Report of Ex-post Evaluation

PD 105/01 Rev.3 (F)

Towards Sustainable Timber Production in Ghana: Stage I. Improving Shoot Borer Resistance and Developing Silvicultural Systems to Maximize Mahogany Plantation Success

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EX-POST EVALUATION OF PD 105/01 Rev.3 (F)

Towards Sustainable Timber Production in Ghana: Stage I. Improving shoot borer resistance and developing silvicutural systems to maximize Mahogany success

FINAL REPORT

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EXTERNAL CONSULTANT

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EXECUTIVE SUMMARY

The ex-post evaluation of the PD 105/01 Rév.3(F) is the subject of this report. It aims at presenting the efficiency of actions launched and strategies implemented in the framework of the project. While explaining the current stage of the project and its ongoing activities taken into consideration, it points out the positive results and the weak points of the project as well as the factors of success and various stakes. It also underscores the contribution of the project towards the achievements of ITTO objectives 2000, the criteria of the Yokohama Action Plan, and it draws lessons that can be used to improve future stages or similar projects.

For more than two decades, the Republic of Ghana has launched a sustainable management policy of its forest resources. Deforestation, as a result of roving agriculture and its subsequent bush fires, added to the intensification of forest exploitation activities, has negatively impacted on the degradation of forest zones and the impoverishment of prime species in the forest.

Market supply with these prime species has become irregular and uncertain. Consequently, their contribution to the export revenues and the Gross Domestic Products has collapsed.

On the ecological plane, it is acknowledged that forest zones are more and more getting degraded and genetic resources are progressively disappearing.

In this context, the Republic of Ghana launched a Plantation Program in all the ecological zones in order to rehabilitate the forest cover and boost the timber economy.

As they named them, sixteen scarlet star species were listed and chosen to stop bushfires and the others to restore the degraded forests.

This Plantation Program did not include Meliaceae (*Khaya and Entandrophragma spp*) in plantation even though they remain the best and most valuable species in the market. However, the Meliaceae plantations are threatened by an omnipresent plague caused by the shoot borer which destroys young trees. Khaya species seem to be the most vulnerable to the attacks of that insect, Hypsipyla, which inhibits the development of plantations.

The project therefore was designed to improve the resistance and/or tolerance of Mahogany in the face of the shoot borer.

In order to successfully grow mahoganies in plantations to replenish depleting stock in the natural forest, a solution to the *Hypsipyla robusta* (shoot borer) pest problem must be found.

The project originates from the following acknowledgements:

All actors of timber sector point out the exhaustion of Mahogany reserves in natural forests of Ghana

The absence of tree farmers in planting is due to the omnipresence of Mahogany plague, *Hypsipyla robusta* Moore, which devastates plantations, so, Mahogany was not included in the list of trees selected by the National plantation Program because the problem of Hypsipyla must be solved first.

The project is also a response to ITTO report on the status of the plantation program in Ghana. This report reveals the lack of success of natural mahogany and Meliaceae in plantations due to Hypsipyla which provokes excessive low branching and a delay in growth for mahoganies.

The need of an integrated approach to manage Hypsipyla is recurrently identified as the appropriate solution.

Forests and industrials companies (ABTS, SMARTEX, SWISS LUMBER) which invest in reforestation and mahogany plantations follow close behind to stress the urgency of shoot borer problem.

Damages caused by shoot borer henceforth appeared as a preponderant handicap to the creation of Khaya, Swietenia, and Meliaceae spp plantations.

Different options of Hypsipyla control have been explored but they didn't succeed to cut the damages at an acceptable level.

Besides, it should be noted that before the beginning of this project, no coordinating effort to solve the key problem of Meliaceae has ever been initiated in Ghana.

FORIG researchers(foresters, ecologists, entomologists and plant breeders), the initiators of the project convened meetings and involved stakeholders in the critical analysis of questions. All the stakeholders agreed on the fact that in West Africa, Meliaceaes and artificial Swietenia are sensitive to *Hypsipyla robusta* Moore which eats young stems ,therefore delays their growth and provokes an excessive branching which reduces the timber than can be recoverable. Damages caused by the plague are pointed out as the only

cause of the failure of natural Meliaceaces plantations in Ghana, reason why the production of Mahogany in plantations was impossible in Ghana at the beginning of the project.

So, the objective of the project was to solve the problem by developing an integrated strategy which can reduce shoot borer impact in Khaya and Entandrophragma species in plantations.

The various meetings of the project team and the Steering Committee did not detect any obstacle in the implementation of this strategy.

In this way, the results and findings of the identification process seemed to be sufficient for the definition of the problem and the fixation of the objectives.

The strategy was to develop silvicultural systems that would minimize the shoot borer attack and examine socio-economic aspects of shoot borer attack in plantations. This was achieved by working with community farmers, timber industries, policy makers and other stakeholders.

Thus, two objectives were fixed: the development and specific objectives.

(i) The development objective of the project was to improve the sustainability of Mahogany timber supply in Ghana by developing an integrated pest management system to minimize the adverse effects of mahogany shoot borer on young mahogany plantations.
(ii) The specific objective of the project was to examine methods of improving mahogany plantation success by enhancing shoot borer resistance, developing sivicultural systems that minimize shoot borer attacks, and examining socio-economic aspects of shoot borer attacks in plantations.

The strategies adopted in the framework of this project aimed at managing Mahogany pest control through an integrated management strategy based on the identification and plantation of resistant and/or tolerant species as well as the development of silvicultural systems which can reduce the impact of Hypsipyla in Khaya and Entandrophragma plantations.

Research plots were established in the major forest ecological zones in Ghana with the aim to select shoot borer resistance and tolerance mahoganies of the Khaya and Entandrophragma families.

This project supported by ITTO was executed by the Executive Agency, the Forestry Research Institute of Ghana(FORIG), in collaboration with the Michigan Technological University and presided over by the Steering Committee.

As far as the operational arrangement is concerned, there is a management structure led by Principal Investigators assigned with the design, planning and implementation (FORIG).

Assisted by Scientists, geneticists whose tasks were propagation and genetic engineering .

Michigan Technological University assured training .

Silviculturists and Forest Entomologists dealt with biological control activities, plant breeding and provenance and progeny trials.

Socio-economists, consultants and institutions such as Forestry Research Institute of Ghana, School of Forest Resources and Technological University of Michigan were also involved in the project.

In the prospect to address the problem, the Executive team developed the following :

-identification of resistance and tolerance in Khaya and Entandrophragma species, evaluation of silvicultural options of Hypsipyla control, behavioral chemical, and combination of these in an integrated pest management strategy;

-selection of provenances of Khaya and Entandrophragma species which reduced susceptibility to shoot borer. In this case, individual trees showing pest resistance are to be further mass-produced (by cuttings and in-vitro tissue culture) for plantations;

-employment of replicated trials to evaluate different silvicultural options for managing shoot borer with emphasis on identifying and selecting less susceptible mahogany;

-evaluation of most promising silvicultural techniques such as mix and companion plantings and their incorporation in an integrated management system to reduce shoot borer impact;

-examination of state-of-the art forest biotechnology application for conserving and manipulating African mahogany. This led to the examination of the use of cryopreservation for long-term storage of elite Khaya and Entandrophragma species that are endangered or threatened by logging in the one hand , and the examination of Agro-bacterium tumefactions-mediated gene transfer as a mean of incorporating insect resistance genes into Khaya and Entandrophragma species on the other hand.

Moreover, the following approaches have been explored to carry out efficient methods and techniques in this project:

-planting in association with other timber species. The fields trials were established by planting Khaya and Entandrophragma species together with a selection of timber species having different degrees of shade (influence of canopy);

-planting in association with insect repellent trees. Leguminous and other insect repellent trees like neem (*Azadirachta indica*) were used;

-fertilizer application. The impact of calcium fertilizers on shoot borer damage has been assessed in order to measure incidence and severity of attack, larval growth and survival, plant growth, form and chemistry;

-pruning was also an approach in the field.

Some of the mixed plantations studied under the project were established with community farmers and industries which ensured the acceptance of the project techniques and findings as well as the continuing planting of the mahoganies using the techniques developed by the project. Studies were also conducted to assess the socio-economic aspects of the project in the various communities where farmers were involved in the implementation.

Underway, two additional activities were identified and proposed by the Steering Committee to ITTO which accepted them. The questions were about the support of the project for the implication of the Kranka communities , ABTS, and Samaratex farmers in the process and the anatomical study of properties and qualities of timber mahogany from artificial plantations in order to point out differences and similarities between natural Khaya ivorensis and artificial forests.

In summary, except for typical activities of applied research which were both carried out as planned and which required some time before findings exploitable by the research could be drawn, the project has achieved significant goals and, in particular, contributed to mobilize all actors for the development of silviciltural systems likely to minimize shoot borer effects and maximize successful mahogany plantations.

Silvicultural systems were developed through mixed plantations (propagation, level density, appropriate spacing, pruning and mixed plantations with insect repellent trees like neem (*Azadirachta indica*).

Most of these plantations were established with communities of farmers who took over the techniques and findings of the project and will keep on planting in their lands.

This project carried out technical hypothesis trials in the field and lifted up the experiences and findings at the level of public actors. This project will lead to the following results:

-the active participation of stakeholders in the project identification, design, implementation, monitoring and evaluation leads to the successful implementation of this project

-the great implication of communities and industries under the aegis of the project will go on increasing.

As the project unfolds with the implication of more industrials and communities, the problem of harvest and distribution of seeds in quantity and quality arises and is to be solved. In the same perspective, the introduction of new technologies in the factories for processing little diameter trees must be addressed.

But in order to avoid stress due to seasonal aspect of activities, the project must have its own seeds collector. In so doing, the project will easily meet the increasing demand of seeds and at the same time assure the training of other seed collectors in the different ecological zones. It must be underlined that FORIG has only one seed collector for itself and for the project. As the farmer communities and industrials are competent enough in the management of tree nurseries and plantations, such competences must be put at the sum of the project whose battle horse is training.

In the financial aspect, the project suffered from time to time some shortage of funding and stress due to:

- the failure to respect the budget formats of donors,

- the lateness to respect the time limit in writing the report of activities,

- and the slowness of the external auditor in sending certified accounts.

This weakness often brought about a slowing down of activities. This must therefore be settled at the level of the Steering Committee. It must also be written in each semi-annual chronogram of the project activities to avoid these weaknesses.

Whatever the case, the long term funding of the project recurrently arises. Although skills and competences are found at the level of the staff project, industrials and communities , the funding of the project is a long term problem. ITTO has been sponsoring stages of projects and should in any case close its financial

supplies; industrials may sometimes face hard times in their activities and eventually fail to honor their agreements; in this case, the steering committee which has already taken strategic and profitable decisions for the project must look into the financial durability of the project. Solutions can be worked out either in the financing by carbon credit. It should also be acknowledged that there are international partners who are interested in such activities of planetary relevance.

Taking into consideration the interest of industrials and communities for the project, it is timely to widen new and sustainable sources and mechanisms of funding. How unusual it is to find African communities carry such a long term forestry development project! It should be such a great pity that a financial shortage discourages those involved.

In conclusion:

The project has solid foundations which brought meaningful results:

-the project staff is basically made up of technicians and scientists of higher level among which well experienced entomologists, ecologists, socio-economists, anatomists researchers whose expertise ensured the success of the project;.

-the active participation of stakeholders in the project identification, design, implementation, monitoring and evaluation led to the successful results of this project;

-the collaboration between farm communities and the timber industry was quite eventful and encouraged the strategy of engaging farmers to produce on their farmlands, in the off-reserve areas, future industry timber needs;

-the request and expectations so far expressed by the participants, the actors of the project such as the group of tree farmers is a motive for optimism as far as the extension and plantation success are concerned.

The demands and expectations of project participants and stakeholders especially community tree growers have been overwhelming, stimulating the project team and the steering committee to recommend **the development of a second phase of the project.**

As concluded in the project completion report, this second phase aims to refine the silvicultural “tool kit” to optimize planting in mixed stands to reduce economic losses from *Hypsipyla* and promote the establishment of additional industry and community plantations through the development of a ‘‘How to” cultivate indigenous mahogany practical handbook and a series of field workshops for industry foresters and farmers.

LIST of SIGNS and ACRONYMS

ADB	African Development Bank
ASCM	Annual Steering Committee Meeting
CTO	Collaborating Timber Organization
ED	Executive Director
EZ	Ecological Zone
FCPF	Forest Carbon Partnership Fund
FCCRMPS	Forest Commission Collaborative Resource Management Policy and Strategy
FORIG	Forest Research Institute of Ghana
GFWP	Ghana's Forest and Wildlife Policy
IA	Integrated Approach
IFSC	International Forest Science Community
IPMS	Integrated Pest Management System
IS	Integrated Strategy
ITTA	International Tropical Timber Association
ITTO	International Tropical Timber Organization
KCF	Kranka Community Farmers
LLLI	Logs and Lumbers Limited Industry
MC	Memorandum of Collaboration
MTU	Michigan Technological University
NFP	National Forestry Program
NGO	Non Governmental Organization
NPP	National Plantation Program
PP	Plantation Program
PTR	Project Technical Report
REDD+	Reducing Emission from Deforestation and Degradation
RMCU	Resource Management commission Unit
TIA	Timber Industry Association
TMR	Technical Monitoring Role
SC	Steering Committee
WB	World Bank

A. OBJECTIVES AND METHODS OF EVALUATION

1. Objectives of evaluation

The ex-post evaluation of the PD 105/01 Rév.3 (F) is the subject of this report. It aims at presenting the efficiency of actions launched and strategies implemented in the framework of the project. While explaining the current stage of the project and its ongoing activities taken into consideration, it points out the positive results and the weak points of the project as well as the factors of success and various stakes. It also underscores the contribution of the project towards the achievements of ITTO objectives 2000, the criteria of the Yokohama Action Plan, and it draws lessons that can be used to improve future stages or similar projects.

2. Evaluation Team

M. Denis **Keedi ATOK,** External consultant ,Team Leader

DR. Emmanuel Opuni Frimpong, Director of the Executive Agency put at the disposal of the evaluation mission: two (2) assistant Researchers : Miss Nana YAA NYARKO DUAH and Goodwin Andoh KWARKYE. Ibrahim Mohammed was the driver.

3. Methodological Approach

The methodological approach consisted on:

-Document review (project document, evaluation reports, technical reports, research articles and PHD thesis);

-Discussions and exchanges with the FORIG Director, Dr Victor Kwame Agyeman, the Director of the Executive Agency and the Socio Economist Dr. Beatrice Darko Obiri;

-Field visit paid to Bobiri (Forest reserve and research), Mesewam (Trial research and FORIG nursery);

-In Berekum, exchange with the Forest manager Edward Asare and the General Manager, owner of ABTS industries;

-Visit paid to KRANKA community and exchange with Peter Kofi Badu one of the leader;

-Visit paid to Logs and Lumbers Limited Industry and the interview with Mr. Simon Awfful (Forest Manager in charge of certification in forest);

-Visit paid to the Resource Management Commission Unit in KUMASI and exchange with Kofi Affum-Baffoe Production Manager;

-Visit paid to SAMARTEX-BOIS industrie and interviews with the GENERAL MANAGER Richard Nsenkyire and his staff;

-Visit paid to the Forestry Commission: interviews with Hugh C. A. Brown (Operations Manager-Plantations); Raphael Yeboah (Executive Director);

-Debriefing with the Director of Executive Agency and his staff.

The list of people encountered is hereby attached in ANNEX 2.

4. Period of the evaluation:

From 01 July to 08 July 2012, during which assessments on the field from 02 to 07 July 2012

B. CONTEXT AND PROJECT DESIGN

The forestry sector contributes about 6% of the Gross Domestic Product, with timber from native mahoganies contributing about 12% of these timber exports. The sector also employs directly and indirectly about 2.5 million people in the forest industry. The forest cover of Ghana which used to be about 8 million hectares has been reduced to a current state of about 2 million hectares. This reduction of the forest cover is due primarily to deforestation which is mostly as a result of over-exploitation of the prime timber species (including the native mahoganies) of Ghana. Current research on climate change showed that deforestation alone contributes to about 20% of the carbon oxide component of the green-house gas. The project was sited in the high forest of Ghana with experiments distributed across the three major ecological zones of Ghana. The project conformed to the overall goal of Ghana's Forest and Wildlife Policy of 1994, which all the forest management legislations, strategies, programmes and projects in Ghana should support. The project supported the national forestry programme to conserve and sustainably develop the nation's forest

resources while maintaining environmental quality and perpetual flow of benefits to all segments of society. The project also supported the Forestry Commission Collaborative Resource Management Policy and Strategy, with the goal of working in partnership with different stakeholders, which enhances the management and development of forest and wildlife resources and leads to equitable distribution of benefits.

C. ORIGIN AND PROBLEM

Mahogany (Meliaceae, Swietenoideae) is a valuable tropical timber, but continuous supply is threatened by over-exploitation of natural forests and reserves. Further complicating the supply is a major insect pest problem, the ubiquitous shoot-boring moth, *Hypsipyla robusta*, that continues to devastate young stands and plantations of mahogany by killing main stems, causing excessive forking and branching, and in worst cases, contributing to mortality. In West Africa, most native Meliaceae and introduced Swietenia are susceptible to the shoot borer *Hypsipyla robusta* Moore. The shoot borer larvae feeds on and kills the terminal shoots which results in stunted growth and excessive branching, and reduces the quantity of timber which can be recovered. The damage caused by the pest is frequently cited as the cause of failure of native Meliaceae plantations in Ghana. At the beginning of this study, therefore, the production of African mahogany in plantations in West Africa was practically impossible due to damage by shoot borer. The project aimed at addressing this problem by developing an integrated strategy for reducing the impact of shoot borer on the establishment of Khaya and Entandrophragma species in plantations.

D. OBJECTIVES AND STRATEGIES OF THE PROJECT IMPLEMENTATION

1. Objectives

The development objective of the project was to improve the sustainability of mahogany timber supply in Ghana by developing an integrated pest management system to minimize the adverse effect of shoot borer on young mahogany plantations.

The specific objective of the project was to develop an integrated plantation management system that incorporates multiple components to reduce shoot borer attack to sub-economic level by:

-identifying, propagating and utilizing shoot borer resistant trees,
-identifying, propagating and utilizing shoot bore tolerant trees,
-developing and utilizing silvicultural strategies to reduce shoot attack,
-developing and utilizing semi-chemical technologies to reduce shoot borer attack.

The integrated pest management system and the involvement of relevant institutions, State organisms, scientific research, University and particularly, the industrials and community associations are the main innovation and uniqueness of the project's strategy.
The previous analysis underline were taken into consideration to carry out and implement these strategies.

Previous research in Ghana and other West African countries have identified the shoot borer (*Hypsipyla robusta*) as the key element restricting the culture of African mahogany plantations**.** In West Africa, most native Meliaceae and introduced Swietenia are susceptible to the shoot borer *Hypsipyla robusta* Moore. Attack has been reported in other species: *Carapa grandiflora, C. procera, Entandrophragma angolense, E. candollei, E. cylindricum Khaya anthotheca, K. grandifoliola, K. ivorensis, K. nyassica, K. senegalensis, Lovoa trichiliodes, Pseudocedrela kotschi and Swietenia macro phyla*. Hypsipyla larvae feeds on and kills the leading shoots. Growth is stunted and excessive branching caused by death of the terminal shoot reduces the quantity of timber which can be recoverable. This project is a response to the 1991 report to ITTO, which revealed a poor success of native mahogany (Meliaceae) in plantations, as evidenced by excessive branching, main-stem forking, and stunted growth attributed to the shoot borer. The need for an integrated approach to manage Hypsipyla has been repeatedly identified as the most promising solution to the problem. Recent ITTO initiatives are directly related to this proposal, particularly the recently completed project 'Development Work to Phase out Trade in Unsustainably Produced Timber: 1: Assessment of Future Mahogany Supply and Alternative Industrial Operations for Sustainable Production'. One of the suggestions produced by the report was that a study should be carried out to solve the problem of the mahogany shoot borer, caused by Hypsipyla. The report noted that although progress has been made "in several areas of biotechnology, applied biology and pest control, such advances have not been adequately applied so as to explain and, particularly, implement effective, low-cost and environmentally acceptable control systems for Hypsipyla." Most companies that invest in reforestation or planting of mahogany urgently stress a solution to the shoot borer problem. Thus damage by shoot borers is the overriding factor restricting the establishment of plantations of Khaya species, Swietenia species and other valued tropical timbers of Meliaceae mahogany species worldwide. Although several different options for the management of shoot borer species have been

explored, they failed to reduce damage to acceptable levels. However, until the commencement of the project no major coordinated effort aimed at solving this vital issue for mahogany and other Meliaceae was initiated in Ghana.

2. Project Implementation Strategy

The mahogany shoot borer is perhaps the most economically important insect pest in tropical forest. The problem has attracted a great deal of attention from foresters, ecologists, entomologists and plant breeders, but previous attempts at managing *Hypsipyla* have largely been unsuccessful. Recently, however, the prospects for controlling the mahogany shoot borer in West Africa and elsewhere have increased markedly with the identification of partial resistance and tolerance in *Swietenia macrophylla* and *Cedrela odorant* to *Hypsipyla grandella* and African mahoganies to *Hypsipyla robusta*. In the context of shoot borers on mahogany, resistance is defined as the ability of a plant to avoid, suppress, prevent, overcome or tolerate insect attack. Currently FORIG was collaborating with SODEFOR of Cote d`Ivoire and FRIN of Nigeria on the pre-project "Development of an integrated strategy for the reduction of shoot borer impact on African mahogany in the tropical humid forest of Africa". It is timely that the experience gained in Latin America and elsewhere be applied and further developed in West Africa, to select resistant or tolerant mahogany genotypes. Because resistance, or any other method, alone, will not reduce the impact of *Hypsipyla* to uneconomic levels, an integrated pest management strategy based on incorporating pest resistant planting stock into silvicultural systems that seek to encourage natural biological control was adopted.

Thus, the concept underlying this project was to develop an integrated pest management strategy for *Hypsipyla* in plantations of mahogany in Ghana.

It has been suggested that systemic insecticides may prove to be economically and ecologically advantageous when compared with conventional spraying because of the lower volume of insecticide required and their greater degree of specificity. However, subsequent field trials have found them to be completely ineffective. **The main use of systemic insecticides may be for protecting plants in the nursery.**

Although there are several alternatives to the use of insecticides to control shoot borers, the best strategy is undoubtedly to reduce damage to a tolerable level by using a number of different methods in an integrated way. This approach, however, requires at least one method which will have a significant effect alone and which will form the basis to build an integrated pest management strategy. Thus, in reviewing past research aimed at controlling mahogany shoot borers, **an integrated pest management** strategy based on the incorporation of "pest resistant planting stock in silvicultural systems which will reduce the impact of Hypsipyla in plantations"was adopted. This project directly addresses this need by identifying resistance and tolerance in Khaya and Entandrophragma species, evaluating silvicultural options of *Hypsipyla* control, evaluating behavioral chemicals, and combining these in an integrated pest management strategy.

The selection of resistance within a tree species has a number of advantages. First, it avoids the problem of insects developing resistance to artificial chemical control methods. Second, as the main problem of shoot borer damage is the effect on tree form, any selection based on superior apical growth or recuperative ability should also lead to improvements in tree form as well as tolerance to attack. Further, genetic screening and conservation of many Meliaceae species is now a matter of urgency, as a result of the continuing high rate of depletion of natural stands, especially because pest-resistant genotypes may exist. The project therefore sought to select provenances of *Khaya* and *Entandrophragma* species with reduced susceptibility to shoot borer. Individual trees showing pest resistance will be further mass-produced (by cuttings and *in-vitro* tissue culture) for plantations.

Gains from the use of genetically improved trees can only be fully realized if appropriate silvicultural management systems are employed. This might involve the use of mixed species plantations. Species mixtures may alter plant suitability for growth of the insect, may screen host plants from adult insects, or may increase levels of natural enemies. Mixed native species plantations serve as the foundation to tropical forest restoration activities. A canopy of native species along with a seed bank or seed rain is usually sufficient to restore deforested land into natural forests.

This project employed replicated trials to evaluate different silvicultural options for managing shoot borer. The value of different silvicultural methods were measured both in terms of differences in shoot borer damage and the underlying mechanism(s) or any reduction in shoot borer damage observed e.g. the degree to which plant mixtures reduce shoot borer attack, decrease the biochemical suitability of mahogany for shoot borers, or increase the effectiveness of predators and parasites of the shoot borer. Project activities therefore focused on identifying and selecting less susceptible mahogany, the evaluation of the most promising silvicultural techniques (such as mixed and companion plantings) and their incorporation in an integrated management system to reduce shoot borer impact. This project demonstrates operational-scale

restoration plantings incorporating successful principles of restoration ecology and integrated pest management.

Finally, the project examined the use of tissue culture for long-term conservation of elite *Khaya* and *Entandrophragma* species genotypes that are endangered or threatened by logging.

E. HYPOTHESIS AND RISKS

The following principal assumptions have been identified with corresponding risk. Each risk has been addressed and minimized in the project design. These assumptions and risk anticipated at the inception of the project were managed as initially planned;

- The existence of variation in susceptibility within the individual mahogany population might affect the selection of mahogany to be planted in the experimental plots;

- the selection of improved stock is dependent upon the existence of variation in susceptibility within the population sampled. This assumption was right as the 90 families of mahogany varied in their response to shoot borer attacks;

- The investment of communities may still not be enthused to plant mahogany if some aspects of the results are not in their favour. Farmers and other stakeholders may not be willing to wait for a long period before mahogany plantations are mature, till trees are mature to be harvested for timber;

- the implementation team anticipated the interest of the stakeholders who were later overwhelmed by demands for seedlings by the community farmers, especially in Kranka. Their demands were managed and kept within the financial resource of the project budget;

- the continuous planting of mahoganies by all stakeholders is sufficient evidence that the risk of collaborators losing interest in the project was successfully managed;

- the demonstrations of strategies for establishing mahogany plantations encouraged investment in mahogany plantations and plantation program in Ghana; and

- the propagation of mature trees became possible as far as the communities were interested in long term and mature tree plantations mixed with agro forestry (Taungya plantations). The system to generate interim benefits to the farmer is essential for household cash needs and maintenance of the plantation over the years. This is important because after the initial benefits from food crop harvests in the next (4-5) years in the establishment phase, farmers may have to wait for long periods till trees are mature to be harvested. The potential for the farmer to source addition income through carbon credit will be looked upon in the next phase of the project.

F. MANAGEMENT EFFICIENCY AND IMPLEMENTATION OF THE PROJECT

The project activities generating outcomes for the achievement of the planned objectives remained adequate and appropriate during the implementation with two additional activities considered as a key to sustainability of the project: (1)support to KRANKA community and (2) study of wood properties of plantation grown mahogany.

1. Organisation

All project activities were carried out through a smooth implementation to be attributed to the high expertise of the Executive Agency, the cooperation of project key stakeholders such as the Ghana Forestry Commission, FORIG, private sector, leaders of NGO and associations representing local communities operating in different project sites.

The Partners

State Institutions:

- Forest Commission representative chaired the steering committee to support the project implementation with policy advice; and

- Director of the Forest Research Institute of Ghana, supervised the overall implementation of the project as the director of the executing agency.

Private sectors:

Timber Industry Association representative provided advice on the expectations of the timber industry and was also the link to inform the industry of the research outputs:

- SAMARATEX, a collaborating timber organization in the implementation of the project, was involved in most of the project activities and their contributions at the steering committee

meetings and of help in directing the research and execution of the activities to make the results user friendly to the timber industries;

- There are other private partners whose roles are also significant in plantation investment**:** ABTS, Logs and Lumber.

External Partner:

Michigan Technological University is a collaborating organization which provided funds and trained FORIG staff in forest science at PhD level. The experts participation at the steering committee meetings helped to improve the project implementation.

ITTO representative

guided steering committee in implementing the project as defined in the project document as part of the Technical monitoring role of ITTO.

Communities Associations:

Kranka Community Farmers served the interest of the community farmers involved in the implementation of the project at the steering committee level to make sure the project took care of the interests of farmers.

2. Technical Efficiency of the project

Logical Framework and Planification

The project has a logical framework made up of assumptions, project elements (development and specific objectives), indicators objectively verifiable and means of verification.

A multiannual plan, coherent with the framework, points out results to achieve, responsibilities, activities and sources of funding. That clearly and transparently maps out the implementation of the project.

Data Base

The project has a data base from major research: fructification period, seed sources and seedling production, experimental nurseries and plantations, data on hypsipyla attacks collected from communities and industries plantations, variation in wood properties in relation to hysipyla attack, in vitro propagation, socio-economic studies. These data provide precious and useful informations for the orientation of ongoing activities and the elaboration of the next phases of the project.

Project document

The project team developed a scheme of keeping project records and documentation for reporting, monitoring and publication of project results. The project made sure that all reports: biannual progress reports to ITTO and project results presentation at workshops and conferences to stakeholders were all kept both electronically and in hard copies. Project financial documents and reports were kept according to financial standards of the Forestry Research Institute of Ghana. Project technical reports and student research thesis that used project research material have been kept electronically and in hard copies at the project secretariat.

Monitoring and evaluation

The project team had regular interactions and meetings with project participants (community farmers, timber industries that donated lands) as a way of monitoring project progress with the various participants. Provisions of memoranda of collaboration concluded by the project and these partners were respected; and the agreements concerning the achievement of objectives were discussed and managed during the technical meetings of the project and the annual meeting of the Steering Committee. The annual steering committee meetings with representation of ITTO and all the major stakeholders and beneficiaries of project results helped keep the project in line with the objectives. Major additions like the Kranka community and anatomic studies of plantation grown mahogany in comparison with natural forest mahogany were identified during one of the monitoring and evaluation meetings of stakeholders and collaborators.

The annual operationnalization of activities set by the annual chronogram and semi-annual technical reports were established in order to give account to the stakeholders and partners. Eight (8) technical reports were established during the implementation of the project. The project team elaborated its own monthly and weekly internal planning, monitoring and evaluation in order to modify or adapt and determine whether the project is on line with the objectives. In this way, partners, stakeholders and collaborators easily measured the progress so far made by the project.

Efficiency of Results Dissemination

The project team published a number of articles from results (list in Annex 5) and presented them at a number of forums, seminars and workshops to stakeholders. Refered publications on managing mahogany shoot borer were developed and disseminated. Journal publications, posters and abstracts have been published from the results of studies. Many requests come from the international forest science community for reprints of the project team's publications. That demonstrates the acceptance of the results of these studies.

3 Financial Management

Budget and Funding		
Total		US$ 590,581
ITTO		US$ 337,027
Government of Japan	US$ 337,027	
Government of Ghana		US$ 160,282
Michigan Tech. University		US$ 93,272

The funding from ITTO and collaborating agencies were provided as planned.

The Executive Agency assured the financial management and disbursement in conformity with the planning of activities. Detailed financial reports are inserted in semi-annual reports of activities. All the expenditures are gathered and consolidated in Excel format. These financial reports are prepared according to the donor's requirements. On behalf of ITTO, annual audits are carried out by NEXIA DEBRAH & Co. chartered Accountants.

The project suffered from time to time some shortage of funding and stress due to: the failure to respect the budget formats of donors, lateness to respect the time limit in writing the report of activities, and slowness of the external auditor in sending certified accounts. This weakness often brought about a slowing down of activities and must therefore be settled at the level of the Steering Committee. It must also be written in each semi-annual chronogram of the project's activities to avoid these weaknesses. Whatever the case, the long term funding of the project recurrently arises.

G. INTEREST AND TANGIBLE OUTPUTS

Farmers perceived the farms as legacies to their children and the unborn descendants.

The deep interest and the strong involvement of all stakeholders and the project team in the critical analysis of identification, design, implementation and evaluation of the project helped to make the project components to be adequate, appropriate and successful.

The assumptions and risks anticipated were managed, planned and avoided.

All the activities planned were carried out and executed while waiting for the meaningful conclusions of some studies such as wood properties of grown mahogany in plantations.

Industrials ABTS, SAMARATEX and SWISS LUMBERS established 30 ha a year of mahogany mixed plantation as mahogany restoration program. Tangible outputs come from both communities and industries which resulted in planting over 80 hectares of experimental and demonstration plots across the forest zones of Ghana.

Smallholders integrated mahogany plantation with KRANKA farmers.

The project implementation is structured such that after its implementation, there will be maintenance and continuity of operations with reference to the project findings.

The project steering committee was constituted such that the Director of the Ghana Forest Commission was the Chairman who facilitated major decisions for the implementation of the project. The major private industries and investors were well represented in the steering committee. Communities and smallholder tree growers were also represented in the project to make sure that the project results are readily available to all stakeholders for immediate utilization to support forest management in Ghana. The investors will maintain the trees based on the recommendation by the project scientists and will provide the financial resources for the annual monitoring to be conducted by the above mentioned scientists.

Valuable seed trees have been protected with appropriate protocols. In four reserves representing four ecological zones, over 50 seed trees have been marked.

As far as training and technology transfer are concerned, the project offered many facilities on its field experiments for training:

-one (1) PHD level training of scientist from FORIG at Michigan Technological University (project partner USA), this is a significant output from the project;

-three Masters Level graduate students for their thesis research;

-five under graduate students(thesis research);

-more than ten under graduates (internship).

At last, the project team was basically made up of technicians and scientists among whom well experienced silviculturists, ecologists, socio-economists, anatomist researchers whose expertise ensured the success of the project.

H. CHALLENGES AND STAKES

Sustainable funding of activities related to the project's sustainability remains a key problem even for industries which are great companies in Ghana. Farmers without means are however enthusiastic as far as farm extension is concerned but they are in need of seeds and basic equipments(boots, machetes, watering cans, etc),transport facilities and markets for food crops.

These stakeholders who have already taken over the techniques and strategies used during the implementation highly need seeds in order to extend nurseries and plantations.

Expectations and requests expressed by all stakeholders and the group of farmers underline the importance of the problem.

In the financial aspect, the project suffered from time to time some shortage of funding and stress due to the failure to respect the budget formats of donors, lateness to respect the time limit in elaborating the reports of activities and the slowness of the internal auditor in sending certified accounts. This weakness often brought about a slowing down of activities. Elsewhere, the long term funding of the project recurrently arises. Although skills and competences are found at the level of the project, industrials and communities, the funding of the project is a long term problem. ITTO has been sponsoring stages of the project and should, in a term, close its financial supplies and industrials may sometimes face hard times in their activities and eventually fail to honor their agreements.

The sole hypothesis and risks to fear is the decrease of funds, the failure to strengthen the project staff with seed collectors.

Recommendations

The project should have its own seed collector who will train other seed collectors in the different ecological zones. That will be a response to more demands of seeds expressed by all stakeholders (industries, communities and small farmers).

Including more Khaya and Entandrophragma spp in the National Plantation Program will guaranty the development and the extension of prime species plantations in Ghana.

Concerning the financial aspects, the steering Committee which has already taken strategic and profitable decisions for the project must look into the innovative and sustainable financing mechanisms.

Solutions can be worked out in the carbon market because the impact of forest carbon stocks by natural increase or planting is one of the tools used in sustainable deforestation control under the framework of REDD+ mechanism. The project may have technical role while the Forest Commission develops the REDD+ strategy and holds a political role on the whole forest cover through a REDD+ Steering Committee. The Forest Carbon Partnership Fund of the World Bank can therefore be seized for the implementation of this REDD+ mechanism. It can be an outstanding source of funding and potential income for farmers planting trees.

It should also be acknowledged that there are international partners who are interested in such activities of planetary relevance (NGO, GIZ, ADB, WB..). Taking into consideration the increasing interest of industrials and communities for the project, it timely to widen new and sustainable sources and mechanisms of funding. It is unusual to find an African community carry upon such a long term forestry development project. It should be a great pity that a financial shortage discourages those involved.

I. LINKS BETWEEN SUSTAINABLE FOREST PLANTATION MANAGEMENT AND ITTO CRITERIA AND INDICATORS FOR SUSTAINABLE FOREST MANAGEMENT (details annex 6)

This project, which seeks to enable sustainable mahogany production via plantation culture,

is closely linked to ITTO Criteria and Indicators for Sustainable Forest Management.

The project will seek holistic planning for multiple land use based on land capability and community needs. To do this, it will work closely with industrial partners and with village leaders to ensure their commitment to sustainable forest management. It will carefully choose sites to minimize soil disturbance and will monitor soil nutrient levels as well as plantation growth and health. It will also seek the following criteria and indicators for mahogany plantations:

- productivity maintained;
- no adverse effects on soil or water quality;
- maintain genetic diversity;
- maintain appropriate silvicultural management (*i.e*., use high quality planting stock,

plant with minimal soil disturbance, and weed, thin, and prune to appropriate

levels) to ensure plantation success; and

- integrate plantations into the communities by employing local people in

plantation establishment and maintenance and by basing some of them on

community lands.

These ITTO criteria and indicators were among those listed in Hopmans *et al.* (2003) for Sustainable Forest Management of Tropical Plantation Forests.

Compliance with ITTO

This project is sponsored by ITTO and institutional donors such as the Michigan Technological University and the Republic of Ghana and is entitled: Project PD 105/01 Rev. 3(F): Towards Sustainable Timber production in Ghana: Stage 1 Improving Shoot Borer Resistance and developing sivicultural systems to maximize mahogany plantation success.

The private sector (forest industry) and communities were involved in the project. This participatory approach allowed the identification, design and implementation of the project. With the implication of the stakeholders, the project developed silvicultural methods which helped cut economic losses caused by Hypsipyla attacks on the Meliaceae plantations (*Khaya spp* and *Entandrophragma spp*) which are timber of high trade value. The project is attending the National Plantation Program and the Republic of Ghana in the attainment of forests sustainable management objectives while contributing to the reconstitution of forest cover and genetic resources exhausted by overexploitation. Therefore, this project is in relation with ITTO objectives.

Conformity with the ITTA Objectives

The project is concerned with the sustainable production of Meliaceae in the various ecological zones in Ghana. The implementation of the partnership between the Republic of Ghana, the private sector, the civil society and local communities aims at maintaining in the future a sustainable supply of Meliaceae in local and international markets. This is thus in line with the objectives stated by the International Agreement on Tropical Timber (objectives c, d, f and l).

Conformity with the criteria

This project is also in line with the criteria of selection of article 25, paragraph 2 of International Agreement on Tropical Timber (Criteria A, B, C, D, and G).

Conformity with the Yokohama Action Plan and The 2000 Objectives

The project abides by ITTO action plan and to its main objective as concerns forests sustainable management. Strategies and actions are in accordance with ITTO's directives on the conservation of biological diversity (in situ and ex situ) in production forests.

J. PROJECT PERFORMANCE

1. Specific objectives

The specific objective of the project was to examine methods of improving mahogany plantation success by enhancing shoot borer resistance, developing silvicultural systems that minimizes shoot borer attack, and examining socio-economic aspects of shoot borer attack in plantations.

2. Outputs

Output 1: Variation in susceptibility to *Hypsipyla* among mahogany species and provenances examined and resistant or tolerant individuals identified

Assessment and analysis

Nurseries were successfully established at FORIG, ABTS, Kranka community and SAMARATEX, from seeds of *Khaya* and *Entandrophragma,* collected from across the high forest ecological zones in Ghana. Provenance and spacing trials were then set up in the dry semi-deciduous, moist semi-deciduous and moist evergreen forest types from nurseries established. Three (3) species of Khaya and four(4) species of Entandrophragma were used in these Mahogany species studied in the project.

Strong points

- Training was given to local farmers to build their capacity in nursery and plantation establishment.
- Excellent collaboration from communities, timber industry and other stakeholders.

-Plots established contributed to reforesting degraded areas.

Weak points

- The numbers of seed trees fruiting during the collection period were not sufficient.
- FORIG and the project had only one seed collector.

Recommendation on this Output

- Potential seed trees should be identified before hand, marked and protected to enhance seed collection.
  For more efficiency, it is essential that the project should have its own seeds collector.

Output 2: Methods for cloning/mass production of resistant genotypes developed

Assessment and analysis

Propagation of leafy cuttings of *Khaya* and *Entandrophragma* species were undertaken, with results showing that selected cuttings rooted successfully. In addition, in vitro culture of *K. anthotheca* and *K. ivorensis* were developed from resistant genotypes for mass production. Protocols for in vitro culture of Khaya anthotheca and *Khaya ivorensis* which were selected for this study were developed. This study will continue in the second phase.

Strong point

This output led to the selection of tolerant and resistant mahogany individuals which can be used for creating seed orchards for future plantations.

Weak point

This experiment will be conducted for many years in order to draw appropriate conclusions**.**

Output 3: Genetic basis for resistance/tolerance and interaction with shoot borer behaviour modifying chemicals studied

Assessment and analysis

Colonies of mahogany shoot borer (*Hypsipyla robusta*) were established in the FORIG entomology laboratory to provide specimens for other studies in the project.

Hypsipyla larvae survival rate on artificial media mixed with *Khaya* leaf extracts was compared to *Entandrophragma* and *Cedrela* leaf extracts.

Insect traps using the synthesized female hormones of the *Hypsipyla* were used in trapping male *Hypsipyla.*

Feeding responses of extracts of plant material from field trees demonstrating resistance and susceptibility were studied. All these studies initiated during the project will continue in the next phase.

Strong points

Feeding shoot borer larvae on artificial diet under laboratory conditions increased the knowledge based on the biology of insect. This experiment can aid in future management of mahogany shoot borer.

Recommendation

In order to draw positive conclusions, this experiment must be repeated.

Output 4: Impacts of companion plantings and natural enemies on *Hypsipyla* attack determined

Assessment and analysis

Mixed plantations were established as a demonstration on farm studied with Kranka community, ABTS and SAMARATEX community farmers. *K. anthotheca* was planted in a mixed stands with other timber species to determine the effect of the mixed stands on the attack levels of the shoot borer. These studies aimed to evaluate the effect of three (3) density levels of Khaya anthotheca in a mixture with other timber species conducted through the establishment of three (3) Khaya ivorensis plots in ten years old neem stands and realized that the neems were protecting the Khaya trees from Hysipyla attack.

The effect of neem trees as insect repellents on *Khaya* and *Entandrophragma* trees were also studied with positive results.

These studies revealed that mixed stands do not prevent Hysipyla attack but they appear to improve the ability of mahogany trees to tolerate Hypsipyla attack.

Leguminous trees, like Albizia, seem to grow faster and cast shade on the Khaya species reducing available light resource for the mahogany trees to make use of any possible improvement in the soil nutrients by Albizia.

Strong points

- This study showed promising results for silvicultural management of the mahogany shoot borer with mixed species stands.
- The use of mixed species in plantation contributed to biological diversity especially using native species in the stands.

Some degraded lands were reforested during this study.

Recommendation

It is important to widen this participatory approach of mixed plantations to **councils** in order to extend the reforestation of degraded lands.

Output 5: Genetic engineering of mahogany species with Lepidopteran Bt-genes and proteinase inhibitor genes done

Assessment and analysis

There was the testing of *Agrobacterium*-mediated gene transfer in mahogany. Nodal segments with buds and leave midrib were tissues stimulated to develop callus for these studies. Investigation of Bt and PI genes into mahogany and testing of insect responses were also undertaken.

Weak points

- Most of the callus died few weeks after the inoculation with the *Bt-gene*.

Recommendation

This study requires more experiments, resources and time for the implementation.

Output 6: Integrated pest management plantation and forest restoration feasibility demonstrated

Assessment and analysis

Three demonstration plots of provenance studies were established using output one(1) to five(5) of the project, in collaboration with selected collaborating farmers. ABTS and SAMARATEX Timber Company also established mahogany plantations in their restoration program, using results of the project.

The socio-economic analysis shows that the smallholders integrated mahogany plantation with Kranka is profitable at 10% discount rate and stable to downward changes in cost and yield factors up to 50%. The sensitivity analysis also shows that even at the worst case scenario, i.e.50% decrease in timber yield and 50% increase in total costs, these plantations are profitable. The socio-economic survey will continue in the second phase.

Recommendation

- More sensitisation should be embarked on especially for local farmers to educate them on the importance of restoring degraded lands with tree species such as the mahogany.
  Needs for more seeds remain a problem to be solved

Output 7: Conservation of native Ghana mahogany genotypes done

Assessment and analysis

Strong points

- Biodiversity conservation plots of various mahogany species were established in various ecological zones.
- Valuable seed trees were protected with appropriate protocols. Over 50 seed trees have been marked in Bobiri, Ayum, Tano Numire and Tano Awia Forest Reserves.
- *In vitro* studies revealed the potential for conservation of elite plant materials through the protocol developed.
- Comparative anatomical study of the wood of *Khaya ivorensis* from forests and 43 years old plantation infested by Hypsipyla was carried out to establish differences in their wood strength properties. This study showed that wood from trees in natural forest stands produced better wood strength properties than plantation trees. However the difference was relatively small to be considered to have any effect on its utilisation purposes.

Recommendations

- Further investigations are to be carried out to establish the correlation between characters and strength properties for natural and plantation trees of Khaya ivorensis as well as the other mahogany species, with similar diameter class to confirm or reject the current observation during the second phase.

The restoration and conservation of mahogany in Ghana should be an on-going work, continuing after the project ends.

Output 8: Training and technology transfer occurred

Assessment and analysis

Training was given to community farmers and other stakeholders in mahogany plantation establishment and management.

As far as training and technology transfer are concerned, the project offered many facilities on its field experiments for training:

-One (1) PHD level training of scientist from FORIG at Michigan Technological University (project partner USA), this is a significant output from the project;

-three Masters Level graduate students for their thesis research;

-five under graduate students(thesis research);

-more than ten under graduate (internship).

Strong points

- PhD in Forest Science Was completed successfully.
- Project results have been presented at a number of forums and workshops to stakeholders.

  Journal publications, posters and abstracts have been published from the results of these studies.

K. OUTCOMES AND IMPACTS

The achievement of the project specific objective contributing to the realization of the development objective set by the project design could be attributed to the commitment of all stakeholders in the project implementation. It led to the following main outcomes and impacts:

On state institutions

The institutions invited to participate in the project were carefully selected by the Executive Agency who involved all stakeholders able to maximize the impact on the forestry sector in Ghana as a whole;

The Director in charge of plantations at the Ghana Forestry Commission was made the Chairman of the Steering Committee. This helped to influence the policy decisions to include the mahoganies in the National Plantation Program launched on 2010 by the President of the Republic of Ghana.

Through an increased efficiency, this project will strengthen forest services and allow senior categories of stakeholders (public services, communities, private sector, civil society, research sector) to work together.

As far as applied forest research is concerned as regards human resources, tropical forest cover and genetic resources, the Republic of Ghana will stand as a reference and leader in the sub-region.

On Timber Industry

SAMARATEX, ABTS, SWISS LUMBER companies are lead investors in timber plantations and major players in timber industry in Ghana and their role on the project was very appropriate to influence investors confidence in mahogany plantations.

On Communities

The extension of the project techniques and findings to the other communities which were not involved in the project implementation is due to the excellent role played by community tree growers. This will contribute to the creation of community farmers.

Overall, the project has contributed to sensitize key forest related stakeholders (Ghana Forestry Commission, timber private sector , local communities) on the importance to use Khaya, Entandrophragma and other indigenous species for the establishment of mixed species forest plantations. This could be considered as the most influential impact which would contribute to the success of future reforestation and afforestation activities in Ghana.

Economical effects

In general, the project will bring the following:

-job creation which will help mitigates economic problems of rural communities;

-guarantee timber supply to industries and the creation of an important added value;

-better competences in the domain such as research and nursery and plantations management;

-long term profitability of enterprises will be better provided by forest exploitation sustainability or steady timber exports (so far as the supply is concerned), and by long term jobs and revenues.

Environmental effects

Forest Plantations contribute to the reconstitution of the forest cover and genetic resources. Long term REDD+ mechanism, if implemented, will allow the reduction of greenhouse gas as well as the mitigation and adaptation measures to negative effect risks related to global warming.

Social effects

Trainings given to stakeholders at PHD, degrees and other levels will permit future generations to acquire abilities to meet the commitment of the State and private sector.

The capacity building of community members will allow bring about technology transfer, professionalization and new outlet acquisition.

Plantations, both community and private, will allow a social impetus related to lands, bushfire management, multi-partner approach.

The establishment of plantations, through maintenance assures the creation of direct and indirect jobs in rural areas.

L. LESSONS LEARNED AND SUSTAINABLITY

The project's main goal was to restore Mahogany in the forest State of Ghana by developing mechanisms that will reduce pest impacts in mahogany plantations.

The outcomes recorded by the project are the result of a better identification by participatory approach. Among the lessons learnt to attain that goal, it is relevant to highlight the following:

The need for an integrated approach to manage Hysipyla has been repeatedly indentified by stakeholders as the most promising solution to overcome the problem associated with growing mahogany in plantations.

Sustaining funding for plantation activities were found to be a major issue even for the industries which are big corporation in Ghana, as the return on investment is for long term.

The poor community farmers are enthusiastic about continuing to expand their farm forestry, through agroforestry using indigenous species provided they could continue get access to seeds, basic equipments and additional lands.

The possibilities of using the plantation, established or to be established, to explore opportunities in carbon trading were encouraged and should be part of the activities to carry in the second phase of this project.

-in its implementation, the project has recorded positive outcomes in all the components including its appropriation by all the actors;

-the appropriation of techniques and findings by the actors is a factor of success for the project, this implies the development of future plantations and reveals the pertinence of the identification process;

-the participatory approach which implies all the stakeholders (industrials, association of communities) and whose contributions have been integrated in the identification and implementation of the project is a singularity and an innovation of this project.

Success in project implementation should count favor of the following:

- commitment and ability of the Executive Agency,

-succinct and flexible mechanism in its carrying out,

-the pleasant monitoring and evaluation which was executed by all actors,

- establishment of pilot and/ or experimental plantations in lands granted by the various stakeholders had a spillover effect in the involvement of the latters in the experiences of the project and their evaluation; this led to the easy acceptance and the appropriation of the project outputs as the stakeholders were already acquainted with the technology and the strategies of the field,

-parties extended their plantations thanks to technologies developed in the framework of this project,

-thanks to the personal involvement of the Director in charge of plantations at the Ghana Forestry Commission, all *Khaya* and *Entandrophragma spp* will from now be planted within the framework of the new National Plantation program of the Republic of Ghana.

As far as the organization is concerned:

-the project team leader under the Director of the Executive Agency ensured the successful completion of the project,

-the success of such a project requires the collaboration with the industrial which runs, plants and prompts to planting,

-the relevance of the technical and scientific cooperation between the project and some countries or external organizations should be mentioned (*Khaya anthotheca*/Ghana versus Swietenia/Brazil) and Australia (contribution to Hypsipyla pest management).

This cooperation has contributed to the improvement of Hypsipyla pest management and Meliaceae plantations success.

-the partnership between the project and Michigan Technological University is a contribution to the development of Ghana's human resources.

-the bonds of confidence between the industrial and the communities as well as the interpenetration of their interests bring about progress in rural areas.

-formal meetings and interpersonal relations of the project team with all stakeholders in order to debate about the expectations and outcomes of the project contributed to its success.

Innovations and the positive outcomes were stimulated thanks to:

-the accessibility of the equipment to all the members and even the trainees;

-the smooth and simple organization of the management structure helped to avoid bureaucratic slowness which sometimes paralyzes the implementation of projects;

In itself, the project was a suitable platform for debates and exchanges between stakeholders. The communication between the members of the project team and stakeholders apart from formal meetings and exchanges helped permanently share problems and outcomes.

M. REPLICATION/DUPLICATION

The project developed technical and scientific itineraries, silvicultural methods which made the project successful and are to be considered significant for the development of plantations in Ghana. This offers to the project potential tools for replication.

In itself, the project is a reference of applied research, training and diffusion of knowledge. The project team published quite a good number of articles and presented the results obtained at several seminars. Studies and outcomes have been accepted by the international forest science community and the reprinting of publications is permanently requested.

Stakeholders have already taken over the techniques and strategies used during the implementation.

The collaboration in such a project with private sector is essential.

Expectations and requests expressed by all the stakeholders and the various groups of farmers are very high. This demonstrates the viability of the strategies and methods of the project for replication.

The lessons learned in this project would likely have use in other areas of the world where shoot borers are problems. Such results are related to ITTO objectives m, n.

N. CONCLUSIONS AND RECOMMENDATIONS

Overall, the project has contributed to sensitize key forest related stakeholders (Ghana Forestry Commission, timber private sector , local communities) on the importance to use Khaya, Entandrophragma and other indigenous species for the establishment of mixed species forest plantations. This could be considered as the most influential impact which would contribute to the success of future reforestation and afforestation activities in Ghana.

The collaboration with farm communities and the timber industry was quite eventful and encouraged the strategy of engaging farmers to produce in their farmlands, the off-reserve areas, the future industry timber needs and must be promoted at all levels.

The institutional arrangements with timber industries that guarantee market for tree produce will make initiatives attractive for investment by smallholders, for multi-strata mixtures with fast growing species providing income in the short, medium and long terms.

These positive results induced the project team and the Steering Committee to apply for a second phase of the project. This second phase of the project aims at modernizing and refining the technique strategies in order to extend mixed plantations and mainly cut economic losses due to Hypsipyla, and to promote the establishment of new plantations and community industries. Modernized and refined technique strategies will be formulated and spread out in a practical guidebook of artificial mahogany plantation with the view to hold a series of workshops for the actors of timber industry and communities of farmers.

The funding of this second phase is therefore recommended, considering the positive impacts of the first phase on the all stakeholders, restoration of degraded forest and reconstitution of Khaya and Entandrophragma genetic resources. This second phase should be considered as the continuation and the improvement of the first one.

The project should have its own seeds collector who will train other seeds collectors in the different ecological zones. That will be a response to the increasing demand of seeds expressed by all stakeholders (industries, communities and small farmers).

Including more Khaya and Entandrophragma spp in the National Plantation Program will guaranty the development and the extension of prime species plantations in Ghana.

Concerning the financial aspects, the steering Committee which has already taken strategic and profitable decisions for the project, must look into the innovative and sustainable financing mechanisms.

Solutions can be worked out in the carbon market because the impact of forest carbon stocks by natural increase or planting is one of the tools used in sustainable deforestation control under the framework of REDD+ mechanism . The project may have technical role while the Forest Commission develops the REDD+ strategy and holds a political role on the whole forest cover through a REDD+ Steering Committee. The Forest Carbon Partnership Fund of the World Bank can therefore be seized for the implementation of this REDD+ mechanism. It can be an outstanding source of funding and additional income source for farmers planting trees.

It should also be acknowledged that there are international partners who are interested in such activities of planetary relevance (NGO, GIZ, ADB, WB). Taking into consideration the increasing interest of industrials and communities for the project, and thinking about the end of ITTO fund, it is timely to widen new and sustainable sources and mechanisms of funding. It is unusual to find such an African community carry such a long term forestry development project. It should be a great pity that a financial shortage discourages those involved in this project.

ANNEXES

Annexe 1: Terms of reference
Annexe 2: List of people and organisms encountered
Annexe 3: Calendar of mission
Annexe4: Bibligraphy
Annexe 5: Publication of results
Annexe6: Links with ITTO objectives
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Annexe1: Terms of reference
Ex-Post Evaluation of ITTO Projects on
Biodiversity Conservation / Conservation Areas
Improvement and Conservation of genetic resources

I. Background

ITTO is an intergovernmental commodity organization established in 1986 to administer the provisions and operation of the International Tropical Timber Agreement (ITTA), particularly in the promotion of international trade in tropical timber, the sustainable management of tropical forests and the development of tropical forest industries through international cooperation, policy work and project activities.

The two projects that will be the subject of the Ex-post Evaluation are as follows:

PD 105/01 Rev.3 (F): Towards Sustainable Timber Production in Ghana: Stage I. Improving shoot borer resistance and developing silvicultural systems to maximize Mahogany plantation success (Ghana)

PD 310/04 Rev.2 (F): Biodiversity management and conservation in forest concessions adjacent to totally protected area (Nouabale-Ndoki National Park), Northern Republic of Congo – Phase II

The background information of both projects is provided in Annex to the Terms of Reference.

II. Purpose and Scope of Evaluation

A) Purpose

The primary purpose of the evaluation is to provide a concise diagnosis of two projects with one related to *Biodiversity Conservation / Conservation Areas*, and the other related to *Improvement and Conservation of Genetic Resources,* so as to point out the successful and unsuccessful outcomes, the reasons for successes and failures, and the contribution of the projects towards the achievement of ITTO's Objective 2000, and to draw lessons that can be used to improve similar projects in the future.

B) Scope of Work

a) Analyze and assess for each project:

1. The overall role and contribution of each of both projects in light of sectoral policies, development programmes, priorities and requirements to achieve the rehabilitation of degraded forest lands and the sustainable management of forest resources in the country concerned.
2. Specific measures taken to incorporate project results in the national forestry and environmental policies and legislation.
3. The current management status of the forests within the project's area of influence, the effectiveness of the project's implementation and its effectiveness in promoting sustainable forest management as defined in the ITTO Guidelines and Criteria and Indicators for Sustainable Forest Management.
4. The contributions of the specific studies in various forestry-related disciplines prepared by the project to the development of forestry in the project's area of influence and on other similar and/or related projects being implemented in the countries concerned.
5. GHANA: The results and potential impact of the applied research conducted by the project [PD 105/01 Rev.3 (F)] on *Improvement and Conservation of Genetic Resources* practices and its contribution to the overall forestry-related knowledge in Ghana.
6. CONGO: The impact of project activities on the livelihoods of target populations, for PD 310/04 Rev.2 (F).
7. The effectiveness of dissemination of project results.
8. The overall post-project situation in the project's area of influence.

9. The unexpected effects and impacts, either harmful or beneficial, and the reasons for their occurrences.
10. The cost efficiency in the implementation of the project, including the technical, financial and managerial aspects.
11. Follow-up actions in order to enhance uptake of project results.
12. follow up / implementation of recommendations of 2007 evaluation in Congo
13. The project's relative success or failure, including a summary of the key lessons learnt; and the identification of any issues or problems that should be taken into account in designing and implementing similar projects in the future.

b) Provide a synthesis to:

1. Assess the overall role and meaningful contribution of the two projects in achieving sustainable management of forest resources in both tropical timber producing countries (Ghana and Republic of Congo) taking into account ITTO's objectives, the ITTO Action Plans [Libreville Action Plan 1998-2001 for PD 105/01 Rev.3 (F) and Yokohama Action Plan 2002-2006] and Objective 2000, as follows:
    - Adopt a forest policy and apply legislation; and
    - Secure the permanent forest estate.
2. Assess the overall appropriateness of the design and objectives, outputs and implementation approach of the two projects in light of its efficiency and effectiveness to assist promoting sustainable forest management.
3. Evaluate the overall impact on and relevance of the two projects for the Executing Agencies, the forest industry sector and local communities being served and the countries concerned.
4. Evaluate the overall attainment of the objectives and assess the overall effectiveness of the two projects.
5. Evaluate the overall appropriateness of the costs and cost structure and use of resources within the two projects.

And make recommendations on:

1. The needs for similar projects in the future.
2. The objectives of such future projects.
3. Innovative approaches/designs for projects aiming at promoting sustainable forest management in the tropics.
4. The effectiveness of the two projects' approach to promoting sustainable forest management.
5. Appropriate target groups, e.g. countries, government, organizations, forestry sector, local communities.
6. The organizational arrangements of the project.
7. Follow-up and evaluation practices.
8. Supplemental, alternative activities, processes, procedures, and/or follow-up programmes in the field of Sustainable Forest Management, if appropriate.
9. Further actions needed to sustain or increase the intended effects on sustainable forest management and Objective 2000 and to draw conclusions which may be of relevance to other ITTO projects in the field of sustainable forest management.

III. Approach

A) Composition of the evaluation team

The team will be composed of two consultants. One of the consultants will be the Team Leader in charge of the final report and the presentation of the results at the Forty-eighth Council Session in Yokohama (Japan), in November 2012. The assignment of the other consultant will be to carry out the mission to the Republic of Congo. The assignment of specific tasks within the TOR will be left to the Team Leader based on the individual expertise of the members of the team.

B) Consultation during evaluation exercise

The team will maintain close liaison with ITTO and will carry out its work in close cooperation with the concerned Executing Agencies and Governments in the countries concerned. Although the team should feel free to discuss with the authorities concerned all matters relevant to its assignment, it is not authorized to make any commitments on behalf of ITTO.

C) Activities and report of the team

The work required in this evaluation will consist of:

1. Desk review of project-related documents and materials provided by ITTO.
2. Missions in Ghana and the Republic of Congo. The consultants will visit each project's Executing Agency headquarters for a further desk review of project materials and to carry out evaluation work in collaboration with the Executing Agencies. The missions shall also include a field visit to each of the projects' area of influence to review field implementation and to evaluate the project results and impact, and should include discussions with project stakeholders and target beneficiaries. Approximately 10-14 working days are required for each project in their respective countries.
3. Preparation of an Ex-post Evaluation Report for each project in accordance with the Scope of Work and the checklist contained in the ITTO Manual for Project Monitoring, Review and Evaluation. The report for Ghana should be in English, and the report for the Republic of Congo should be in French;
4. Preparation of a synthesis report [see b) Scope of Work] of the two ex-post evaluation reports in one of ITTO's languages, focusing on the overall assessment of the projects' relative success in contributing to ITTO's Objectives, the Objective 2000 and the ITTO Action Plans [Libreville Action Plan 1998-2001 for PD 105/01 Rev.3 (F) and Yokohama Action Plan 2002-2006], summarizing the key lessons learnt; and identifying any issues or problems which constrained their contribution to the achievement of Objective 2000.
5. Presentation of the synthesis report (to be called: Overall Executive Summary) at the Forty-eighth Session of the International Tropical Timber Council (November 2012, Yokohama).

In writing the Ex-post Evaluation reports, the team will have the opportunity to discuss its preliminary findings, conclusions and recommendations with the representatives of each of the Executing Agencies, Governments and ITTO before the final version of the report is made. Responsibility for the final content of the reports, however, remains with the evaluation team.

D) Duration of the assignment

The duration of the assignment will be nine weeks for the Team Leader, and four weeks for the second consultant (dealing particularly with the Republic of Congo). Travel time for each project to be visited will be approximately two weeks. The remaining time will be used for preparation of the evaluation and report writing.

E) Proposed Work Schedule

April 2012:	Desk review
May – June 2012:	Missions in the Republic of Congo and in Ghana
31 July 2012:	Submission of draft reports to ITTO Secretariat and to each of the Project Executing Agencies for comments and suggestions.
31 August 2012:	Submission of both full ex-post evaluation reports and the overall executive summary to ITTO Secretariat.
November 2012:	Presentation of the findings, recommendations and conclusion of the ex-post evaluation of both projects at the Joint Session of the Committees during the Forty-eighth Council Session in Yokohama (Team Leader). Submission of the final version of both full ex-post evaluation reports, taking into account the comments made by of the delegates during the Joint Session of the Committees.

F) Proposed Consultants

Mr. Denis KEEDI ATOK, Team Leader (Ghana & Republic of Congo – 9 weeks)
Ms. Monica BORNER, Consultant (Republic of Congo – 4 weeks)

Annexe 2: List of People and Organizations encountered.

IN Accra, Kumasi, and Yields:

1) Executive Agency

Dr. Emmanuel OPuni Frimpong, Director of the Executive Agency

Miss NANA YAA Nyarko Duah , Assistant Researcher

Mrs. Goodwin Andoh Kialegee, Assistant Researcher

Dr.Beatrice Darko Obiri, Scio-economist

2) FORIG

Dr. Victor Kwame Agyeman, Director of FORIG

3)Community of Kranka:

Peter Kofi Badu, one of the leader and the farmers

3) Timber Industry:

General Manager**,** owner **of ABTS Industry** and Edward AS , Forest Manager

Mr. Simon Awfful, Forest Manager in charge of certification in forest at **Logs and Lumbers Limited** Industry

Mr. Richard Nsenkyire, General Manager of **Samaratex**, and his staff.

4) Forestry Commision:

C.A. Brown, Operations Manager

Raphael Yeboah, ,Executive Director and their staff.

Annexe 3: Calendar for the evaluation mission

Ex Post Evaluation PD 105/01 Rev. 3 (F) Schedule

Places visited:

1. Accra
2. Berekum
3. Kranka
4. Samreboi
5. Bobiri
6. Mesewam
7. FORIG

Persons interviewed:

1. Director of plantations, Forestry Commission of Ghana.
2. Director of FORIG, Dr. V. Agyeman.
3. Socio-economist of FORIG, Dr. Darko-Obiri.
4. Leader of Kranka tree growers' farmers.
5. Manager of ABTS, Berekum.
6. Plantation manager, SAMARTEX.
7. Managing Director, SAMARTEX.

Schedule

Date	Activity
2nd July	Field visit to Samreboi, SAMARTEX plantations
	Overnight stay in Samreboi
3rd July	Interview with Managing Director and Plantation manager of SAMARTEX
	Departure to Sunyani
	Overnight stay in Sunyani
4th July	Field visit to Berekum ABTS
	Interview with manager of ABTS
	Overnight stay in Sunyani
5th July	Field visit to Kranka
	Interview with Kranka tree farmers
	Return to Kumasi
6th July	Interview with FORIG Director and Socio-economist
	Field visit to Mesewam and Bobiri
7th July	Interview with Director of Plantations, Forestry Commission of Ghana.
8th July	Departure from Ghana

Annexe 4 : Bibliography

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Annexe 5 :Pulications of Rsults

E. Opuni-Frimpong, Owusu, S A., Ameyaw, L. K., and Storer, A. J. (2010). Integrated Approach to Restore African Mahogany in Ghana's Forest for Sustainable Timber Production and Biodiversity Conservation. (Accepted IUFRO 2010 World Congress)

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Annexe6: Links with ITTO

Compliance with ITTA 1994 Objectives

The project is related to 8 of the 14 ITTO objectives described below:

Objectives c, d. This project contributes towards developing plantation management systems which will assist Ghana to have sustainable production of its native mahoganies. Shoot borers now are a major limiting factor to mahogany plantation success in Ghana.

Objective f. This project involves forest management research in plantation establishment which, are ongoing successful, and will relieve pressure on the harvesting of native mahoganies. It also involves conservation of superior mahogany genotypes.

Objective i. This project developed methods for sustainable mahogany plantation establishment. Since mahogany timber is used in many ways in Ghana and is also a highly valued export, this project will help provide future long-term jobs in forestry and timber-use industries.

Objective j. Developing successful mahogany forest plantation establishment and management systems will allow for producing high value mahogany plantations on previously degraded lands, as mahoganies can grow on these sites but are not because of the likelihood of excessive shoot borer damage.

Objective l. This project is aimed at developing sustainable mahogany plantation management systems and it includes provisions for preserving and conserving valuable mahogany genotypes in several ways.

Objectives m, n. The lessons learned in the project would likely have use in other areas of the world where shoot borers are problems. The results will be freely shared in technical publications and scientific journal articles.

2. Compliance with ITTO Action Plan

The project addresses each of the four priorities identified by the Permanent Committee on Reforestation and Forest Management under the ITTO Action Plan: Promotion, Diagnosis, Demonstration and Facilitation. The project will contribute to the promotion of reforestation by reducing the impacts of the principal pest preventing mahogany plantation establishment.

Annexed 7: Profile of the Executive Agency

1 Expertise of the Executing Agency FORIG

The mission of FORIG, Ghana's forestry research institute and the executing agency is to conduct use-focused research that generates scientific knowledge and appropriate technologies to enhance sustainable development, conservation, and efficient utilisation of Ghana's forest resources. FORIG also disseminates forestry information for the improvement of social, economic and environmental well being of the people of Ghana. Completed and ongoing ITTO assisted projects are as found below.

2 Infrastructure of the Executing Agency FORIG

The Institute's permanent offices and laboratories are located at Fumesua, near Kumasi. It has research centres at Bobiri and Amantia both in the Moist, Semi-Deciduous Forest Zone, Benso in the Wet Evergreen Zone, and Bolgatanga in the Savanna Zone. There are also research stations at Subri, Afram, Pra-Anum Area, Main Northern Grassland and BiaTano and Asenanyo. The laboratories of the Institute have a wide range of equipment for research and development. They include impregnation plants, seasoning kilns, wood testing machines, steam generators, microscopes, growth chamber and UV spectrophotometer. The Institute's library facilities include a CD-ROM workstation and The CD compiled by CAB International.

4 FORIG Personnel

Quantitative experts with post-graduation degrees - 29

Quantitative experts with graduation degrees - 9

Quantitative of middle level technicians - 33

Quantitative of administrative personnel - 21

Total number of FORIG personnel in forestry-related fields – 71

Annex 8 LETTERS of SUPPORT

FOREST PLANTATION DEVELOPMENT CENTRE

LOCATION: AKYAWKROM, NEAR EJISU, KUMASI

P. O. Box 213
EJISU, GHANA-W/A
TEL. 027-871004
FAX: 027-871004
EMAIL: fpdc@hotmail.Com

Our Ref FPDC/6/308

Your Ref .....

8th January 2002

Dr. Cobbinah
Forestry Research Institute of Ghana
UPO Box 63
Kumasi

Dear Sir,

COLLABORATION ON THE IMPLEMENTATION OF THE "TOWARDS SUSTAINABLE TIMBER PRODUCTION IN GHANA: STAGE I. IMPROVING SHOOT BORER RESISTANCE AND DEVELOPING SILVICULTURAL SYSTEMS TO MAXIMIZE MAHOGANY PLANTATION SUCCESS" PROJECT

It is a pleasure to co-operate with you on your project entitled "Towards Sustainable Timber Production in Ghana: Stage I. Improving Shoot Borer Resistance and Developing Silvicultural Systems to Maximize Mahogany Plantation Success".

African Mahogany is one of the species selected by the government of Ghana for the National Forest Plantation Development Programme because it contributes significally to the nation's timber export revenue. However, the persistent attack on this species by pests is having a negative impact in the promotion of Mahogany plantations not only in Ghana but also within the entire West African sub-region.

The National Forest Plantation Development Programme aimed at planting 20,000ha per annum throughout the country is interested in collaborating in the implementation of the above mentioned project because farmers preference for planting this species due to its high economic value will have a high potential impact on forest plantation development in the country. This will in turn ensure the long-term sustainability of the project.

Yours sincerely,

Dr. V. K. Agyeman
(PROJECT MANAGER)

GWZ **Swiss Lumber Company Ltd.**

P.O. Box 964 Tel: +233 (0)31 22327
TAKORADI Fax: +233 (0)31 22293
GHANA E-mail: smsghana@africaonline.com.gh

January 13, 2003

Dr. Joseph Cobbinah
Project Coordinator / Director of FORIG
Forestry Research Institute of Ghana
UST P.O.Box 63
Kumasi, Ghana

Dear Dr. Cobbinah

COLLABORATION ON MAHOGANY PROJECT

It is with great pleasure and honor that we agree to be partners with you in your quest to identify solutions to the Mahogany shoot borer problem. While we would like to include African mahoganies in our reforestation programs, at the present time we are at a loss as to how to bring plantations through this terrible pest.

We agree to provide space on our plantation lands for you to establish a mahogany species trail. We also agree to help maintain the plantation free of weed competition. Should you need assistance after the four-year ITTO project, we will help you conduct measurements and to continue the weed control.

Currently, we plant about 25-30 hectares per year in Ghana.

Sincerely,
For Swiss Lumber Co. Ltd.

SWISS LUMBER CO. LTD.
P. O. BOX 7721 - KUMASI
GHANA / W-AFRIKA
TEL: 051-26714
FAX: 051-24120

Y. GYASI -NIMAKO
(Director)

cc. File

ASUO WAM COMPLEX LIMITED

SAWMILL DIVISION
O. BOX 42, WAMFIE - GHANA
TEL: 0642 - 22186, 22285
FAX: 0642 - 22186

SUNYANI OFFICE
P. O. BOX 815, SUNYANI, B/A GHANA - W/A
TEL: (061) 7337, 7149, 7208
FAX: (061) 7338

ACCRA OFFICE
P. O. BOX 678, ACHIMOTA
ACCRA - GHANA
TEL: (021) 220598
MOBITEL: 027 556899
RESIDENCE: TEL: 400057

OUR REF: YOUR REF: DATE:

Dear Sir,

PROPOSED ESTABLISHMENT OF MAHOGANY SPECIES TRIALS IN OUR REFORESTATION SITE IN PAMU BEREKUM FOREST RESERVE IN DORMAA AHENKRO FOREST DISTRICT

It is a privilege to be associated with the intended project.
This is because, at both the domestic and international fronts, an ultimate solution to the mahogany shoot borer problem will generally help to enhance the prospects of successful forest plantation development.
Our modest contribution in that regard will remain in the annals of International Forest Plantation development which will constitute a source of pride to our company.
We therefore wholeheartedly agree to provide adequate space in our reforestation site to enable you establish mahogany species trials separately from our annual planting target of 50 hectares.
We pledge our maximum co-operation to ensure that the objective of the proposed project is achieved.
Thank you in anticipation.

Yours faithfully

Clement Appiah Boateng
(Managing Director)

Dr. Joseph Cobbinah
Project Co-ordinator/Director of Forig
Forest Research Institute of Ghana, UST
P. O. Box 63
Kumasi, Ghana