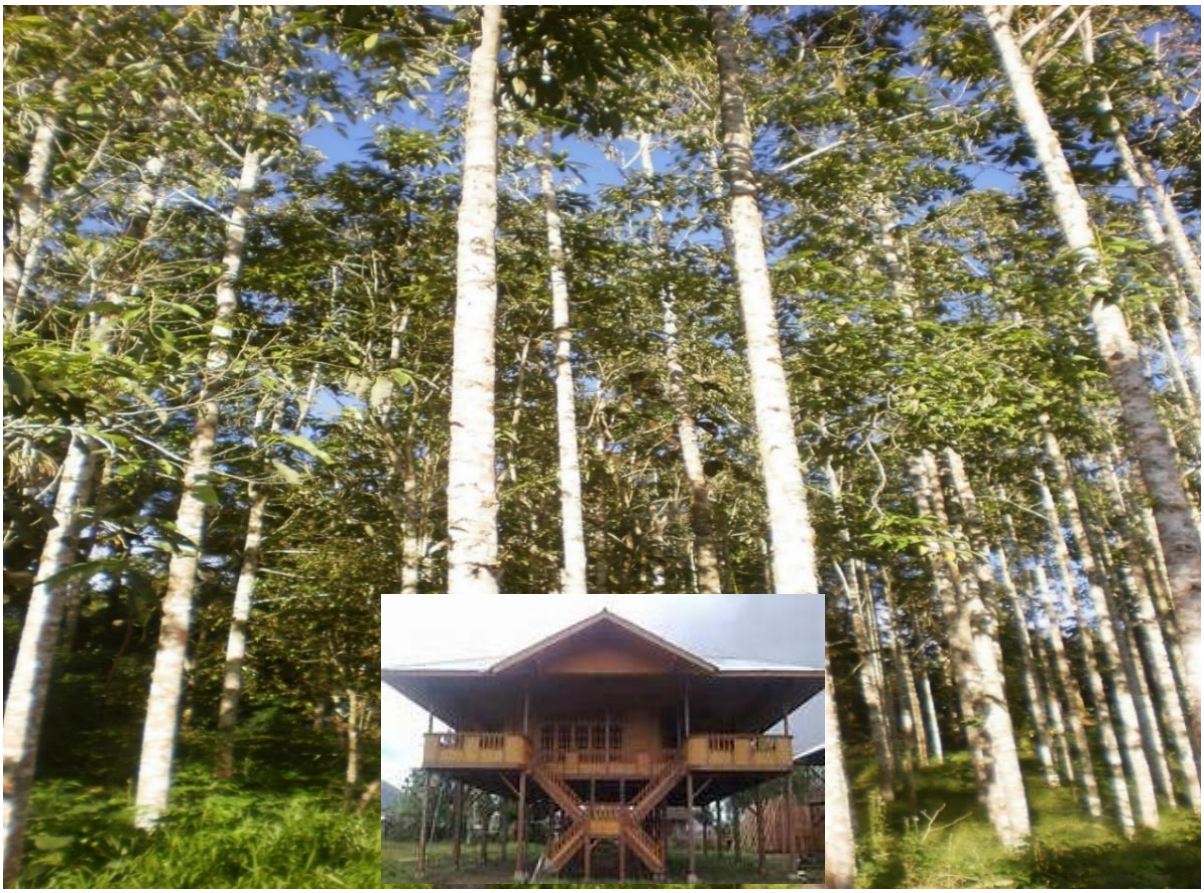
SILVICULTURAL TECHNIQUES OF CEMPAKA WASIAN TREE SPECIES IN NORTH SULAWESI

By: Riskan Effendy



Institute of Research and Development of Environment and Forestry Manado
In cooperation with
International Tropical Timber Organization (ITTO)
Manado, October 2016

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1. INTRODUCTION

Figure 1. Cempaka wasian tree species

Cempaka wasian tree species had already been known by communities in North Sulawesi especially ethnic of Minahasa since centuries ago. Cempaka wasian timber is one of main raw materials of traditional wooden stage house of Minahasa ethnic known as "Rumah Woloan" or “Traditional Minahasa stage house”. The house has an advantage of anti-earthquake. This traditional stage house is, recently, also using modern techniques i.e. knock down system, so that the house is easy to be moved (Kinho and Mahfudz, 2011). Village of Woloan 1 is located in West Tomohon, Tomohon City or about 35 km South of Manado is one of the villages producing Rumah Woloan. Currently Woloan house also is one of North Sulawesi provincial export commodities to foreign countries, such as Singapore, Germany, the Netherlands, United States, Australia, and Costa Rica. Besides, Woloan House is also sold in major cities in Indonesia (Rocky *et al*., 2007).

International Tropical Timber Organization or ITTO with its headquarters in Yokohama, Japan has shown concern for the conservation of Cempaka wood particularly in North Sulawesi. Management of ITTO has agreed to fund the Cooperation of ITTO with the Ministry of Environment and Forestry / Institute of Research and Development of Environment and Forestry (BP2LHK) Manado. Title of cooperation is "Initiating the Conservation of Cempaka Tree Species (*Elmerrillia* spp.) through Plantation Development with Local Community Participation in North Sulawesi, Indonesia", or ITTO Project PD 646/12 Rev.3 (F) and is scheduled for three years from 2016.

Until now Cempaka wood has also been used for various purposes such as to make traditional music *kolintang*, material for making boats, sports equipment, furniture and other household appliances. Cempaka Wood already traded by the public in the form of logs, sawn wood, cabinets, doors, windows, boats and plywood. Wasian wood is also used for coffin and has proven to be durable, especially in North Sulawesi (Whitmore *et al*. 1989; Mahfudz *et al*., 2011).

Wasian tree species is endemic in Indonesia and only found in Sulawesi and Maluku. In order to increase public awareness of Minahasa community, the South Minahasa Local Government has appointed Wasian trees as an icon to preserve nature and environment through cultural approach. In 2016, Head of South Minahasa District, Christiany E. Paruntu SE, who received an award as the First Winner of the Tree Planting in Indonesia, submitted by the President of the Republic of Indonesia, welcomed the initiative of the United Nations through

ITTO to establish 10 ha of Wasian tree species area as mother plants. Furthermore, Head of District expected that the cooperation related to Wasian wood in South Minahasa District really become the most important icon that should be known by the community in the South Minahasa District (Suara Sulut, 2016).

Wasian tree species is classified as medium growing species. Around Masarang Mountain, Tomohon, an information was obtained where tree growth reached 1.17 m per year and diameter increase of 2.7 cm per year. Based on these figures, wasian tree will reach diameter of approximately 40.5 cm at age of 15 years. Due to wood high demand, the timber harvesting was conducted at the age of 15-20 years, because it can be made boards or beams (Kinho 2010; Kinho and Mahfudz, 2011).

Due to lack of effort to utilize natural forests having wasian trees, sustainably and did not follow the Indonesian Selective Logging System (TPTI) correctly in the past, has resulted in a decrease of potential wasian timber in natural forests. The establishment of wasian plantation forest by community has not fulfilled wood demand of community. In fact, wood demand for producing traditional Woloan House for export increased by about 60% in 2011 (Kinho and Mahfudz, 2011).

North Sulawesi province has forest area of 794,904.12 ha, consisted of protection forest (HL) 164,551.79 ha, conservation forest (PPA) 335,339.07 ha, production forest (HP) 66.692.95 ha, limited production forest (HPT) 213,393.22 ha and convertible production forest (HPK) 14867.12 ha (BPS, 2016). Based on Data and Information of Forest Utilization Year 2014, production forest of North Sulawesi province is 287,990 ha, and has been utilized in form IUPHHKHA (Business Permit of Wood Forest Product Collection in Natural Forest) (1 unit): 26,800 ha, IUPHHK-HTI (Business Permit of Wood Forest Product in Industrial Plantation Forest) (1 unit): 7,500 ha, Back up of HTR Community Forest (9 unit): 48,140 ha and HKm (2 units): 250 ha (entirely at HL). The locations of production forest utilization areas are in districts of: Bolaang Mongondow, South Bolmong. North Minahasa, Southeast Minahasa, South Mnahasa, Minahasa, South Bolmong, North Bolmong and Kep. Talaud. Production forest area that have not been given utilization permit are 205,049 ha and protected forest area that has not given utilization permit is 161,560 ha (Anonymus, 2015). Data of forest area in detail by district and city are presented in Appendix 1 and Map of Forest Utilization of North Sulawesi is presented in Appendix 2.

With relatively not so large of permanent production forest, so the establishment of plantation forest should be carried out effectively and efficiently with high productivity. Application of Intensive Silviculture (SILIN) for forest plantation development, especially wasian species should be implemented in order to produce timber production to meet the needs of the community and also to sustain Cempaka forests in North Sulawesi. Sukotjo (2009) put forward three main principles in the application of Intensive Silviculture (SILIN) i.e. use of superior seeds, proper manipulation of the environment and integrated prevention of pests and diseases. Application of Silin has been done in some areas in Sumatra and Kalimantan.

The Sustainability of Cempaka and wasian tree species in North Sulawesi, in addition to establishment of plantations, also needs to be conducted in-*situ* and *ex-situ* conservation of

Magnolia tsiampacca species. Currently ex-situ conservation Magnolia tsiampacca species a limited number have been done in Bogor Botanical Gardens and Cibodas Botanical Gardens in West Java province. The botanical name used at both botanical garden is *Magnolia vriesiana* (Miq.) Pierre ex Baill which is the synonym of *Magnolia tsiampacca*. The species conservation status based on IUCN is Not evaluated / NE (Rozak, 2012).

A survey of plant species as a flagship species in a tourist destination, a case study in Mahawu, Tomohon, North Sulawesi was done by Butar-butar *et a*l., (2015). The survey results based on questionnaires and interviews with the tourists, it is known that according to level of importance for the tourists, the pitcher plants species (*Nepenthes maxima* Reinw. Ex Nees) ranks first as the most selected. The wasian tree species was ranked 8th out of 26 selected species. This proves that the cempaka wasian quite important, especially in Mahawu, Tomohon.

Some constraints in development of Wasian forest plantation including: (1) The silvicultural techniques applied by communities in the establishment of plantations have not fully understood (2) seedling procurement derived from selected parent trees with superior quality has not been widely understood by the community (3) the procurement of good quality seedlings in sufficient quantities and available when needed, still need to be improved. The role of government in fostering forest farmers is still needed so that community can increase wood production in the future and sustainability of wasian species can be assured.

This book is intended to present data and information related to Cempaka/ wasian especially existed in North Sulawesi. The aspects presented includes botany and taxonomy, site and natural distribution, seed, procurement of seeds, land preparation, seedlings, planting, maintenance, growth and yield, resistance to pests and diseases, harvesting, properties and uses of wood and financial analysis of wasian plantation development.

It is expected that the data and information will be useful in the efforts to increase timber production of cempaka wasian to meet wood demand of the community and also to sustain cempaka wasian tree species in North Sulawesi.

2. BOTANY AND TAXONOMY

2.1. Botany

Cempaka tree species in North Sulawesi, known by several names namely cempaka, wasian, cempaka wasian, cempaka hutan, cempaka alus and taas. The name that will be used in this technical report book is or cempaka wasian.

Cempaka wasian can reach 45 m with diameter reaching 200 cm (Lemmens *et al*., 1995; Kinho and Mahfudz, 2011). Morphological characteristics of wasian found in South Minahasa and Bolaang Mongondow, North Sulawesi are as follow (Kinho and Irawan, 2012):

Stem. the surface of stem on young plants (saplings and small trees) smooth, grayish black with white patches, spread evenly almost over the entire stem surface

Leaf, single, leaf sitting crossed, leaf base tapering, leaf tip pointed, surface of young leaf soft hairy silvery colored, surface of young leaves slippery, green colored, back leaf whitish colored like wax layer (lignin), length of petiole 2-3 cm, cm length of leaf 21-42, width of leaf 4.5 to 11 cm, edge of leaf flat

Fruit, berry-shaped, very similar to the *E.celebica* Dandy. Average fruit size length 5.4 to 7.3 cm, diameter around 1.2 to 2 cm. Total in one stalk ranged between 50-80 seeds

Figure 2. Stem, leaf and fruit of cempaka wasian (Photo: Kinho et al., 2012)

2.2. Taxonomy

Tree species of cempaka, cempaka wasian, wasian, cempaka hutan, cempaka alus and taas have long been known by communities in North Sulawesi. Botanical names of those vernacular names varied.

The results of study on diversity of tree species related to cempaka in North Sulawesi (Kinho and Irawan, 2011; Kinho and Mahfudz, 2011) showed that based on morphological characters namely stems, leaves and fruit, cempaka belong to Magnolia genus and Magnoliaceae family and Magnoliales order.

Generally, community in North Sulawesi know cempaka wasian with botanical names of *Elmerrillia ovalis* (Miq.) Dandy (Kinho and Mahfudz (2011). However recent revised botanical names is *Magnolia tsiampacca* (L.) Figlar & Noot., comb.nov. In Indonesia cempaka was known by the names of cempaka hutan, cempaka kuning, magnolia (Java), jeumpa (Aceh), capaka (Halmahera). Cempaka hutan kasar, cempaka wasian (Sulawesi), minjaran (Sumatra), arimot (Biak, Irian Jaya). International trade name of cempaka wasian is Wau beech (England).

This technical report book will focus only to cempaka wasian with botanical name : *Magnolia tsiampacca* (L.) Figlar & Noot., comb.nov.

Classification of *Magnolia tsiampacca*:
Kingdom: Plantae (Plants)
Subkingdom: Tracheobionta (vascular plants)
Super Division: Spermatophyta (seed Produce)
Division: Magnoliophyta (flowering plants)
Class: Magnoliopsida (dashed two / dikotil)
Sub Class: Magnoliidae
Order: magnoliales

Family: Magnoliaceae
Genus: Magnolia
Species: *Magnolia tsiampacca* (L.) Figlar & Noot., comb.nov.

3. SITE PROPERTIES AND SPECIES DISTRIBUTION

3.1. Site Properties

Cempaka wasian grows in North Sulawesi, ranging from lowlands up to an altitude of 1000 m above sea level. Rainfall ranging between 1400-2600 mm per year, with average nine wet months and average two dry months. The soil type is unfertile volcanic sand, clay and soil without stagnant water. It also grown on red yellow Mediterranean soil and latosol having clay texture (Whitmore *et al*., 1989; Lemmens *et al*., 1995; Sumijarto *et al*., 2002; Abdurochim *et al*., 2004; Kinho and Mahfudz, 2011; Irawan and Halawane, 2011; Rozak, 2012).

In general, wasian tree species do not need high growth requirements and can grow in less fertile soils. Wasian tree species grows naturally in primary forests and can also be found in logged-over forest.

Based on field observation in North Sulawesi, cempaka wasian trees grow in flat area, medium slope and even in very steep slopes. This tree species are also found in house yard mixed with fruit and tree species like mango, jack fruit, mahogany. Mixed of old coconuts trees and cempaka wasian plantation are also found.

3.2. Species Distribution

Natural and plantation distribution of wasian in North Sulawesi covering Minahasa district, North Minahasa district ,Tomohon city, South Minahasa districts , Southeast Minahasa district and Bolaang Mongondow district (Kinho and Mahfudz , 2011; Kinho and Irawan 2011; Irawan and Halawane, 2011). Location of community forest and family forest (*hutan pasini*) of wasian species can be found around Klabat mountain (North Minahasa), Taratara, Pinaras, Mahawu mountain, Masarang mountain (Tomohon city), Kawangkoan, Langowan, East Tondano (Minahasa), Tareran (South Minahasa) dan Modayak (East Bolaang Mongondow). A relatively large area of Wasian and other species plantation forest can also be found around Tondano Lake, North Sulawesi

Whitten *et al*., (1988) reported wasian tree species in form of big trees were found in riverin forest, influenced by humid condition and new sediment in Sopu valley Northeast of Lindu Lake. This species was also associated with Duabanga *moluccana* dan *Ficus* (Mora).

In Tree Flora of Indonesia Check List for Sulawesi book (Whitmore *et al*., 1989) reported that Magnolia tsiampacca syn. Elmerrillia ovalis (Miq.) Dandy was naturally found in Sulawesi and the Moluccas (Morotai, Ambon). The same was also reported by Lemmens *et al*., 1995).

Field observation in most district of North Sulawesi in October 2016 showed that cempaka wasian tree species either in small (0.5- 2 ha) monoculture plantation or mixed with other tree species like coconuts and cloves plantation are easily found. Around a hill surrounding Tondano Lake, mixed plantation of cempaka wasian, mahogany, and gmelina was established by community.

4. CEMPAKA PLANTATION DEVELOPMENT TECHNOLOGIES

4.1. Seed and Seedling Production

The success of plantation forest establishment among others depends on quality of planted seedlings. Good seedlings is determined by the quality of the seed. Seed collection depends on flowering and fruiting season, therefore it is necessary to know the right time of flowering and fruiting in order to facilitate the collection of fruit later. Every tree species has a different fruiting season and also depend on location.

Based on literature study the fruiting season of cempaka wasian (*Magnolia tsiampacca*) found in most of districts of Minahasa, North Minahasa, South Minahasa, Southeast Minahasa, Tomohon city and East Bolaang Mongondow in North Sulawesi province is twice a year namely in the months of March-April and November – December (Irawan and Hidayah, 2013). Only one or two trees having fruit was found during field trip in Minahasa in October 2016.

Fruit of cempaka wasian are collected from selected good mother trees through tree climbing. The selected mother trees should have a straight stems, high branchless stem and in a healthy condition. Good seed sources are required for plantation development of cempaka wasian. Examples of fruit and seeds of cempaka wasian is presented in Figure 2.

Figure 3. Fruit (left) and seed (right) of cempaka wasian (Photo: Irawan et al., 2013)

Locations of cempaka wasian seed sources are mostly in community plantation forests that scattered in most districts in North Sulawesi among others in South Minahasa, Minahasa, Tomohon, North Minahasa.

Selection of good mother trees having good phenotypes such as straight stems, high enough branchless and did not attack by pests and diseases was carried out by Prasetyawati (2012). As many as 25 trees with the girth between 93 cm to 158 cm and between 21 – 43 m high and clear bole of 10 – 22 m had been selected. The location of those mother trees are in villages of Rumoon Atas Dua, sub district of Tareran, Tumaluntung village , sub district of Suluun Tareran and Talaitad village , Suluun Tarera subdistrict all of them are in the district of South Minahasa, North Sulawesi province. The detailed identity of selected mother trees are presented in Appendix 3.

An analysis of the genetic diversity of identified seed stands of Cempaka wasian (*Magnolia tsiampacca*) have been conducted in the districts of Sa'dan Matallo and Sa'dan Balusu, North Toraja district, South Sulawesi. The analyses was based on Random Amplified Polymorphic DNA (RAPD) molecular markers. The results of the analyses showed that the genetic diversity of cempaka wasian was classified as high. The other obtained result was that in analyzing the genetic diversity that compatible were a primary OPP-08 and OPQ-07, which resulted more and brighter DNA of 35 bands and 22 bands respectively compared to other primary. (Ramba *et al*., 2014).

Seed Properties. Seed of cempaka wasian (*Magnolia tsiampacca*) is grouped into recalcitrant type, because the seeds cannot be stored for a long time. Seed viability will disappear when the seed are dried. Its germinating capability is very low. There are as many as 91,000 seeds per kg. (Lemmens *et al*., 1995; Irawan and Halawane 2011; Prasetyawati, 2012). The size of wasian seed, its diameter is 0.5 to 1.0 cm and fruit size, 5.4 to 7.3 cm long and 1.2 to 2 cm wide. The number of seeds in the fruit is estimated to range between 50-80 seeds (Kinho and Mahfudz, 2011; Irawan and Hidayah, 2013).

Irawan and Leksono (2012) mentioned that superior seed from breeding tree program will result in higher wood production, so, many people paid attention to this benefit in forest establishment. Na'iem (2007) in Irawan and Leksono (2012) reported that genetic gains derived from the best provenances reached 300%. Superior seeds of *Acacia mangium* has increased increment up to 49 m^3/year from an average of 25 m3. *Shorea leprosula* tree species aged 4.5 years from the best seedlings reach 15.85 cm in diameter compared with mean diameter of 10.48 cm (Soekotjo 2009 in Irawan and Leksono, 2012).

In general, an overview of the differences in use of improved seed from breeding technique can be seen in Figure 3 (Irawan and Leksono, 2012)

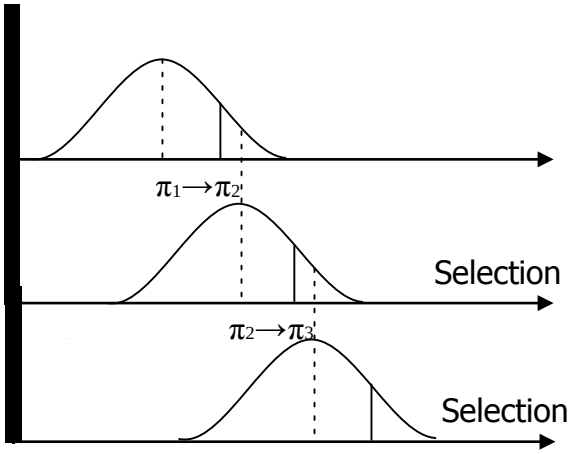


Figure 4. Influence of seed selection of breeding product

The government has determined that the seeds to be planted either in HTI, HTR or HR should be from certified seeds. Sources of certified seedlings is a tree stand in form of natural forests and plantation forest plantations of certain species that fulfilled the criteria stated y Permenhut (Rule of Forestry Minister) P.072 / 2009. Certified seed source is issued by competent authorities, among others BPTH (Forest Plant Seed Institute) or local Forest Service.

There are 7 (seven) seed source classification based Permenhut P.072 / 2009. The classification from lowest to highest are: Identified Seed Stand (TBT), Selected Seed Stand (TBS), l Seed Production Area (APB), Provenance Seed Stand (TBP), Seedling Seed Orchard (KBS), Clonal Seed Orchard (KBK) and Hedge Orchard (KP). Appendix 3 presented detail of each those seed sources classification.

Seed Procurement. The collected cempaka wasian seeds were scarified. Seed extraction is done by drying fruits under sun light, until fruit skin break. Then the seeds which are still coated by epidermis were collected. The epidermis is removed by soaking in water and then cleaned. Pay attention that no epidermis attached to the seeds, because this can cause appearance of fungi, when the seeds will be stored or germinated. Storage of seeds should be in airtight plastic bags and stored at AC rooms. Furthermore, result of seed calculation through weighing of 1000 seeds namely as weigh as 28.4 grams. Thus there are 35, 211 seeds in 1 kg (Irawan and Hidayah, 2013).

Nursery. Procurement of seedlings for plantation forest establishment is generally produced in the nursery, either in permanent nursery or in temporary nursery. Good nurseries require, among others: availability of water throughout the year, sufficient land area, good accessibility, available workforce, especially women workers or mothers to work on weaning of seedlings to polybags. Temporary nursery location is generally close to the planting site, while the location of permanent nursery may be far from planting site but the road network to the planting location should be is easy and all weather roads.

Permanent and modern nursery that produced seedlings of cempaka wasian (*Magnolia tsiampacca*) and other tree species such as nantu (*Palaquium* sp.), jabon merah (*Anthcephalus macrophylla*), trembesi (*Samanea saman*) etc., is located at Kima Atas Mapanget subdistrict, Manado city. Geographically the nursery is located at coordinates of between 1^0 0.56185 – 1^0 0.5632 North and between 124^0 0.9010 – 124^0 0.9022 East, at an altitude of 70 m above sea level, mean temperature 34^0 C, average monthly rainfall 270 mm. The area of the nursery is 2.5 ha. Production of seedlings from 2011 to 2013 reached 2.5 million seedlings consisting 13 forest tree and fruit species. Production of wasian in the nursery from 2011 -2013 in 2013 reached 532.800 seedlings. Distribution of seedlings as many as 45.6% to the public as individuals and 7.6% to Forest Farmers Group (Suryawan and Irawan, 2014).

The nursery is managed by BP DAS (Institute of Watershed Management) Tondano in cooperation with BP2LHK (Institute of Research and Development of Environment and Forestry) Manado. Those seedlings were given freely by government to communities in the National Tree Planting program.

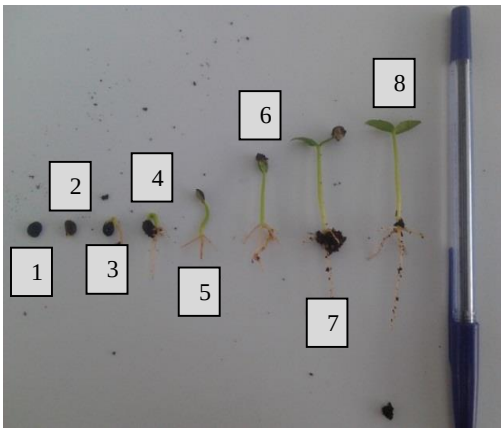
In a limited amount several communities such as in Tondano, have made simple nursery. They produced seedlings of cempaka wasian and also sell the seedlings to community to be planted at their lands.

Figure 5. Permanent Nursery in Manado and cempaka wasian seedlings (Photo: Rudi).

Generative propagation. Forest tree seedlings are generally produced generatively through seeds and wildings. Seedlings of cempaka wasian are produced through seed germination. Various treatments of seed scarification has been carried out to improve germination. Besides, research on wildlings collection in the forest and then maintained in the nursery have also been conducted.

Process of cempaka wasian seed germination was reported by Irawan and Hidayah (2013). Firstly the seeds were sown germinating box that had been filled with sand, and would be better to use sterilized sand. Fungicides may be given to reduce fungal attack. Seed sowing should be done carefully and evenly throughout the basin box. Then they are covered with fine sand. Fine wire sieve is used to cover the box to avoid the disruption of ants. Box location should be in a place that avoid disruption of mice and ants. Watering in was done twice a day, morning and evening using hand sprayer except rain day

Seeds begin to germinate after 2-3 weeks since they were germinated. Weaning to polybag was conducted after seedlings have two completed leaves. Weaning is done in the morning or afternoon. Polybag use the media in form of a mixture of soil with manure in the ratio 2: 1. Seedlings that are well maintained by watering, fertilizing, weed cleaning etc., will reach a height of 25-30 cm after five months and the seedlings can be planted to the field.



Remarks :

1 = Addition of seed volume
2 = Radicule begin to grow
3 = Hipokotil lengthened
4 = Roots grow and develop
5 = Seed skin lifted upwards
6 = Hipokotil start straightening up
7 = Plamula oen
8 = Fruit skin apart

Figure 6. Germination proses of cempaka wasian (Photo: Irawan *et al*., 2013).

Further reported by Irawan *et al.,* (2013) that firstly appear plamula leaves of cempaka wasian its form was oval with length and width average 1.57 cm and 0.94 cm. respectively. The formed roots are fiber root, the length of main roots is 4.11 cm and root number varied from 5-8 pieces. Average of seedling high after fruit skin off is 3.21 cm apart. Based on the germination process it was known that cempaka wasian seed germination belongs to epigeal type.

An experiments of using cocopeat for weaning media at polytube of cempaka was conducted by Irawan *et al*., (2014). The results showed that cocopeat media was less suitable. Seedling growth in diameter and height after four months was 0.17 cm and 3.52 cm respectively with 18.75% survival rates. While using top soil media, reached 96.88% survival. The lower result of cocopeat media was caused by much tannins substances.

An investigated on the influence of light intensity and fertilization on wildling growth of cempaka was conducted by Kurniaty and Heryati (2003). Wildlings were taken from Tana Toraja, South Sulawesi. The study was conducted at Experimental Garden of BPTPTH in Nagrak, Bogor for 3 months. The light intensity in the nursery, using paranet covered with palm leaf. There are three shade treatments namely 15% (1990 to 2019 lux), 20% (2642 to 2663 lux) and 30% (3829-3838 lux) and five treatments of NPK fertilizer i.e. 0 grams (without fertilizer), 0.05 gram (1 grain NPK), 0.10 grams (2 grains NPK), 0.15 grams (3 grains NPK) and 0.20 grams (4 grains NPK). The results indicated that NPK fertilizer given to wildling gave effect to survival after maintained for 3 months. The highest survival (90%) was obtained with 30% light intensity. The best height growth after three months age (25.53 cm) was obtained in the treatment of 30% light intensity and 0.15 gram (3 grains) NPK fertilizer. The best diameter growth was 30 % light intensity while NPK fertilizer its influence was insignificant.

Experiment on various shade density and various kinds of fertilizer to determine the optimal growth of Cempaka wasian seedlings has been carried out in the BP2LHK nursery Manado by Irawan *et a*l., (2012). Wasian seeds were collected from Suluun Village, District Suluun Tareran, South Minahasa regency, North Sulawesi. The treatment level of shade density consisted of (a) 55%, (b) 65% and (c) 75%. Fertilization treatment consisted of no fertilizer, manure and NPK fertilizer. Observations after five months showed that shade treatment that gave the best effect on the growth Cempaka wasian is 55% shade. Fertilization treatment in this experiment did not significantly affect seedling growth of cempaka wasian.

Irawan and Kafiar (2015) have carried out experiments on utilization of top soil, cocopeat and paddy rice husk charcoal for planting medium of Cempaka wasian. Location of the study was BP2LHK nursery. Seed Germination of is done on a plastic tube with sand media. The seeds germinated 10-14 days after sowing and weaning was done one week later. Three treatments of planting medium for weaning have been tried, namely:

(A) top soil
(B) top soil + cocopeat; and
(C) topsoil + paddy rice husk charcoal.

Comparison of composites and top soil is 1: 1. The parameters observed were high, stem diameter, shoot dry weight and root dry weight. Measurements were made six months after weaning. The design used was completely randomized design with three treatments and

three replications. Results obtained from this research showed that utilization of organic material in form of paddy rice husk charcoal mixed with top soil media (treatment c) gave a better response compared with cocopeat. Response of top soil + husk charcoal on height growth 15.37 cm, diameter: 4.77 mm, shoot dry weight: 1.44 g and root dry weight: 1.17 g.

The role of paddy husk charcoal was quite a lot, they can improve the porosity of the media so it is good for the respiration of roots, it can retain soil moisture, because it binds water and released into the micropores to be absorbed by plants, promote the growth of useful microorganisms for soil and plants and having properties more crumb than other planting medium.

Maintenance technique of wasian seedlings in nursery was conducted by Suhartati and Misto (1999). The materials used are seedling of cempaka, alcosorb AB3F type, fertilizer NPK (15:15:15) and polybag. Design used is completely randomized design with factorial. Treatment applied consisted of watering with alcosorb (3 levels) and dosage of NPK fertilizer (4 levels and 1 control) as follows:

Watering with alcosorb:
S0: Watering without alcosorb (Control)
S3: Watering with alcosorb every 3 days
S6: Watering with alcosorb every 6 days

NPK fertilizer:
P0: Without fertilizer (Control)
P1: Fertilization 0.5 grams / bag
P2: Fertilization of 1.0 g / bag
P3: Fertilization 1.5 grams / bag
P4: Fertilization 2.0 g / bag

The results showed that the combination of interval watering every three days with alcosorb and fertilizer 1.0 gram bag gave best effect and efficient on seedling growth until four months old. The use alcosorb besides improving the high growth and wet weight and quality of seeds cempaka index (0.70), also reduces the use of water for watering of seedlings, which is only done once every three days.

Natural regeneration of wasian in primary forest is very limited, but natural regeneration often found in the logged over forest (Abducrochim et al., 2004). Furthermore Lemmens et al., (1995) reported that in a survey of primary forest area covering 25 ha in Klabat, North Sulawesi, where wasian important (11%) of all trees with a diameter> 20 cm), there are only 22 young plants, it does show that natural regeneration is almost non-existent. However, abundant natural regeneration in secondary forests, it shows that this type arise after heavy degradation of forests

Vegetative propagation has been done, especially if the fruiting season is rarely or irregular, or difficult to obtain seed. Vegetative propagation by shoot cuttings/ stem cutting was

applied to meranti (*Shorea* spp.), stem cuttings to Sungkai (*Peronema canescens*) and root cuttings to sonokeling (*Dalbergia latifolia*). The other method is through the production of clones of shoots as the teak plants. Good vegetative propagation will produce seedlings that are the same as the parent, where the selected parent trees having superior properties. There are forest plants propagated by clones such as teak (*Tectona grandis*), mangium (*Acacia mangium*) and eucalyptus (*Eucalyptus spp*.).

Experiment on vegetative seedling multiplication of wasian using shoot cuttings have been done by Irawan and Suryawan (2013) in greenhouse nurseries at Permanent Kima Atas, Mapanget District of Manado City. The location was at an altitude of 70 m above sea level. Environmental conditions as follow: humidity 86% - 99%, the temperature of 25.3^0 C 35.4^0 C, light intensity of 233 lux - 14,650 lux. Cuttings material derived from seedling of wasian aged one year. The length of leaf 8 cm, two leaves were left and cut half parts to reduce evaporation. Rooting cuttings with KOFFCO system (Komatsu Forda Fogging Cooling) that use plastic box, plastic lid (Figure 6).

The treatment applied was soaking cuttings in Rootone-F solution with a concentration of 0,1g / ml and soaking time consists of:
P0: Without treatment Rootone-F (Control)
P1: Use Rootone-F by way dipped
P2: Use Rootone-F and soaked for 15 minutes and
P3: Use Rootone-F with and soaked for 30 minutes.

Each treatment consisted of three replicates and each experimental unit consisted of 12 cuttings, so the number of cuttings planted were 144 cuttings. The design used was completely randomized design. Responses observed, namely rooted percentage, number of roots, root length, percent sprout, the number of new leaves, new leaf length and width.

The experimental results showed that the use of growth hormone Rootone-F have a significant influence on the growth of shoot cuttings of wasian to rooted percentage, average length of the root, sprout percentage, the average number of new leaves, and the average new leaf length. Influence of hormone soaking treatment Rootone-F for 30 minutes (P3) gave the highest percentage of rooted as much as 66.67%, while the treatment of Rootone-F with immersion method (P1) and soaking for 15 minutes (P2) as well as the control treatment (P0) gave survival of 27.67%, 30.33% and 16.67% respectively. In this experiment the best treatment is soaking in Rootone-F plant growth regulator for 30 minutes (Irawan and Suryawan (2013). The complete data experimental results are presented in Appendix 4.

Figure 7. Four months old wasian stem cutting using Rootone-F treatment. (Photo: Irawan *et al*., 2013).

Observation results in the field showed that the wasian tree stem has the ability to sprout. Besides, it can also sprout vertically on a branch (see photo). With the availability of the sprouts, shoot cuttings production is possible from selected good trees. The establishment of clonal forest with the seedlings comes shoot cutting from superior trees will improve not only the timber quality but also the production of timber stands.

Figure 8. Sprout at tree stems and branch of wasian tree

Growth of seedlings originating from teak clones to the spacing has been conducted in the Center for Biotechnology and Forest Tree Improvement in Playen, Gunung Kidul, Yogyakarta. A total of 12 clones from Cepu (C1-C5) and Madison (M6-M12) derived from shoot cuttings and two spacing, 3 x 3 m and 6 x 2 m have been observed on plants teak from 12 clones aged 3 years and 9 months old. Complete Random Design Berblok or Randomized Complete Block Design (RCBD) was used in the test.

Based on the survey results revealed that teak clones that showed the best growth in the field include high growth, diameter growth, appearance and slope tree canopy conditions up to age 3 years and 9 months is Cepu1 clone. Data showed that C1 clone has an average height

of 8.2469 m as the highest, and biggest diameter is 8.5925 cm. Furthermore, the spacing of the best clones of teak aged 3 years and 9 months is 6 x 2 m, where the average diameter is 7.9375 cm, while in 3x3 meter spacing the diameter is 6.5813 cm. (Mahfudz and Anggoro (2011).

4.2. Land Preparation

Land preparation, aimed at creating a good preconditions for planting of seedlings and aligned to keep soil fertility and environmentally friendly. Besides, in order the soil physic condition can facilitate cultivation, support roots development and reduces competition between planted trees with weeds (Hendromono *et al*., 2006). Cleaning the field by land burning has been banned by the government since 1995 because it is very detrimental to environment and cause substantial losses. Losses due to land burning has disturbed air transportation and public health.

Clearing the land manually use axe, chainsaw, crowbars, knives and undergrowth cutter. Large trees may be used for building materials such as beams or boards. Branches, tree stumps and twigs can be made charcoal. Cut leaves are dried and later may be used as compost for fertilizer. Those dried leaves can also be used as MDK for future plant maintenance.

Land clearing activity for forest plantation depends on tree species, whether the tree species need shade at a young age (semi tolerant) like meranti (*Shorea* spp.) or do not require shade (intolerant) such as sengon (*Falcataria moluccana*). Clearing of land for semi-tolerant tree species should be done in stripe of 3-5 m wide. Distance of stripe depend to spacing. While for intolerant tree species which require full light, total land clearing should be applied (Hendromono *et al*., 2006).

After clearing the land are then installed with marker stick (*ajir*) according to planting distance. Marker stick is a piece of wood or bamboo with length of 1 - 1.5 m and diameter of 2-3 cm. The tree planting will be done at this stick. Furthermore, hole making for planting is done at marker stick sizing 40x40x40. Before planting, the hole should be given basic fertilizer in form of cow dung manure as much as 3-5 kg per hole.

Spacing on community forests are usually a of 3 x 3 or 2 x 2 m for monoculture plantation, While in mixed plantation spacing are 5 x 5 m. Spacing often irregular, especially on community forests in the past, but currently forest farmers plant trees regularly (Mindawati *et al.,* 2006).

Land clearing activities, installation of stakes locally known as *ajir*, hole making for planting and tree planting is done in the first year.

4.3. Planting

Monoculture forest plantation consisted of only one tree species. This method has disadvantage especially when attacked by pests and diseases it will be exposed entirely, so the loss will be immense. Besides, in terms of biodiversity it is limited to only one species. Monoculture plantation was usually done in large scale area such as Industrial Plantation Forest

(HTI) of *Acacia mangium* tree species in Riau and South Sumatra and East Kalimantan and teak (*Tectona grandis*) in Java. But community sometime also establish monoculture forest such as sengon forest in Java. During field visit in North Sulawesi, monoculture plantation of wasian was also found in community land but the area was not so large.

Mixed plantation forests consist of more than one species for example in most community forests in Java. In North Sulawesi community has also planted wasian with mahogany or nantu tree species in their garden. At old coconut gardens or approaching maximum age when production has decreased, then wasian tree species are planted among coconut trees. Agroforestry system namely combining forest tree species with agricultural, horticultural and medicinal plants have been practiced in community forest. Commonly planted seasonal plants are corn (*Zea Mays*), paddy (*Oriza sativa*), peanuts and cayenna pepper. Intercropping system has been commonly applied in plantation forests of teak, mahogany, pine, sengon in Java. Plants species varies depending on location, for example, pineapple among sengon tree in Perhutani Kediri, spices and medicinal plants (turmeric, ginger, cardamom) in Ciamis.

The community forest managed by the community in the North Sulawesi is dominated by cempaka wasian and cempaka putih. Forest plantations are usually in form of community forests, family forest or *Pasini*. Community forest is widely available in Minahasa district (Kawangkoan, Langowan, and East Tondano), North Minahasa district (around Klabat Mountain), Tomohon (Taratara, Pinaras, mountain Mahawu, mountain Masarang), South Minahasa district, Southeast Minahasa district and Bolaang Mongondow (Modayak) (Kinho and Mahfudz, 2011).

Cempaka wasian plantation, managed by communities in Minahasa, usually in form of intercropping where besides the main trees of wasian species, other plants such as bananas and vegetables are also planted (Rompas, 2016, pers.comm). Based on observations in the field, information was obtained regarding other trees found among wasian trees namely cloves, coffee, nutmeg, cinnamon, vegetables, and coconut. Plant spacing of wasian varied, but generally 3 x 3 m or 2 x 3 m. If the tree stand are not thinned after five years or more then diameter growth cannot grow larger as expected. Based on field observations in some wasian plantation, at the age of 5-10 years old, tree diameter (dbh) is still small about 10-15 cm due to competition to get light and nutrients. Trees with larger diameter generally occurred at plantation edge where competition is less, while those at the center mostly having small diameter size, only about 20 % having large dbh.

A multi strata mixed plantation should be enhanced to community. Wasian tree species may be combined with coconut (*Cocos nucifera*), clove (*Sizygium aromaticum*), and sugar palm (*Arenga pinnata*). The last three species are most widely planted in North Sulawesi province commonly known as waving coconut province. They are used for copra, cigarette industry and traditional drinks known as cap *tikus* brand and recently for ethanol production respectively. Wasian and coconut trees planted at the highest stratum with more than 30 m high, the second stratum 10-30 m for cloves, sugar palm, nutmeg (*Myristica fragrans*) and cinnamon (*Cinnamomum verum*). The lower stratum for fruits such as banana (*Musa paradisiaca*), papaya (*Carica papaya*). The lowest stratum for corn (*Zea mays*), cayenna pepper (*Capsium frutescens)* and vegetables. This system can give income to forest farmers in short term (chilly, corn, vegetables, and fruits), mid-term (clove, sugar plant, coconuts) and

long term (wasian timber). Based on field observation, wasian trees had been planted at old coconut areas

Figure 9. Mixed stand of cempaka wasian and cloves

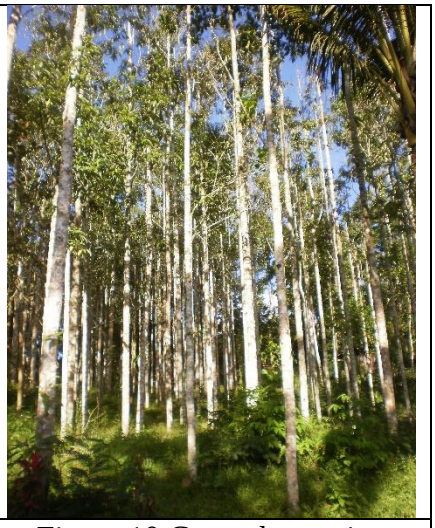


Figure 10 Cempaka wasian monoculture plantation

Asir *et al*., (2008) reported the effect of plant combinations of cempaka wasian with mahogany (*Swietenia mahogany* King) and seasonal crops such as cauliflower (*Brassica oleracea)* and *Allium porum* L.) against run off and erosion using soil and water conservation techniques. Trial sites in Masarang sub watershed, Watershed Catchment Area of Tondano Lake, which is located on Mount Masarang-Rurukan, East Tomohon district, Tomohon, North Sulawesi Province. Annual rainfall and rain days in 2008, were 1,582 mm and 118 days respectively. Spacing used to cempaka and mahogany plantation are 3 x 4 m. The treatment were in form of slope (a) 15-30%, (b) 30-45%, and (c)> 45% and a combination of beds, cauliflower, , onion plants in accordance with practices by local farmers and vertical mulching, cempaka and mahogany trees which is the application of soil and water conservation techniques. The results obtained from these experiments particularly the growth of cempaka and mahogany aged four years were presented in Table 1.

Table 1. Height and diameter growth of cempaka and mahogany.

No	Tree species	Height (m)	Diameter (cm)
1	Cempaka	9,35	5,57
2	Mahogany	7,95	6,08

Furthermore the impact of treatment on erosion showed that the highest erosion occurred at soil conservation technique in form of bed namely 0.1723 ton/ha while the lowest erosion occurred at soil conservation technique combined with vertical mulch, cauliflower, onion plant, cempaka and mahogany trees.

Establishment of wasian clonal forest where seedlings originated from clones should be encouraged to communities or private companies in order to produce high productivity plantation forest. The purpose is to fulfill increasing wood demand of wasian especially for export in form of “rumah woloan / traditional minahasa stage house”. Technology for

producing seedlings from clones is available such as for teak, eucalypts and mangium. Related to that effort, the government in this case Institute of Research and Development of Environment and Forestry (BP2LHK) Manado need to guide private company to produce superior vegetative seedlings through clones. Those superior wasian seedlings should be distributed to communities in subsidized price.

4.4. Plantation Maintenance

The success of forest plantation development among others determined by maintenance activities. In general, plant maintenance activities in the field include replanting, weeding, fertilizing. pruning and thinning. As widely known many forest rehabilitation projects and national greening week in the past that failed, due to lack of maintenance which were not timely and properly done. Recently, the government has stated that planting and maintenance is a package at least until three years old.

Beating up. Activity of beating up must be executed so that the volume of harvested timber later would be as much as expected at the beginning. The purpose of beating up is to replace dead trees, diseased trees, dying trees and trees that cannot grow normally or dwarf.

Beating up is done in the first year so that the difference between planted trees is not so much different. Seedlings to be used for beating up should be in good quality and not affected by pests and diseases. Their age should be the same with main plant. Beating up work is done during the rainy season so that sufficient water is available for the growth of beaten up trees

Weeding is done when around planted trees are already covered by weeds such as grasses, reeds and other wild plants. The area to be cleaned around tree approximately one meter so that main tree may grow faster. This activity is conducted every 3-4 months until 3 years old. It can also be done with stripe system where the stripe width is about 1 meter where main trees as its axis.

The purpose of tillage activity is to improve soil around tree base, so that tree growth will be accelerated. Seedlings which are moved to the plantation field from nursery with good environmental conditions and then transplanted to the field having conditions quite different from those in the nursery will affect the growth of young plants. Soil improving using hoes, and should be done carefully to avoid cutting or disturbing tree roots. Weeding is usually conducted every 3-4 months depending on weed condition and soil condition around plant. This activity should be executed at least until 3 years old. Weeding should be done according to maintenance frequency. If weeding and tillage activities are late or rarely conducted or not at all, then weed will disturb tree growth and may cause the trees died. Tree planting and maintenance must be made as a package at least until 3 years old.

Rompas (2016 pers.comm.) mentioned that maintenance of community-owned wasian plantations was usually done three times a year. Weeding activities at the location having wide enough areas often use grass cutting machine around main trees and along planting stripes. In fertile soils, weed plants, or wild grass, will grow faster and will compete for food with the main crop, or will cover and even making the main plant died. In connection with that, the

maintenance should be done at least until the age of three years, where at that age, main trees already exceeds the weed and is strong enough to compete with weeds.

In the community plantation forests usually farmers tended the plants diligently especially when plantation near to their houses. Under the plantation they also seasonal plants such as in Java island. In addition they also usually planted herbs for kitchen purposes such as Cayenne pepper, kapulaga, turmeric, lemongrass, and ginger, even vegetables such as beans, spinach, cucumber and cassava.

Figure 11. Kapulaga under sengon trees in Ciamis, West Java.

The use of dry leaf mulching (MDK). Maintenance of young plants up to three years old may also use of dry leaf mulch. Effendi (2012) mentioned how to use of dry leaf mulching (MDK) on young plants aged less than three years. In the field, there are many dried leaves around or in forests or around house yard. Those leaves were collected and brought to the site of the plantation. MDK is a cheap and environmentally friendly ways to maintain plantation. Newly planted seedlings until the age of three years or a height from 0.5 m to 3 m may be given MDK around the plant. The size of mulching about 1 m x 1 m with minimum thickness of 20 cm or more, the thicker the better. Large and long leaves like keruing, jabon and ketapang should be chopped becoming small size about 5-10 cm long.

Some benefits of using MDK:

- ✓ Suppress weeds around main trees. Weeds will not grow because covered by MDK
- ✓ Decomposed MDK will fertilize main trees, so the plants will grow faster. MDK will decompose about 6 months depending on thickness and type of leaf. After that MDK need to be added again or replaced as high as 20 cm.
- ✓ Application of MDK will reduce maintenance costs which are usually carried out 3-4 times a year but with MDK only twice a year.
- ✓ Environmental conditions around trees are moist, low temperature and not dry because sunlight cannot penetrate the soil. Below MDK there are many worms that make hole in soil causing better aeration.

Figure 12. Maintenance of *Ficus variegata* using MDK around tree base. Photo: Effendi, 2012)

Figure 13. Use of MDK at *Antocephlus macrophyla* plantation (Photo: Effendi, 2014).

Fertilizing. The purpose of fertilization on young plants so that the plants can grow well, because the conditions in the field is quite different nursery. Besides, the newly planted seedlings need sufficient nutrients to grow normally. Type of fertilizer commonly given to planted trees are manure and NPK fertilizer. The amount of cow dung manure ranges between 3-5 kg/hole, even up to 10 kg/hole.

Fertilization activities is conducted after weeding so that only main trees absorb fertilizer. Fertilizer application is used at the beginning of rainy season. The way to give fertilizer to the plants is described by Irawan and Purwanto (2012):

- Prepare fertilizer in accordance with dosage e.g. 100 grams NPK/hole
- Clean and weed surrounding tree canopy projection and make trench 5-10 cm deep surrounding tree projection
- Sow fertilizer in trenches and covered with soil to avoid fixation for phosphate and potash.

Fertilization of cempaka plantation aimed at giving better and faster growth. Fertilizer used are NPK fertilizers and duration of fertilization until the first three years of age (Sumijarto and Dewi, 2002).

In the fertile lands like in Minahasa, community forest plantation rarely use fertilizer, for cempaka wasian plantaion as the trees still grow even though not so good (Rompas, 2016. pers.comm.).

Pruning. The purpose of pruning is to get a high clear bole. In addition also aimed at obtaining a good quality stem. Pruning activity is carried out at the beginning of the rainy season, for example in teak (Effendi *et al*., 2015). Pruning is conducted to branch or small twig and should be done correctly to avoid a hole in the trunk. Wood quality is determined among others length of stems and no knots.

Until now pruning activity to community forests of wasian tree species in Minahasa, North Sulawesi, has not been done yet or only conducted limitedly by the community. It is

suggested that community should prune their wasian trees. The correct way to do pruning is presented in Figure 13.

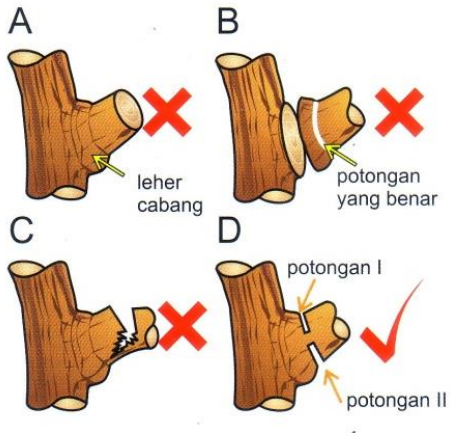


Figure 14. Correct ways of pruning (V) and wrong (X)

Thinning. In general thinning activity depend on tree growth , for fast-growing species, first thinning is carried out at age of 3-4 years old while for medium and slow growth thinning is conducted at 5-10 years (Hendromono *et al*., 2006). The purpose of thinning on plantations is to produce a good quality construction timber. Thinning of cempaka wasian plantation according Sumijarto and Dewi (2002) was conducted two times, first thinning was done 7 years old and the second thinning was done 11 years.

Based on field visits to wasian plantation managed by community in various locations, showed that thinning has not been done yet or only limitedly applied. One of reasons is lack knowledge about the importance of thinning to obtain large diameter stem. Thinning was only done by a few farmers who know the benefits of thinning.

4.5. Pests and Diseases

Almost all trees are attacked by pests and diseases. Seeds of cempaka wasian were disturbed by pest in the nursery. The pests include ants and mouse. In addition caterpillars also attack the seedlings. There are holes at attacked leaves (Irawan and Hidayah, 2013). Ants also attack fruit of wasian that fall to the ground or forest floor.

Diseases that attacks the seedling of cempaka wasian in the nursery among others damping off. The disease is characterized by withering of seedling stem and eventually will break. Damping off disease is caused less sterile of growing medium (Irawan and Hidayah, 2013). According to (Sumiajrto and Dewi, 2002) young trees of Cempaka wasian was also attacked by blight (phytoptora).

Field observations on wasian plantations managed by community in South Minahasa district has discovered a bump in the stem (see photo). Bump sizes vary between 1-3 cm in diameter. This needs to be studied further to know the effect of bump on wood quality of wasian.

Dead cempaka wasian trees were found at several locations. Those dead trees caused by a prolonged drought occurred in 2015. Diameter of those cempaka wasian tree ranged between 20-25 cm and a height of 10-15 m (see photo).

Figure 15. Bumps found on the stem of wasian in South Minahasa district

Figure 16. Dead wasian trees (back) due to long dry season in 2015.

Pests that attack wasian seedlings at sowing box namely ants and mice are controlled by placing the box in a location which is free or far away from ants and mice.

Damping off diseases is prevented by means of destroying the attacked seedlings to avoid spreading to other seedlings. Attacks by caterpillars are controlled by spraying chemical insecticides (Irawan and Hidayah, 2013).

Control of blight attack (Phytopthora) on young plants of cempaka wasian is done by using Indofin 85 sp. It can also be used Benlate fungicide. (Sumijarto and Dewi, 2002)

4.6. Financial Feasibility

Financial feasibility of Cempaka wasian community forests was carried out by Sumijarto and Dewi (2002).The location were at villages of Tandengan, Lansut, Runukan, Wasian and Pangolombian Minahasa district, North Sulawesi province. Obtained information related to potential of cempaka wasian community forest showed that 16 years old stand produced wood volume of 550 m^3/ha with 220 trees of remaining stand. Furthermore, based on financial analyses results they reported B/C ratio of 13.98, value of IRR 29.47% and NPV IDR 77.697.000. This means that the community forest business of cempaka wasian tree species is very viable with an interest below 29%. Appendix 6 gave detailed information on cost analyses and revenue of cempaka wasian community forest business in North Sulawesi. Comparing with clove as one of main plantations in North Sulawesi, cempaka species was still less popular. However due to a decrease in clove price, community started to consider cempaka wasian to be planted in large scale. They suggested to use community forest pattern as one of alternatives to be considered.

Wurangian *et al*., (2013) also conducted financial analyses of community forest using Government program of Village Seedling Garden or KBR. They analyzed in two scenarios i.e. With and without KBR program. Four analyzed tree species were mahogany, cempaka wasian , nantu and sengon.

The assumptions used especially for Cempaka wasian tree species were as follow:
• Planting was done in monoculture with 440 trees per ha.
• The price of wood IDR 2.500.000. per m^3 (2013).
• Harvesting age 16 years
• The total of production volume at the age of 16 years in good soil reach 550 m^3/ha with 220 trees/ha remaining stand (Kinho and Mahfudz, 2010) and mean annual increment reach 34.375 m^3/ha/year. The results of financial analyses were presented in Table 2.

Table 2. Results of financial analyses according to each scenario.

Scenario / Tree species	Interest rate of 8%			Interest rate of 12%		
	NPV	IRR	B/C Ratio	NPV	IRR	B/C Ratio
A. Community forest without KBR program						
1. Mahoni	32,246,425.39	23%	13.60	6,830,352.09	18%	8.74
2. Sengon	89,158,575.27	88%	19.75	55,870,693.95	81%	16.79
3. Nantu	83,020,967.81	45%	22.19	37,107,284.12	39%	16.66
4. Cempaka wasian	108,745,591.62	30%	39.01	29,319,430.96	25%	24.18
1. Mahoni	33,062,849.50	24%	15.02	7,591,611.24	19%	9.73
2. Sengon	90,195,955.24	95%	23.10	56,835,298.55	88%	19.71
3. Nantu	84,058,347.78	48%	25.42	38,071,888.71	42%	19.20
4. Cempaka wasian	109,782,971.59	31%	43.78	30,284,035.55	27%	27.37

Source: Wurangian *et al*., (2013)

Results of financial analyses showed that feasibility of cempaka wasian community forest business either with or without KBR program was feasible. This was shown in Table 11 where BC ratio value > 1 and high IRR values.

Wurangian et al., (2013) also concluded that the highest NPV at 8% interest rate is KBR activity using cempaka wasian tree species while at 12 % interest rate was sengon species. The highest value of IRR both with 8 % and 12% interest rate was the KBR activity using cempaka

wasian tree species. A combination of fast growing species (sengon) with medium growing one in community forest business may be applied.

Economic study and community based standard price of plantation forest product at three districts in North Sulawesi province was conducted by Mairi (2013). Three investment criteria, namely NPV, BCR and IRR were used in this study. Based on this study, it was concluded that the establishment of Community Plantation Forest (HTR) was feasible and profitable to be implemented.

Increasing wood demand in line with population growth and for export purposes, and reduced or very small timber production from natural forests, has resulted in an increase wood price in the market. Currently the price of cempaka wasian timber range from IDR 5,500,000 - IDR 6,000,000 per m^3 (Rompas, 2016. pers.comm).

Result of field visit to cempaka wasian community forest and interviews with farmers revealed that usually farmers will sell the trees after diameter reaching about 50 cm dbh or about 20-25 years old. Most of farmers and owners of cempaka wasian plantation generally in North Sulawesi also have large area cloves and coconuts gardens that they can harvest the crops every six months. At least there are two ways of selling the trees namely in form of standing trees or in form of sown timber i.e. boards and beams to build traditional house known as "Rumah Woloan". There are two villages that make "Woloan House/Minahasa traditional stage house" namely Woloan and Tombosian villages, may be more.

The price of sawn timber as told by the carpenters making the house was IDR.4, 600,000 per m^3 at the village, while the price in building material store may reach IDR5, 500,000 per m^3. The price of Minahasa traditional stage house varied according to size and carving. In Tombosian village the traditional house measuring 7 x 9 m is IDR 85,000,000. The house used knock down system. In Manado city if somebody buy the house farmers will rebuild the house without any extra payment it is included in the price of the house.

Figure 17. Newly made traditional wooden stage Minahasa house

5. GROWTH AND YIELD

One of goals in establishment of cempaka wasian plantation is to get a rapid stand growth and having good quality timber.

Measurements of cempaka wasian plantation growth having age variations of 4-34 years with 5 % sampling intensity in some locations has been conducted by Sumijarto and Dewi (2002). The results obtained in form of cempaka wasian growth in Minahasa district is presented in Table 3.

Table 3. Growth of height, diameter and volume of cempaka wasian

Age (year)	Height (m)	Diameter (cm)	Volume (m^3)
4	6.10	9	0.06
11	13.10	38	1.15
16	19.70	48	2.50Z
34	20.20	65	4.70

Source: Sumijarto & Dewi (2002)

Considering that growth data, cempaka wasian was then classified as medium growing species. Besides, the trees has also been harvested by the community at the age of 15-20 years. They also further informed the potential of cempaka wasian plantation managed by community in Minahasa District. At the age of 16 years with a total of 220 remaining tree stands, produced timber volume of 550 m^3.

Measurements to know the growth of cempaka wasian trees in community forest using intercropping patterns with cabbages, carrots, onions and sweet potato was carried out at location around mountain Masarang, Tomohon. Average growth data of height is 1.17 m per year and average diameter of 2.7 cm per year (Asir *et al*., 2007).

According to Langi (2007) at the age of 5-7 years height of cempaka wasian between 15-20 m height and its diameter between 15-25 cm, or mean annual increment (MAI) about 2-3 cm

Research to determine the increment of Cempaka wasian has been carried out at two locations namely Pinaras and Masarang, North Sulawesi by Lawe *et al* (2012). Climatic and environmental conditions at the two locations are presented in Table 4.

Table 4. Environment condition at Pinaras and Masarang

No.	Location	Altitude (m asl)	Annual rainfall (mm/yr.)	Temperature (^{0} C)	Humidity (%)	Organic material (%)	Soil fertility
1	Pinaras	665	3,048	22.7	90,28	1,5-1,83 (low)	Less fertile
2	Masarang	869	2,099	21.6	90,28	(2,12-2,15) (medium)	More Fertile

Source: Lawe *et al*., (2012)

Measurement results of eight years old empaka wasian plantation covering height and diameter were presented at Table 5.

Table 5. Average diameter and height of 8 years cempaka wasian Plantation in Pinaras and Masarang, North Sulawesi

No.	Location	Average Diameter (cm)	Average Height (m)
1	Pinaras	17 (15,7 – 18,7	14
2	Masarang	18 (16,7-20,7)	13 (12-14)

The results of analyses showed that the average diameter increment in Pinaras was 2.13 cm/year and in Masarang was 2.25 cm / year. While height increment for both locations are 1.75 m/year and 1.65 m/year respectively. Conclusion of the study indicated that increment in the two locations i.e. Pinaras and in Masarang was not different. In addition the factors at both locations namely soil fertility, different soil texture and growth site did not became obstacle to the growth of cempaka wasian tree species. Based on Table 7 it can be seen that the maximum annual diameter increment can reach 2.58 cm.

According Langi (2007) the growth of cempaka wasian in nutrient-rich forest areas, at the age of 6-7 years after planting its height in the range of 15-20 m (clear bole height 8-10 m) and diameter ranging from 15 cm to 25 cm. Furthermore, he also reported the average annual increment (MAI) as much as 2-3 cm.

Observation results of cempaka wasian stands at various ages and locations and tree position showed variations, both in diameter and height. Wasian trees that grow at plot edge and roadside, generally have a larger size of both diameter and height. This is because in these positions trees get more sunlight and more nutrients compared with trees located in the middle. Cempaka wasian trees that grow on the slopes overlooking the East generally has an average height greater than those at other place. The measurement results of diameter and height of cempaka wasian in several locations was presented in Table 6.

Table 6. Diameter and height of Cempaka wasian according to age.

Age (year)	Diameter (cm)	Clear bole height (m)	Total tree height
6	15	8	12
7	22	8	15
4-6	10-15	5-8	8-12
5-10	10-20	6-10	10-16
7	22	8	15
8	25	10	15
12	30	12	20
15	40	8	22
15	41	14	20
15	50,3	15	22

Source: Result of Field visit to North Sulawesi

In general the diameter growth is highly dependent on age, plant spacing, soil conditions whether fertile or not, and the position of the slope to the sun, which is facing the East will grow better.

Similarly, the position of cempaka wasian tree, if it is below or very close to sugar palm trees, or clove the tree grows not as fast as in the open. Wasian tree species belongs to full light demanders. Trees that are under other wasian tree will be depressed and has less normal growth

Figure 18. Monoculture cempaka wasian community plantation

6. HARVESTING, WOOD PROPERTIES AND WOOD USES

6.1.Harvesting

Cempaka wasian tree harvesting in community forests is generally carried out in accordance with the needs of the owners. This has causes tree harvesting is done before the age of maximum harvest. Even the harvest is also done at the age of about 15 years, so it is still a small diameter stem and still young trees.

Langi (2007) reported that harvesting of cempaka wasian trees in natural forests and in private forests in North Sulawesi, generally performed in a selective / selective cutting and planting. Timber harvesting is usually done when the wood has had a selling price, and generally at the age of 30-40 years, with a diameter at breast height of 60-100 cm. As for their own consumption harvesting is usually done at the age of 25-30 years with a diameter at breast height of 50 cm to 60 cm. Furthermore he also reported that the average production of cempaka wasian was 65 m3/ha/yr.

Research on models to estimate biomass and carbon in cempaka wasian community forest was carried out at two locations namely Masarang village and Tareran village, both at Minahasa district, North Sulawesi Langi (2007). The general characteristic patterns of community forests at Masarang and Tareran was presented in Table 7.

Tabel 7. General characteristic pattern of community forest in Masarang and Tareran.

Parameter	Characteristics of community forest stand	
	Masarang	Tareran
Species composition	More homogenous species, cempaka wasian dominant, other species small	Mixed species, combination of species, various rotation, fruit and seasonal plants
Canopy stratification	Stratified canopy	Multi strata stratified canopy
Planting pattern	Adapted to cempaka shade, artificial regeneration	Not depend to other species, artificial and natural regeneration for certain species
Main product	Cempaka wasian trees, sugar palm, and naturally grown other species	Cempaka wasian trees, and other tree species, short and long rotation and seasonal plants
Management practices	More intensive soil process, planting and maintenance but only dominant tree species.	Combination of intensive tillage and not tillaged, depend on topography, distance and soil type.
Topography	Flat, hilly 25-40% to steep, border with protection forest	Flat, hilly to steep (>45%)
Land ownership	Average of ownership wider minimum 1 ha. The location belongs to Foundation	Average ownership is smaller, minimum 0.25 ha

Source: Langi (2007).

The results of the study are as follows:
Model of selected allometric equations to estimate total biomass for cempaka wasian:

$Y = 0{,}1991D^{2.40}$, with coefficient of determination (R^2) = 99.2%.

Model of allometric equation to estimate total carbon uptake for cempaka wasian:

LogY = -1.21 + 2,55LogD, value of R2 = 99.2%.

He father reported the components of the largest biomass of cempaka wasian species was stem (58.5%), followed branches (13.5%), roots (10.5%), bark (5.8%), twigs (5.9%), leaves (5.3%) and fruit (0.5%).

6.2. Wood Properties

Cempaka wasian (*Magnolia tsiampacca*) according Ginoga (1987) is one of widely known timber trees in North Sulawesi. As for its properties belong to Strength Class II, Durability Class II-III; the wood density as reported by Lemmens *et al*., (1995) is between 310-500 kgandm3 at 15% moisture content.

Mandang and Pandit (2002) reported general characteristic and wood anatomical features of cempaka wasian as follows:

General characteristic: color of sapwood is white yellowish. Heartwood brownish yellow and gradually turned into to brown, its boundary with sapwood is clear, having homogenous complexion. Its texture is somewhat coarse, straight fiber direction, less shiny, touch impression slightly rough. The smell of fresh wood is somewhat fragrant. Wood strength is rather soft to rather hard.

Anatomical features: Pore/vessel: mingle, solitary, multiple radial and consists of 2-4 pores, and several clusters, its size rather small to small, its amount quite many. perforation stairs shaped, tilosis exist, there is usually a white precipitate. Paranchyme ribbon shaped, its distance irregular and far apart. Its radius is rather wide with rare – rather rare frequency and short sized

Veneer made from Cempaka wasian are good, and do not need pretreatment. Peel angle 900 30’ for 1.5 mm veneer thickness. Production of plywood, this tree species uses Urea formaldehyde (UF) and the produced plywood is waterproof and fulfill Indonesian National Standard (SNI) No.01.5008-2000, Japan (JAS) No.1639 and Germany (DIN) No.68705. (Puslitbang Hasil Hutan, 2009).

Puslitbang Hasil Hutan (Forest Product Research and Development) (2009) presented working nature of cempaka wasian as presented in Table 8.

Table 8. Working nature of cempaka wasian (*M.tsiampacca*)

Working nature	% free deform	Working class
Shaving	89.00	Very good (I)
Shaping	87.00	Very good (I)
Lathing	40.00	Moderate (III)
Boring	79.00	Good (II)
Sanding	90.30	Very good (I)

Source: Puslitbang Hasil Hutan, 2009.

Chemical components of cempaka wasian are as follow: cellulose 45.59%; lignin 29.99%; pentosan 18.50%; ash 1.55% and silica 1.50%. Solubility in alcohol benzene 11.86%; cold water 8.42%; hot water 8.92% and 1% NaOH : 19.93 %. The specific gravity of cempaka wasian is 0.43 (0.31-0.50). Shrinkage (%) from wet to air dry 0.67 (R); 1.19 (T); Shrinkage from wet to oven dry 2.93 (R); 5.16 (T). (Mandang and Pandit, 2002).

6.3. Wood Uses

The uses of cempaka wasian wood are many covering house buildings, plywood, furniture, wallboard, door and window frames, sports equipment, musical instruments, sculptures, carvings, handicrafts, luxury veneer, pencils, and molding, household furniture, ship building (deck) including desk Cano, boats, pole at freshwater, drawing tools and formatted wood. This species is not good for pulp/paper (Ginoga, 1987; Mandang and Pandit, 2002).

Cempaka wasian wood is also commonly used for making traditional stage houses known as "Rumah Woloan/Minahasa traditional stage house". Besides, wood of cempaka wasian is also used for kolintang. Kolintang is a typical organ music from Minahasa (North Sulawesi). This instrument has a wooden base and when beaten Kolintang can make a sound that is quite long and is able to hit the high notes.

Figure 19. Wooden traditional Minahasa stage house.

Figure 20. "Kolintang" wooden music made of wasian wood

7. CONCLUSIONS AND RECOMMENDATIONS

7.1. Conclusions

Cempaka wasian plantation forest managed by comunities in form of monoculture stand or mixed plantation may be found in most distrcits of North Sulawesi province. The area of those plantation varies between 1 ha – 10 ha. In general communities are willing to plant cempaka wasian in their land mixed with clove and coconuts as well as agricultural crops.

Based on field visit in some community forest plantations it was found that tree growth was quite large variation especially in diameter due to lack of maintenance e.g. thinning and pruning. Farmers usually planted their trees with 3 x 3 m spacing and thinning at five years time when tree canopy overlapped to each other were rarely done causing small diameter trees. In addition most of seedlings quality were not from certified selected superior source.

In general most of communities when established plantation forest did not fully followed the intensive silviculture techniques, that result in a low timber productivity. On the other hand wood demand for making "woloan house" for export increased.

7.2.Recommendations

1. In-situ and ex-situ conservation of cempaka wasian (*Magnolia tsiampacca*) natural forest area as well as in commmunity pantation forest in North Sulawesi. At present primary forest containing cempaka wasian is limited so it is urgently needed to appoint *in-situ* conservation area. *M.tsiampacca* is endemic species to Indonesia and only found in Sulawesi and Maluku. Tree breeding program to produce improved quality seed, normally requires among others genetic source from primary forest. In-situ conservation of cempaka wasian is also aimed at the sustainability of this species.

2. Establishment of superior seed source area. High productivity plantation forest is needed to fulfill increasing demand of wasian wood both for domestic use and export. Technology to establish superior seedling source area have been obtained such as for teak, eucalypts and mangium.

3. Manual of Wasian silviculture needs to be published. This manual is very important in guiding forest farmers in establishing plantation forest of wasian correctly, based on relevant research results and experiences. Recently plantation forests, including cempaka wasian, managed by communities have increased significantly in North Sulawesi and government should give guidance to manage them.

4. Certified cempaka wasian seedlings for plantation forest establishment need to be widely socialized by government. Communities are advised to use only certified wasian seedlings to be planted in their land to avoid disappointment at harvest time as

the result unqualified seedlings. Subsidized high quality seedlings may be provided by government so that farmers are able to obtain good seedlings.

5. Establishment of wasian clonal forest should be encouraged to communities or private companies in order to produce high productivity plantation forest. The purpose is to fulfill increasing wood demand of cempaka wasian especially for export in form of "rumah woloan / traditional Minahasa stage house". Technology for producing seedlings from clones is available such as for teak, eucalypts and mangium. Related to that effort, the government in this case Institute of Research and Development of Environment and Forestry (BP2LHK) Manado need to guide private company to produce superior vegetative seedlings trough clones. Those superior wasian seedlings should be distributed to communities in subsidized price.

6. Plantation system of multi strata mixed planting should be encouraged to community. Wasian tree species may be combined with coconut trees as the highest stratum, second stratum cloves (*Sizygium aromaticum*), nutmeg (*Myristica fragrans*), cinnamon (*Cinnamomum verum*) and sugar palm (*Arenga pinnata*) and lower stratum planted with fruits i.e. banana (*Musa paradisiaca*), papaya (*Carica papaya*), and the lowest stratum with corn (*Zea mays*), cayenne pepper and vegetables (ginger etc.). Coconuts, cloves and sugar palm (*Arenga pinnata)* are most widely planted commodities in North Sulawesi. They are used for copra, industry and traditional drinks ("tikus brand") and ethanol production respectively. This system can give income to forest farmers in short term, 6-12 months, for example cayenna pepper , corn, vegetables, fruits; middle term, every 6 months namely clove, sugar plant, coconuts and long term or final harvest in form of cempaka wasian timber. With this mixed plantation, farmers will visit frequently the plantation including cempaka wasian plantation. At the same time they will maintain the trees such as weeding, pruning and observing pests and diseases. Number and tree composition of cempaka wasian, coconuts, clove and sugar palms should consider market and topography. Cempaka wasian grow better and faster, at steep slopes facing East, while cloves and sugar palm, coconuts and other crops need flat or light slopes. In case there is no other crops (clove, sugar palm, corn etc.), usually cempaka wasian plantation rarely maintained by farmers, causing slow growing trees and there are many small diameter trees. Field visit at community forest plantation in North Sulawesi found many cempaka wasian plantation which were not well or less maintained.

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