excel, producing the most stable of all ecosystems. But there is a widespread deforestation in many countries of Asia. The main causes of deforestation are: expansion of cultivated land, shifting cultivation, and timber exploitation. Deforestation is most wide-spread in logged over productive forests and is the least in unproductive closed forests. So, this study attempted to find out the current situation of forest resources in Asia and scope for its improvement.

The study is based on literature review. The situation of forest resources in the Far Eastern region of Asia was as follows: (a) the region with over 18 percent of I under forests was well forested in terms of area but he average forest area per head of population is very small with only 0.3 ha percent; (b) the forest area on average is lightly stocked (76 m^3 per ha) as compared with managed temperate forests, but quite highly stocked as compared with tropical forests genaral; (c) the resource is unevenly distributed between sub-regions by area ranging from 23 percent of the total area in Insular Southeast Asia down to less than 10 percent in each of the East Asia and Oceania sub-regions; (d) it is much more unevenly distributed by growing stock with 34 percent of the regional total in Insular South-East Asia and 8 percent in Oceania, and particularly in terms of area with relation o population it was 0.1 ha per caput in South Asia and 12.0 in Oceania and the growing stock was a little over 3 m^3 per caput, in South Asia while Oceania has over 150 m^3 per caput; and (e) the rate of removal of industrial roundwood at the time amounts to less than one percent of the region's commercial growimg stock, but in certain sub-regions is higher than increment.

The study showed that tungya system was a practical and relatively cheaper method of obtaining results in the enrichment of the tropical forests. Other remedial measures identified to control deforetation are:

(1) replacing the poor stands by pure, regular stands of valuable species to improve the commercial quality of the forests;

(2) increasing agricultural production through the use of appropriate technology;

(3) controlled fire burning to improve the stands of forest; and

(4) controlled forest grazing.

The different aspects like intensive forest management, multiple use forestry, imporved plantation/afforestation, techniques mechanization of logging and transport, training and research as well as wood processing, are as the other areas for improvement of the forest resources. Various recommendations were made based on these findings of the study.

A CASE STUDY OF COMMUNITY FORESTRY PRACTICE IN SAGADA, MOUNTAIN PROVINCE, PHILIPPINES

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M.Sc. (1995)
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ABSTRACT

This study was conducted to (1) identify indigenous forest management practices (2) assess existing community forestry practices in Sagada, (3) assess the role of the Department of Environment and Natural Resources (DENR), and (4) find out people's participation in existing community forestry practice. The data were supplied by 108 local respondents from Sagada and 29 DENR personnel from Sagada, Bontoc, Sabangan and Baguio regional offices.

Indigenous forestry practices known as lakon or komunal were managed similarly to community forestry except regarding some customary laws on punishment.

Community forestry practice in Sagada involved the following sequence of activities: committee formation, management plan preparation, plantation establishment and forest protection.

The DENR activities relate significantly to people's participation in plantation establishment and forest protection, so the presence of DENR can increase people's participation in these activities. Dissatisfaction with the DENR centered on insufficient technical assistance, extension service and financial support.

The results show that most people were participating in the development of community or clan forest management in Sagada. The respondents were highly participatory especially in plantation establishment and forest protection. Highly educated people, however, had a greater degree of participation in forest protection.

STUDY OF THE FACTORS AFFECTING BREEDING SUCCESS OF THE PINE SHOOT BEETLE *TOMICUS PINIPERDA* L. (COL., SCOLYPIDAE) WITH SPECIAL REFERENCE TO GALE-DAMAGED PINES.

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ABSTRACT

The suitability of gale-damaged Corsican pine for the pine shoot beetle *Tomicus piniperda* L. was assessed in comparison to scot pine, its preferred host. 83 Scot Pine trees in various categories of damage were studied for susceptibility to beetle attack by measuring the number of attacks per tree in each category. The infestation was heavier in Scots pine than in Corsican pine. Snapped trees were most susceptible, followed next by browning trees. Although adult *T. piniperda* bored into flushing trees, no successful galleries were observed. Galleries were slightly longer in Scots pine (but $P > 0.05$). A density of 0.667 mm^{-2} of egg gallery was calculated from 98 galleries and this was uninfluenced by the species of the host. The larvae (third and fourth instar) from Corsican pine were significantly smaller than their counterparts from Scots pine. No comparison of adult weights could be made.

The effect of bark thickness on intensity of attack was slight and no significant difference was observed in the gallery density (as opposed to number of initial attacks) between the two host species. Gallery length (thus the number of eggs laid) and the ratio of increase (number of new adult beetles per parent beetle) decreased with increase in gallery density. Beetle production (number of new beetles per m^{-2} of bark area) increased with gallery density. No significant difference was observed in other the ratio of increase or beetle production in the two host species. The ratio of increase was 7.91, which was chiefly determined by attack density. It is suggested that gale-damaged trees, especially those flushing in 1988, and the few scattered standing trees should be harvested before the following spring to prevent heavy build-up of *T. piniperda* populations in 1989.

COMPARATIVE STUDY OF INFILTRATION RATES UNDER DIFFERENT LAND USE AND SOIL CONDITIONS

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ABSTRACT

Four types of land use in the Mount Makiling area were evaluated for their efficiency of water intake. The land uses were: forest (dipterocarp), upland crop (gabi or cassava), coconut (pure); and grassland (cogon).

Soil properties were influenced by different land uses. The forested area had the lowest bulk density and the highest organic matter content, soil moisture content, pore space and silt content. There was a positive correlation between the number of trees and silt content in the forested area. In the grassland the grass weight was positively correlated with organic matter content, soil moisture content, sand and silt content. However the number of plants in the upland crop area was negatively correlated with organic matter, sand and silt content and positively correlated with bulk density.

There was a large variation in initial and final infiltration rates both within and between sampling sites. The mean values of the initial infiltration rates for the different land uses were, in increasing order: coconut (20.12 cm/hr), grassland (24.99 cm/hr) upland crop (33.48 cm/hr) and forest (132.34 cm/hr). Similarly, the mean values of the final infiltration rates were: grassland (8.61 cm/hr), coconut (12.09 cm/hr), upland crop (15.6 cm/hr) and forest (38.95 cm/hr).

In the infiltration rate curves, the mean initial infiltration rate for the forest area started with a high value and declined sharply in contrast to the other three land uses, which showed slow declines in the mean infiltration rates. The forest area took up water faster than the other three land uses.

The relationships between initial infiltration rate and various independent variables, and between final infiltration rate and various independent variables were found to be linear or curvilinear with high regression coefficients. Regressions equations were developed and validated for both initial and final infiltration rates of each of the land uses.

EFFECTS OF FOREST FIRE PROTECTION ON PLANT DIVERSITY, TREE PHENOLOGY, AND SOIL NUTRIENTS IN A DECIDUOUS DIPTEROCARP-OAK FOREST IN DOI SUTHEP-PUI NATIONAL PARK.

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M.Sc. (1997)
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ABSTRACT

A two-hectare plot of a deciduous dipterocarp-oak forest in Doi Suthep-Pui National Park, Thailand protected against fire for 28 years was compared with a similar but frequently burnt forest nearby with respect to changes in the plant community, phenological variation and alteration of soil properties. To survey the tree communities in each site, six meter wide transects with a total length of 650 m were laid out across the slope of the mountain following a bearing of 60°. To survey the ground flora, quadrats of 2 x 2 m square were positioned every 30 m along the transects on alternate sides. Twenty one quadrates were placed in each site, covering 2.3% of the total transect area. The importance value percentage of trees greater than 10 cm diameter at breast height, species composition and diversity, and evenness idiocies, for both tree and ground flora communities, were calculated. The seasonal variation in leafing, flowering and fruiting of trees was monitored over the period of eight months from May to December 1996, using the crown density method. Twenty one 1 kg soil samples was collected from just outside each quadrat and these samples were analysed at the Central Soil Research Laboratory, Chiang Mai University.

Fire protection increased the density of trees and consequently the basal area. It slightly changed the species composition and eliminated *Dipterocarpus tuberculatus* var. *tuberculatus* (Dipterocarpaceae). The species richness of both the ground flora and trees was higher in the protected area, but not significantly different. The occurrence of evergreen or tropophytous trees was greater in the protected area than in the burnt area. Phosphorus content and soil temperatures were significantly higher ($p>0.05$) in the burnt area, but there were no significant differences in other soil parameters between the two sites. Average soil moisture content was significantly higher ($p>0.05$) in the protected area throughout the study period except in September. The mean community scores for senescent leaves in November and December were significantly higher in the burnt area than in the protected area. *Shorea siamensis* var. *siamensis* (Dipterocarpaceae) and *Craibiodendron stellatum* (Ericaceae) retained their leaves

RETROSPECTIVE PROGENY TESTING OF SITKA SPRUCE ON A FARM-FIELD SITE

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ABSTRACT

Time is a critical factor in the genetic improvement of commercial traits for long-lived species. Tree breeders have to wait a long time for results from tests and to make selections in many species. Identification of superior genotypes in progeny tests as soon after planting as possible would significantly reduce the generation interval and the cost of further progeny testing program.

Data collected by the Tree Improvement Branch of the British Forestry Commission's Northern Research Station from an experiment entitled *Retrospective progeny testing of Sitka spruce on a farm-field sites* were analysed. Two experiments consisting of 32 open pollinated families and 33 poly-cross families were tested on a fertile and uniform farm-field site using intensive site preparation and close spacing. The same families had previously been out-planted in two and three based sites in the first experiment and three in the second experiement.

The most important parameters required for early selection are high heritability and strong juvenile-mature correlations. Analysis of both experiments showed low heritability and weak juvenile-mature correlations for all measured traits. Families with best performance at younger farm-field sites were not consistently good performer at older forest based sites. A high genotype × environment interaction was observed between farm-field site and associated forest-based sites.

It was concluded that for Sitka spruce the retrospective progeny tests established by the British Forestry Commission are not a reliable basis for the early selection on the basis of height and diameter.

Analysis showed that both farm-field and forest based sites were far from ideal. The poor site selection is possibly the main reason for the disappointing results. However, the results of this study do not undermine the possibility of future research on successful early selection of Sitka spruce in Britain.

SOIL FACTORS AFFECTING PONDEROSA PINE GROWTH

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ABSTRACT

Ponderosa pine, one of the most valuable species in the montane zone of northern Colorado, needs to be studied as to its relationships with soil factors. This study, dealing with soil and growth relationships in ponderosa pine, is a basis for evolving methods which will eventually lead to site quality classification.

Nineteen plots were selected in the study area. Three pine trees were measured and soils were described on each plot. Soil samples collected from each horizon were analysed for particle size distribution in the laboratory. Soil and tree data were analysed statistically in three steps. In the first step a correlation analysis was made using two dependent and five independent variables. Dependent variables were the five-year growth index and the total height index and independent variables consisted of various methods of expressing soil depth and texture factors. In the second step the dependent variable used was the five-year growth index and independent variables consisted of new methods of expressing depth and texture factors. In the third step a multiple regression analysis was made using the five-year growth index and the best depth and the best texture factor selected from the first and second steps.

The five-year growth index was a better measure of potential growth than the total height index. All methods of expressing depth of the A horizon were significant, but the methods of expressing depth to the C horizon were not significant. All methods of expressing texture as a percentage were significant. Effective depth of A horizon and percent silt plus clay to the C horizon accounted for 36% of total variability in growth of ponderosa pine.

JOB PERFORMANCE OF THE COMMUNITY ENVIRONMENT AND NATURAL RESOURCES OFFICERS (CENRO) AND PROVINCIAL ENVIRONMENT AND NATURAL RESOURCES OFFICERS (PENRO) OF THE DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES (DENR), REGIONS III AND IV, THE PHILIPPINES

Koirala, Jagan Nath.
M.Sc. (1994)
University of The Philippines, Philippines

ABSTRACT

This study was a survey conducted to assess the job performance of CENROs and PENROs of Regions III and IV, DENR. Other objectives of the survey were: to determine whether training improves their job performance and to determine what other institutional and individual factors relate to their job performance.

The majority of officers who responded were graduates in forestry and the rest were graduates in geodetic surveying, engineering, or other courses related to natural resource conservation. The majority of them had work experiences of more than 20 years of various levels. Thirty-three (59%) had received in-service training after having been assigned to their present jobs. Most of them had received management-related training. The majority favoured short-term management courses for in-service training. A few had received Eagle Award. The majority encountered serious problems in law enforcement and scarcity of resources. The motivation level of the respondents was high. A few of those who had not attended any training at their present levels preferred long-term training such as degree courses.

Correlation analysis showed that in general, training was positively associated with job performance. Likewise training variables such as frequency, type, relevance and management of training were found to be associated with job performance. These results could imply that training could be developed as an effective mechanism for enhancing job performance. To ensure training effectiveness, however, training variables such as frequency, type, relevance, and types of training management should be seriously considered in the design and planing of training program. Other institutional variables found to be significantly associated with job performance were salary, frequency of promotion and Eagle Awards. This clearly implies that rewards such as salary rise, promotion and recognition could be effective motivators of high-level performance.

In addition to the institutional variables, there were six individual variables found to be significantly related to job performance of CENROs and PENROS. These were age, educational attainment, professional skill, work experience, motivation, and attitude towards training. The results of the study could imply that to achieve high-level performance, DENR should include in its selection criteria for CENROs and PENROs the above-mentioned variables, and adopt other measures that could improve their professional capabilities, work motivation and attitudes.

AN INVESTIGATION ON A METHOD FOR MEASURING ISOTOPICALLY EXCHANGEABLE PHOSPHATE

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M.Sc. (1987)
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ABSTRACT

The phosphate adsorbed at various equilibration times by a Brazilian dark red latosol soil was determined. Sorption in the first 24 hours was rapid; however the rate decreased with increasing time after 48 hours of equilibration.

The plot of sorption against log of time was a straight line for equilibration times greater than 10 hours. Adsorption isotherms for exchangeable and total adsorbed phosphorus were described. The method was investigated by altering the first and second equilibration times individually and the effect on exchangeable, non-exchangeable and total adsorbed phosphorus was determined.

The amount of exchangeable phosphorus increased with increase in the equilibration time but decreased with increase in the equilibration time. On the other hand non-exchangeable phosphorus decreased with increase in the second equilibration time but increased with increase in the first equilibration time. The amount of total phosphorus adsorbed increased with increase in both first and second equilibration times.

The amount of exchangeable phosphorus in particular changed greatly when either equilibration period was less than 24 hours.

WHITE-TAILED DEER DENSITY AND HABITAT RELATIONSHIPS

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ABSTRACT

Studies on density-related indices for white-tailed deer were conducted at the Conservation Research Centre (CRC) in Warren County, Virginia, from June 1985 to April 1986. Food habits and bark-stripping by deer were also evaluated.

Whole body weights, stored fat status, abomasal parasite counts and blood indices from five deer collected in September on the CRC were compared with deer collected from two reference areas in southwest Virginia. Abomasal parasite counts for the three areas were recorded as 2568, 1292, and 292. No consistent effects of deer density on physical and physiological indices were observed.

Rumen contents from the five deer collected on the CRC were used to determine food habits. The fall diet consisted of green herbage and foliage of woody plants (70% of the total volume) and fruits such as acorns, apples, and black cherry (30%). No consistent effect of deer density on forage use in meadows was observed at the CRC. Meadow utilisation decreased as the growing season progressed. Meadows were utilised more at the edge than 200 m from the edge ($P = 0.06$). No significant difference ($P > 0.05$) was found in percentage of dogwood twigs browsed during winter among areas with different deer densities.

Faecal crude protein values were higher during summer than winter ($P < 0.0001$) but there also was an area season interaction ($P < 0.01$). Acid detergent fibre (ADF) values were significantly different areawise ($P < 0.01$), seasonwise, and areas season interactionwise ($P = 0.0001$). Deer density was positively related to winter ADF values.

Bark-stripping occurred on slippery elm trees during the winter in a high deer density area. No significant association was found between stripping of slippery elms and age, dbh, and height classes. Protein ($P < 0.001$) and starch ($P < 0.01$) contents of the bark were significantly higher in slippery elms than in any other tree species.

DEVOLUTION OF THE INTERGRATED SOCIAL FORESTRY PROGRAM IN REGJON IV, PHILIPPINES: A STUDY ON INSTITUTIONAL COMPLIANCE

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ABSTRACT

This study assessed the local government units' (LGU) compliance with the devolution of the Integrated Social Forestry Program (ISFP) and the factors associated with it. It covered all 11 provinces in Region IV. Respondents were 27 provincial officials, 48 devolved personnel, 34 communities and 36 Department of Envirinment and Natural Resources (DENR) field-level officials. Data were collected by means of a multi-stage sampling survey using interview questionnaires and informal group discussions with key informants. Secondary data were sourced from DENR Region IV and Department of Interior and Local Government Central Office. Descriptive and inferential statistics were used to analyse data.

Most respondents were male and middle-aged, and all had received formal education. Most provinces had a unit concerned with environment and natural resources before devolution. All provinces had general programs of environmental conservation. Only six had adequate budgets. Eight provinces were considered high class. Provincial leaders had a positive attitude towards the ISFP, devolution in general, and devolution of the ISFP in particular. One-day orientation programs as pre-devolution support from DENR were helpful but insufficient. Few provinces received information on farm development techniques, as technical support, and planting material as resource support as post-devolution support.

While the creation of an ENR (Environment and Natural Resources) office and appointment of an ENR officer concerned with ISFP was not mandatory, some provinces created this structure & appointed an ENRO (Environment & Natural Resources Officer).

Eight provinces had a budget allocated for ISFP and most provinces had an ISFP program with limited activities. Contrary to expectation, most of the provinces were found to have assigned ISF devolved personnel to unrelated functions.

Generally, the provinces under study were inconsistent in performing their expected roles. Seven provinces were found to have complied well with the devolution of ISFP. Simple correlation analysis showed that pre-devolution DENR support and provincial leaders' attitudes towards devolution of ISFP were highly associated with compliance rate.

Based on the study's adopted indicators, generally the provinces in Region IV had high compliance. Pre-devolution support and LGU leaders' attitudes toward devolved ISFP significantly affected institutional compliance. Problems related to policy, capability, administration, finance and inputs were encountered by the LGUs. This study recommends the mandatory creation of ENR office and appointment of ENRO in each LGU, and continued close co-ordination and team work among ISFP coordinator, and social forestry desk officers of DENR field offices and devolved personnel.

PEOPLE'S PARTICIPATION IN INTEGRATED SOCIAL FORESTRY PROGRAMME IN PANTABANGAN

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ABSTRACT

This study was designed and conducted to determine the people's participation in integrated social forestry program in Pantabangan.

The data were gathered through a questionnaire, personal interviews and direct observations and were analysed through the frequency distribution, percentage, descriptive rating, rank, mean and standard deviation to test the hypotheses.

The participants' involvement was "very high" in all of the following activities: identifying problems, suggesting and designing activities, making proposals, providing labour, tools and equipment and arranging, supervising and contributing to the activities.

People's participation plays an indispensable role in the success of the integrated social forestry programme. To make people participate, however, some vital factors must be considered. Motivation is one of them. The study found that the participants in the program were strongly motivated by their desire to increase their income and improve their community.

The results of the study showed that participants' expectations were satisfactorily met, their income increased, their community was improved and their knowledge and skills were upgraded. Overall, therefore, their satisfaction of the programme was very high.

On the other hand, the programme would still have failed if the forest officers implementing the programme had been inefficient and incompetent. In the Pantabangan program, the forest officers were always available and were rated as competent by all the participants. Based on these findings, various recommendations were made.

DRYING BEHAVIOUR OF 1-INCH TUAI (*BISCHOFIA JAVANICA* BLUME) IN AN ELECTRICALLY CONTROLLED LUMBER DRY KILN

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ABSTRACT

This study was on drying behaviour of 1-inch Tuai in an experimental electrically controlled lumber dry kiln at the wood processing laboratory of the Department of Wood Science and Technology in August and September 1992. A log of Tuai was obtained from the Makiling forest and sawn to 1-inch thickness planks at the sawmill of the College of Forestry. The planks were dressed and cut into boards 6 inches wide and 2 feet long for the experiment.

The standard drying schedule for Tuai produced by the Forest Products Research Development Institute (FPRDI) was used for runs I and II and the modified drying schedule was used for runs III and IV. In the modified drying schedule low temperature and high relative humidity were used at the initial stage of drying and the temperature increased and the relative humidity lowered when the fraction of total evaporable water remaining in the wood (E)* fell to about 0.7. US Forest Products Laboratory research has shown that it is safe to start lowering relative humidity or increasing temperature when E value is down to 0.7.

The drying time with the use of the modified kiln schedule was longer by 34% than the standard drying schedule. This may be due to the low temperature and the high relative humidity at the initial stage. Another possible explanation for the prolonged drying time was the daily curtailment of electric current which may have disturbed the movement of water and prevented complete heating of the entire cross section of the board to the desired temperature, particularly the core, where the moisture content was the highest. The total drying time using the standard drying schedule was 185 hours, and using the modified drying schedule it was 281 hours.

Pre-steaming of sample boards seemed to affect drying time and quality of the boards but more studies on this are needed for more conclusive observation.

It was found that specimens with final moisture content (MC) of 15% to 20% had better volume recovery upon reconditioning than those with lower final MC. Quarter-sawn boards were generally found to be of better quality than plain sawn boards, but it was difficult to get pure quarter-sawn boards of Taui owing to its spiral, wavy, and interlocked grains. Low temperature and high relative humidity reduced the risk of collapse to some extent but the drying time was considerably prolonged.

The study proved that the drying of Tuai lumber is very difficult because it is highly prone to collapse, drying stresses, and warping. However, there are indications that the drying behaviour can be improved. Further study on this is recommended to improve the quality of dried materials.

* $E = \frac{\text{current MC - equilimium MC}}{\text{green MC - equilimium MC}}$

HISTOPATHOLOGICAL STUDIES OF *CRONARTIUM CONIGENUM* IN CONES OF THREE *PINUS* SPECIES FROM GUATEMALA

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M.Sc. (1987)
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ABSTRACT

The host-parasite responses of cones of three Guatemalan pine species, *Pinus tenuifolia* Benth., *P. pseudostrobus* Lesq., and *P. oocarpa* Sch, to infection by *Cronartium conigenum* (Pat.) Hedgc and Hunt were investigated histopathologically. Diseased cones were fixed in formalin-propionic acid-alcohol. Cone segments 5 mm x 5 mm in size were dehydrated through an ethanol-tertiary butyl alcohol series, embedded in paraffin, sectioned using a rotary microtome, and stained with either cotton blue or double-stained with safranin and haematoxylin. For transmission electron microscopy, tissue segments 1 mm x 2 mm in size from the axis phloem of *P. oocarpa* were processed, sectioned, and photographed.

Most individual cells in the infected cone tissues were dislocated and rounded compared to normal cone tissues. Tannins accumulated in the intra-and intercellular spaces of intensely colonised tissues, especially in *P. oocarpa*. Phloem was largely composed of parenchyma cells, and most of the sieve cells were present at the outer limit and appeared crushed. Most end walls of tracheid cells were blunt in infected cones. Other tissue characteristics of the three pine species were not remarkably different from typical normal cone tissues.

Intercellular spaces of cone tissues were intensively colonised by septate hyphae of *Cronartium conigenum* which grew in all directions and often produced short-intracellular pegs in cortical cells. In phloem, hyphae frequently encircled the sieve area of the sieve cells and often penetrated the sieve cells through the sieve area. The colonisation frequency in xylem parenchyma was greater than in the tracheid cells. Hyphae entered the pith from the interfascicular parenchyama, vascular rays, and xylem. The smallest hyphae were observed in the umbo near the cone surface and in the intertracheal spaces, while the largest hyphae occurred in the phloem tissues. Hyphal characteristics were similar in the comparable tissue types of the infected cones of the three pine species. Haustoria were highly variable in the cortex, protoxylem, and pith parenchyma cells but were simple and less variable in the phloem, vascular rays, metaxylem parenchyma and tracheid cells. Haustorial frequency was higher in cortex, xylem and pith parenchyma than in phloem and tracheid cells. In nucleated host tissues, flattening, indentation and encircling of host nuclei by haustoria were frequent. Haustorial shapes and sizes were most variable in *P. tenuifolia*

SEASONAL VARIATION IN WATER TABLES IN THE AUSTIN CARY FOREST

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ABSTRACT

Seasonal changes in elevation of a perched water table surface and its depth below the soil surface were studied over an 11-month period on a 1 km x 0.5 km area of the Austin Cary Memorial Forest near Gainesville, Florida. The observations were supplemented by examination of hydraulic conductivity, root distribution and soil chemical properties at selected locations. The purposes were to determine the likelihood of ground water use by forest trees and the relationship between water table depth and topography.

With one important exception, the ground water surface was relatively uniform, with an average N-S slope of 1.4% from Lake Mize to the Hatchet Creek bottom. The exception is due to higher elevations of the "sandhill" along the northern half of the western border. Topographic elevations vary more than those of the water table. As a result, minimum and maximum depths of water below the soil surface range from <1 m to >5 m, and <2 m to > 5 m, respectively.

The 29 water table wells were grouped into 8 classes according to the location, depth of water table below the soil surface and response patterns following heavy rains. For example, shallow wells in level sands rose immediately after the rain and thereafter declined, whereas some deeper wells on slopes rose continuously for six to eight days after rain as a result of subsurface inflow.

Roots of <5 mm diameter were distributed throughout the upper 1 to 1.2 m depth and were common (>50% occupancy) at the 1.6 to 1.8 m level. These roots, as well as those >5 mm in diameter, continued downward, suggesting exploitation of the soil to greater depths, even at the lowest ground water levels. Hence the vegetation on more than half of the study area was probably in contact with, or benefited through capillary rise, from the ground water, even at the lowest levels.

AGROFORESTRY ADOPTION PATTERNS IN THREE SELECTED INTEGRATED SOCIAL FORESTRY PROJECTS IN ORIENTAL MINDORO, THE PHILIPPINES

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M.Sc. (1994)
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ABSTRACT

This study identified some significant factors which explain the variability in the adoption of agroforestry practices by Integrated Social Forestry Project (ISFP) participants. It was conducted in three ISF projects in Oriental Mindoro, Region IV, involving 101 respondents.

Data were gathered through personal interviews and through research of secondary information from DENR offices. Direct observations of the study sites were also made. Data were analysed using descriptive and inferential statistics.

Results indicate that ISF farmers in the study sites have low income levels compared to the 1988 national average of P 40408 since a great majority (80.2%) of them have annual household incomes of less than P 10000. They also have limited capital resources, with a mean value of P 14372. The average duration of formal schooling was 2.36 years.

Farm sizes ranged from 0.69 to 9 ha, with an average size of 3.06 ha, which is close to the 1988 national average of 2.94 ha. Most (77.23%) of the respondents had Certificates of Stewardship Contract (CSC). The average farming experience of the respondents was 17.28 years, indicating that they cultivated their farms for quite a long time.

The agroforestry practices adopted were: (1) boundary plantation; (2) random mixture of forest trees, fruit trees and agricultural crops; (3) planting of legume trees in agroforestry farms; (4) weeding; (5) fertilisation and (6) pest control. Based on the number of these agroforestry practices adopted, there were 54 respondents (53.47%) who had adopted all six practices while the rest were as partial adopters. On the basis of the length of time they took to adopt agroforestry practices, respondents were categorised into: (1) innovators; (2) early adopters; (3) early majority; (4) late majority; and (5) laggards. The most frequently mentioned problems were lack of good variety seedlings and farm tools.

Based on the analysis, 12 variables were found to be significantly correlated with patterns of adoption of agroforestry. These included the following: educational attainment, ISF farm size, farming experience, total assets, capital assets, land tenure, credit, perception, attitude, social participation, cosmopoliteness and exposure to print media.

However, using stepwise regression analysis, only 7 variables significantly explained the variations in agro-forestry adoption patterns. These were: attitude, perception, farming experience, farm size, land tenure, educational attainment and social participation. Among these 7 variables, attitudes and perceptions of farmers about agroforestry showed the largest coefficients of determination (R^2), indicating that DENR should improve its extension activities to encourage positive attitudes and improve the perceptions of ISF farmers about agroforestry.

REGIONAL RESOURCE PLANNING ON THE FRINGE OF THE MEGA-URBAN REGION: THE UPPER CILIWUNG WATERSHED OF WEST JAVA, REPUBLIC OF INDONESIA

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ABSTRACT

The Upper Ciliwung watershed in west, Java has to be conserved so that it continues to function as a recharge area for the water supply of Jakarta and also as a recreation site for its urban residents. The Government of Indonesia has responded to these concerns through the enactment of Presidential Decree No 79 in 1985, in the form of land utilisation zoning in order to control and balance the multiple uses of the watershed and to promote sustainable development.

The approach adopted by the study team was based on the strategic planning model with rapid appraisal methods in field data collection. An intensive field survey complemented by analysis of aerial photographs and satellite imagery was carried out, and the results obtained were incorporated into the making of the latest land-use and river system maps of the area. Three major issues were identified; these were related to watershed degradation, land-use conflicts and quality of life in the watershed. These issues have been addressed in the study report in an integrated manner incorporating both the biophysical and socio-economic appraisals.

A major objective of the field data collection was to assess the effectiveness and efficiency of the Presidential Decree. The study found that the existing implementation mechanism still has to be improved to realise all the intended goals of the Decree, but especially the involvement of the community of the watershed.

Recommendations by the study team focused on resource and environmental planning and management. Soil and water conservation is being accorded top priority. From the socio-economic perspective, greater employment opportunities have to be made available while also enhancing the watershed function. With improvements in land-use planning and control, tourism and recreation development is expected to remain as an active economic sector in the study region.

VOLUME AND TAPER EQUATIONS FOR LOBLOLLY PINE TREES USING DIMENSIONAL ANALYSIS

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ABSTRACT

A dimensional analysis approach was applied to derive a general volume equation for a tree. A taper equation compatible with the general volume equation was also developed. Data from loblolly pine trees grown in natural stands in the coastal plain of North Carolina and the coastal plain and piedmont areas of Virginia were used to estimate the parameters for these volume equations.

A dimensionally compatible volume equation is shown to be a better equation for estimation of the volume of loblolly pine trees and can be applied for the estimation of total volume. The taper equation can be applied to predict the diameter for any specified height and to predict height for any top-diameter limit. The volume between any two points on the tree bole can be calculated by integration of the taper equation.

NEURAL NETWORK CLASSIFICATION OF MULTI-SENSOR DATA FOR THEMATIC INFORMATION EXTRACTION

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ABSTRACT

Optical and microwave sensor data can provide complementary information on a ground object. The information can be extracted by the methods of visual and computer analysis. In the visual analysis, a fused image is formed by combining optical and microwave sensor dada. There are different techniques to obtain this fused image. The image can be interpreted to extract the information for a particular application. In computer analysis, a suitable classifier is needed to handle optical and microwave sensor data. Neural network classifiers are suitable for handling the multi-nature data obtained from the different sources. These classifiers do not need a particular frequency distribution as is needed for the conventional statistical classifiers (e.g. maximum likelihood). By providing example patterns, neural network classifiers are able to classify the whole population. There are different classifiers within the neural network domains. The one which was used here is the *back-propagation* network. SPOT and ERS1 SAR. PRI data were taken for the classification. The main objective of the research was to obtain optimum thematic information from the multi-sensor data. Different methods were applied to improve the classification. These were: *inclusion of a prior probability, using filtered SAR data,* and *object-based classification.* A small number of training and test samples were taken for the study. An improved classification result was obtained when including microwave (filtered) data. Because of the small number of samples used in the experiments no concrete conclusions can be made for the cases, *inclusion of a priori probability* and *object-based classification.* The confusion matrices for each case are presented. The learning difficulties (e.g. local minima, overtraining, overfitting etc.) of the networks are discussed.

AN ANALYSIS OF THE INVOLVEMENT OF NON-GOVERNMENTAL ORGANISATIONS IN SELECTED UPLAND DEVELOPMENT PROJECTS IN REGION II PHILIPPINES

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M.Sc. (1993)
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ABSTRACT

The study aimed at determining the characteristics, performance and impact of NGOs in upland development.

The three NGOs studied and the location of their projects were ICAG in Quibal, Penablanca, Cagayan; BURDFI in Rang-ayan, Ilagan, Isabela; and CTFA in Dean in Diffun, Quirino. Their upland development projects were funded by international agencies through DENR. Data were gathered from 99 households in the project areas and from the three recipient- NGOs.

The value of assets of the NGOs studies ranged from p 45,500 to P 3.350,000, while the annual income of the NGOs varied from P15.000 to P2,050,000. The highest budgetary allocation for project operation was P3,000,000. The bigger NGOs had permanent staff, while the smaller NGO lacked permanent staffing due to financial constraints, and where concurrently implementing MESS, ICBM, agroforestry and livelihood projects.

The results indicate that majority of the respondents were satisfied with the overall performance of the projects and the NGOs.

Two characteristices of the respondents -- tenurial status and employment opportunity -- were associated with the respondents household and farm facilities. Household size and the farm size were significantly related to the changes in the both the income and facilities of beneficiaries.

There of the seven independent variables (characteristics of the beneficiaries) of the study -- were associated with the respondents response of equity.

Three characteristics of the respondents, namely: tenurial status, employment opportunity and satisfaction were highly associated with the crop diversity as well as with soil and water conservation measures adopted. Farm size had moderate correlation with soil and water conservation .

Five of the seven characteristics of the respondents (educational attainment, tenurials status, annual income, employment opportunity, and satisfaction) were associated with the forest protection measures; specifically, stoppage of kaingin practices.

Tow variables -- value of assets and years of experience of the NGOs -- were significantly related to difference in household and farm facilities, equity, and crop diversity. Three variables, annual income, budget for operation, and number of staff, were significantly related to stoppage of kaingin practices.

Delay in fund release as well as internal problems within NGOs affected the performance.

CONFLICT RESOLUTION IN THE COMMUNITY FORESTRY PROJECT IN SAT ELENA, CAMARINES NORTE, PHILIPPINES

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ABSTRACT

This study aimed to identify and analyse the factors that bring about conflicts in community forestry and to suggest a process for resolving these. The community forestry project (CFP) studied was in Sta. Elena, Camarines Norte, a project funded by Asian Development Bank (ADB). The CFP involves three major actors, the Department of Environment and Natural Resources (DENR), the assisting non-government organisation (NGO) and the people's organisation (PO). In cases like this where there are multiple actors and interplay of interests, conflicts are always bound to happen.

The CFP included activities such as contract reforestation, agroforestry, assisted natural regeneration and timber stand improvement. Data were gathered from 55 respondents using the Snowballing method. Altogether 14 major conflicts were indentified. These were of three types: conflict between groups, conflict between a group and individuals, and conflict between individuals.

The conflicts identified between the groups were: lack of community mobilising skills, overlap of CFP and Sta. Elena drinking water project areas, tenurial conflict and responsibility of McDAI's for savings funds. Conflicts between group and individuals were over fluidity of membership, indifference of members, and the loose credit policy of the McDAI consumers' store. Conflicts between individuals were on or caused by, boundary matters, bickering among PO leaders, responsibility for draft animals, relations between boss and subordinate, misuse of funds, and inefficient accounting systems.

The results indicated that the most frequent conflicts in the project were between individuals . In most cases, the conflicts were due to personal traits. The next most frequent were due to scarcity of resources and interdependence of work activities. Most of the conflicts were resolved using the consensus method.

The study demonstrated that no single approach to conflict resolution can be presumed to be effective in all situations. The circumstances of conflict, and thus the barriers to resolving a conflict, vary enormously. The root causes of all the 14 conflicts identified in the study were leadership incompetence, lack of community-organising ability by the NGO, and absence of firm policy from the DENR and guidelines from the PO.

Before implementing the CFP, the existing PO should first be re-oriented and the NGO should be made accountable to the PO. When there is conflict between "unequal; power", the method of integrative problem solving is advisable.

EFFECT OF STORAGE ATMOSPHERE ON SEED VIABILITY AND VIGOUR IN *PINUS RADIATA* D. DON

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ABSTRACT

Programs to establish new forests are expanding rapidly, especially in the developing countries of the tropics. Seed is the first requirement in the silvicultural processes for developing and eventually replacing these forests, whether with direct seeding or by planting stock. So maintaining sufficient supplies of seeds is essential and storage of seeds is a practical necessity.

Seed storage has been a problem in developing countries because storage methods which rely on the control of temperature by refrigeration and the control of seed moisture content by dehumidification equipment demand capital investment and high technology which are lacking in such countries. Relatively simple methods of seed storage are therefore needed to maintain the physiological quality of the seed.

Relatively simple methods of controlling the seed storage atmosphere were examined using seed of *Pinus radiata*. Reduction in seed deterioration was achieved by replacing or limiting the oxygen supply and by maintaining the seed moisture content in sealed laminated plastic bags. Of the four storage atmospheres tried, nitrogen was the most effective, followed by carbon dioxide, vacuum and air, in that order, in maintaining the viability and vigour of the seeds. Storage in an atmosphere of nitrogen was most effective at all the storage temperatures tried, which ranged from 5°C to 35°C. Presence of oxygen in the storage atmosphere had deleterious effects on seed viability and vigour.

In developing countries, such relatively simple and cheap storage methods can be employed to improve storage condition. The methods employed here on *P. radiata* should be applicable to other important seeds used in the tropics and subtropics. Depending upon the period of storage required, a particular storage atmosphere can be selected. Nitrogen storage would be advantageous for long-term storage and carbon dioxide for medium-term storage. In field areas, where short-term storage would be sufficient, storage of low moisture content seed in sealed containers in air or in a vacuum would be the simplest and cheapest method to maintain viability and vigour of seed.

STUDY OF FUELWOOD CUTTING IN PLANTATION OF *PROPOSIS JULIFLORA* IN EASTERN KENYA

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ABSTRACT

The main objective of this preliminary study was to study different manual tree-cutting methods for fuelwood production in the Bara Fuelwood Plantation Project. Two different methods of cutting, (i) one-man crew and (ii) two-man crew were investigated. Time study was the main method used to collect the data. Multiple-regression analysis was applied in data analysis.

The effective cutting time depended significantly on the base diameter of the wood. The production costs for both methods were also estimated. The average production cost for method (i) was US \$1.44 per m^3 and for method (ii) it was US \$1.09 per m^3. The cost of making bundles of fuelwood was US \$ 20.08 per m^3. The average total cost, when the felling cost was added, was US \$21.17 per m^3. This was expensive when compared with the market price of fuelwood.

As data were not available for method (ii), the ergonomics were analysed only for method (i). The heart-rate did not depend significantly on either base diameter or temperature. The average energy expenditure was 39.20 KJ per min., the maximal oxygen consumption was 4 L per min. and the degree of strain was 48.75%.

Method (i) was more productive when the tree size was smaller than 8 cm in diameter. When the tree size was bigger than 8 cm in diameter, method (ii) was more productive. The results are preliminary and before being used for routine application should be supplemented by more studies and field experience. Method (ii) required fewer tools.

COMMUNITY PARTICIPATION IN CONTRACT REFORESTATION PROJECTS IN LAGUNA PROVINCE, PHILIPPINES

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ABSTRACT

The study was conducted: (i) to identify and characterise community members involved in Community Contract Reforestation (CCR) and find out how they were organised; (ii) to determine their attitudes towards CCR; and (iii) to assess socio-demographic, physical, psychological, administrative and economic factors related to the participation of community members in CCR.

Five projects were studied, all located in remote upland areas and accessible only by walking for 1.5 to 2.5 hours. Lack of good trails is a general problem. Two projects have a serious lack of water.

Fifty-two participating community members were interviewed using a structured interview schedule. Thirty-six labourers who worked in the CCR areas were also interviewed to elicit additional information which could not be extracted from member respondents. Data were analysed using frequency count, percentage, range, mean, and standard deviation. The Pearson Product Moment Correlation was employed to determine the relationship between variables.

The two major findings of this study were: (i) out of the five organisations involved in CCR only three were real organisations. The other two cannot be considered organisations in the true sense as their members were not involved in any activity of the CCR and (ii) most of the participants were unaware or only poorly aware of the benefits and privileges of the CCR. Only 17% are were of them.

Member respondents actively participated in decision-making and implementation but less in benefit sharing. Most of the member respondents had favourable attitudes toward CCR. Employment and income were their main expectations in joining the CCR project.

Expectations were possibly related to participation in decision-making. Education, awareness, and extension were negatively related to participation in the implementation of projects. Awareness, attitude toward CCR, expectations and accessibility were significantly associated with participation in benefit-sharing but distance from house or village to the project site were negatively related with participation in benefit-sharing.

COPPICING AND RESPROUTING IN MONTANE TROPICAL RAIN FORESTS IN JAMAICA

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ABSTRACT

Two aspects of the vegetative regrowth of trees (coppicing from cut stumps and resprouting from the trunks of naturally damaged trees) were investigated in Jamaican montane tropical rain forests in 1987. Coppicing was studied in two plots, one on a Mor Ridge site and the other on a well-developed Mull Ridge site, in which all the trees had been cut at ground level for biomass measurement 12 and 10 years respectively before this study. In the study, all sprouts of the stump of every cut tree were measured in terms of height, diameter and crown volume.

Resproutng was observed in more detail over a shorter time period in three Mull Ridge forest plots in which all the trees taller than 5 m had been pulled down to ground level in order to imitate the natural impact of a severe hurricane. A few sprouts existed on the trees before the disturbance, and a sample of these were labelled. The damage to the trees led to considerable production of new sprouts and samples of up to three sprouts per tree were measured and labelled 9 months after disturbance. These sprouts were re-recorded (survival and height) 18, 27 (in one plot) and 52 months after disturbance. Additional sprouts were labelled to replace those that had died.

In the Mor Ridge plot 38 out of 51 stumps (75%) and 10 of 12 species coppiced. There were on average 4.3 shoots per stump. The rate of coppicing was lower in the Mull Ridge forest plot: 30 of the 64 stumps (47%) had coppice shoots but for 11 of these all the shoots were dead. On average there were 3.6 live + dead shoots per stool. Nonetheless, 16 of the 19 species had coppiced. The percentage of trees with multiple trunks indicated that past vegetative regrowth had been more frequent in the Mor Ridge forest.

In the Mor Ridge plot no significant relationship was found between the basal area of the stump and incidence of sprouting. However, there was significant correlation between trunk size and sprout number, tallest sprout height and sprout crown volume. In the Mull Ridge plot the incidence of sprouting was significantly greater for larger trees. There were clear differences between the species in the architecture of their coppicing, e.g. of the more vigorously sprouting species in the Mor Ridge plot, *Cyrilla racemiflora* and *Ilex macfadyenii* produced a large number of medium-sized "bushy" sprouts, whereas *Persea alpigena* and *Alchornea latifolia* produced a smaller number of taller sprouts.

In the naturally damaged Mull Ridge plots 52% of trees produced trunk sprouts and only 16% of species failed to produce any sprouts. There was no simple relationship between tree size and incidence of sprouting.

There was clear relationship between the type of damage suffered by the tree and the incidence of sprouting; the trees which had suffered breakage (but not complete severance) of their trunks or breakage in their crowns had the highest percentage of individuals sprouting (78%). The lowest percentages of individuals sprouting were amongst those that had been uprooted (32%) or had suffered no major physical damage (21%). There were significant differences between species in mean and maximum sprout height growth rates.

The species that had coppiced and resprouted most vigorously occupied a much greater proportion of the basal areas in the Mor Ridge forest (89%) than in the Mull Ridge forests (31%). These species tended to have a higher proportion of trees with multiple trunks, e.g. *Vaccinium meridionale, Cyrilla racemiflora* and *Alchornea latifolia*. In the Mor Ridge plot the biomass was dominated by the coppice shoots (e.g. they comprised 73% of stems taller than 4 m, though coppicing stumps comprised only 53% of separate individuals. In the Mull Ridge plots seedlings were dominant over coppice/sprouting shoots. Some species with poor seedling regeneration showed evidence of good resprouting but others did not. Several species showed good ability to regenerate via both mechanisms, however these species were not dominant in the forests studied.

COMPARATIVE ANALYSIS OF SELECTED REGULAR AND FOREIGN-FUNDED INTEGRATED SOCIAL FORESTRY PROJECTS IN REGION IV, THE PHILIPPINES

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ABSTRACT

This study is aimed at comparing the socio-economic and environmental impacts of the regular and foreign-funded integrated social forestry (ISF) projects in Region IV of the Philippines.

Three foreign-funded and two regular project were selected for study: the UNDP/FAO Atimonan ISF Project and the regular Masalukot ISF Project in Quezon Province; the UNDP Parang ng Buho ISF Project in Laguna Province; and the ADB Lantuyan Model ISF Project and the regular Caagutyan ISF Project in Oriental Mindoro Province. Data were gathered from 144 households in the project areas and five project technicians. Descriptive and inferential statistics were employed in data analysis.

The ISF sites were fully operational after 1988. Six types of activities were carried out to meet the goals and objectives of the ISF programme. On the average, 94.50 % percent of most of the activities were completed. People's participation in planning, implementation and benefit sharing was lacking in both types of projects. The level of living of the respondents improved under both types of projects.

The average total income of respondents in both types of projects increased after the implementation of the projects but was still not sufficient for the respondents' daily needs in both types of projects. The prevalence of illnesses among the respondents' respective families was found to be the same before and after the implementation of both types of projects.

The findings showed positive environmental impact (i.e., more crop diversification, soil fertility improvement, more farm-lot development, and better for soil maintenance practices were observed in both types of projects). Kaingin practices were still prevalent in both types of project. The occurrence of pests and diseases was more prevalent after the implementation of the projects because of the planting of more crops, particularly calamansi and coffee.

In the foreign-funded projects, the following variables emerged as consistent factors that were associated with the socio-economic impact of the projects: number of years in the project, perceived competence, frequency of visits, number of training programmes attended, number of staff, material support, expenses, and benefit sharing.

In the regular projects, number of years in the project, frequency of visits, number of training programmes attended, number of staff, material support and expenses emerged as factors that contributed significantly to the projects' socio-economic impacts.

In the foreign-funded projects, number of years in the project, perceived competence, frequency of visits, number of training courses attended, number of staff, expenses, planning, implementation, and benefits sharing, emerged as significant factors that influenced the projects' environmental impacts.

In the regular projects, number of years in the project, perceived competence, number of training programmes attended, material support and expenses were significantly associated with the projects' environmental impacts

The regular and foreign-funded projects were significantly different in the following 6 out of 15 variables studied: total income, income from outside CSC area, off-farm income, change in income, fertiliser application and soil improvement practices.

MINESOIL PROPERTY EFFECTS ON THE HEIGHT OF TEN-YEAR OLD WHITE PINE

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ABSTRACT

Thirty-four 10-year-old white pines (*Pinus strobus* L.) growing on reclaimed minesoils in Virginia were selected to evaluate the effects of selected minesoil properties on tree growth. A 1 m deep backhoe pit was dug at the base of each tree to determine rooting depth, and surface soil samples (0-10 cm) were collected for analysis of selected physical and chemical properties. Multiple regression analysis was used to model the combined effects of minesoil properties on tree height. The minesoil variable that had the greatest influence on tree growth was rooting volume index, defined as depth to a restrictive layer times the soil-sized fraction (%) of the surface 10 cm. The next most influential minesoil property that affected height was soluble salt content; an inverse relationship existed between tree height and electrical conductivity of a 1:5 soil water extract. A linear regression equation describing white pine site index (SI_{50}) as a function of the square root of depth to a restrictive layer was highly significant.

CHANGES IN THE NUTRIENT STATUS OF THE SOIL UNDER LOBLOLLY PINE PLANTATIONS

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ABSTRACT

Soil samples were obtained from loblolly pine (*Pinus taeda* L.) plantation stands ranging in age from 2 to 52 years and from three depths, 0-5, 15-20 and 25-30 cm. Cation exchange capacity, pH, organic matter content, and available nitrogen, phosphorus, potassium, calcium and magnesium were determined for each stand. The data were statistically analysed by the General Linear Models Procedure (Proc GLM). The least-square means thus obtained for each variable were plotted against age.

Although many of the soil nutrient differences among stands of different ages were overshadowed by differences in the initial levels of nutrients and in soil texture among the sites prior to planting, loblolly pine plantations seem to have changed the nutrient status of the soil within the top 15 cm. The differences seen below 15 cm were principally influenced by the inherent soil characteristics of the different stands.

BIOMASS PRODUCTIVITY AND NUTRIENT CONTENT OF *Morus Alba* and *Leucaena Leucocephala* BASED SILVI-PASTORAL SYSTEMS

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ABSTRACT

The study was conducted on the 4-year old forage production plantation trail at research site near dairy farm of Dr Y.S. Parmar University of Horticulture and Forestry, in Solan District, Himanchal Pradesh to explore the biomass productivity, nutrient content of forage and carrying capacity of the systems of two fast-growing multipurpose tree species viz. *Morus alba* var. M-5 and *Leucaena leucocephala* var. K-8 planted at 5 m x 5 m and 4 m x 2 m spacing respectively in Randomised block design with six replications.

L. leucocephala recorded significantly higher biomass production potential. Pollarding height had a direct relation with biomass production. In general, the nutrient composition (N, P, K, Ca, and CP) was significantly higher *L. leucocephala*. As regards soil enrichment potential in comparison to the adjoining unplanted area, there were striking differences between the two species. *L. leucocephala* had relatively higher efficiency in improving soil chemical properties. Biomass production, nutrient composition and carrying capacity were higher in *Leucaena*-based system than *Morus*-based system and natural grassland.

In view of he above advantages and considerations, a *Leucaena*-based silvi-pastoral system with pollarding to 2.0 m was regarded as most promising for degraded sites of same edfaphoclimatic condition in the middle hills of Himanchal Pradesh. The results also showed he usefulness of his land-use system for exploiting the growth performance of crossbred heifers under stall-fed conditions.