A DOMESTICATION STRATEGY OF INDIGENOUS PREMIUM TIMBER SPECIES BY SMALLHOLDERS IN CENTRAL VISAYAS AND NORTHERN MINDANAO, THE PHILIPPINES

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1. INTRODUCTION

The importance of the preservation of the tropical rainforest is discussed all over the world (e.g., 1972 Stockholm Conference, 1975 Helsinki Conference, 1992 Rio de Janeiro Earth Summit, and the 2002 Johannesburg World Summit on Sustainable Development). Tropical rainforest has been recognized as one of the main elements for maintaining climatic conditions, for the prevention of impoverishment of human societies and for the maintenance of biodiversity, since they support an immense richness of life (Withmore, 1990). In addition sustainable management of the environment and elimination of absolute poverty are included as the 21st Century most important challenges embedded in the Millennium Development Goals.

The forest of Southeast Asia constitutes, after the South American, the second most extensive rainforest formation in the world. The archipelago of tropical Southeast Asia is one of the world's great reserves of biodiversity and endemism. This holds true for The Philippines in particular: it is one of the most important “biodiversity hotspots”\(^1\). According to Withmore (1984), Philippine forest represents 10% of worldwide flora as measured in species diversity.

Over the last century, primary forests in The Philippines have been destroyed mainly due to overexploitation by big logging companies and agricultural expansion caused by overpopulation. During the American colonial period (1901-1941), the government granted concessions to logging companies, encouraging them to establish new roads into the interior forest. These access routes to the forest facilitated and enlarged the occupation of the forest by the landless and overgrown population. During the 1960s and early 1970s, the Philippines and Thailand were the leading exporting countries of tropical timber in the world. In 1970, in the Philippines, the forestry sector was one of the major income earners, contributing 12.5% to the gross domestic product (GDP) (ADB, 1994). The situation changed in 1980s when forestry activities began to decline due to overexploitation and subsequent timber and fuelwood shortages. In 1990, the forestry sector’s share of the GDP was only 1.3 percent (ADB, 1994).

Currently, in spite of the existing logging ban in The Philippines, deforestation continues in residual forest, caused by agricultural expansion and small scale illegal logging. While half of the country area (16 million hectares) is categorized as forest land, estimates of the actual forested area in the country are 5.79 million hectares (FAO 2005) of which 0.80 million might be regarded as primary forest. According to Roshetko and Verbist (2000) The Philippines have no remaining undisturbed primary forest.

As consequence of the lost of forest and species richness, an unknown but probably large number of The Philippines’ endemic species of flora and fauna have become extinct or are currently threatened. These species richness, supplied Filipino people with a large diversity of environmental benefits and products including lumber, food, drinks, species and medicine. In 1992, it was estimated that 17 million Filipinos were dependent on forest resources, with half of them directly involved in forest cultivation practices (Quimio, 2001). Currently, the importance of forest resources still plays a fundamental role in farmers’ livelihood, especially for those living in the uplands\(^2\), were the degradation process are greater. Therefore, farmers are forced to collect and gather illegally products from the forest.

Tree plantations have been promoted as one of the solutions to the problem of deforestation and its negative socio-economic and environmental consequences. Several reforestation programs have been promoted by the government, international organizations and

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\(^1\)Biodiversity hotspots are biogeographic regions with more than 1500 species of vascular plants that are a reservoir of biodiversity and threatened to destruction (Myers et al., 2000).

\(^2\)Lands with gentle to steep slope (>30 %) hat extend from the zone between the coastal plain and the high mountains (Garrity, 1993). According to FAO,2005, it correspond with 70% of the total land area.
NGOs. This reforestation approach relies on the assumption that global pressure on natural forest would be reduced as man-made plantations satisfy world demand for tree commodities. However, the implementation of these reforestation projects has not been entirely successful.

Firstly, the role of smallholder farmers as successful land managers has not been genuinely recognized. Instead they have been historically considered, as the main agents of deforestation (Dove, 1992). Nevertheless, in many parts of the country smallholder farmers and local community groups have successfully managed forest and they have even established new tree resources on farms. It is interesting to point out, Ifugo community, in northern Luzon. These families have traditionally obtained timber, rattan and other economically useful forest products from their private forest stands, locally named as muyong\(^3\) (Zita, Orno et al, 1996).

Secondly, in these reforestation projects, the species composition of the original forest that covered the area prior to logging was rarely regarded. Thousands of hectares of the logged areas were transformed into monocultures of fast-growing exotic species (e.g. *Eucaliptus* sp, *Gmelina* sp, *Acacia* sp, *Swietenia macrophylla*). According to Schulte (2002), 95% of all reforestation projects utilized exotic species. Emphasis is still laid on exotic trees, usually introduced from South America, Africa and Australia, which are selected for their fast growth (Milan, 1996). In recent years, as deforestation and environmental degradation show no signs of abating, concern regarding the conservation status of most indigenous tree species has been growing.

In November 2005, a National Conference was organized by the International NGO Haribon Foundation to design a strategy for the massive planting with indigenous trees of 2 million ha across the Philippine archipelago. Moreover, the government, international agencies, research institution and NGOs have recognized the need to promote the use of a wider range of tree species, preferably indigenous trees, in reforestation and tree planting programs. In order to make planting materials widely available, The Department of Environment and Natural Resources (DENR) initiated a research program on the clonal propagation of Dipterocarps and other endangered trees. In addition, the wood processing industry has also recognized the need to develop plantations with a wider range of tree species, including indigenous trees, in order to reduce their dependence on imported timber.

As consequence of this global interest and aiming to solve the problems associated with the scarcity of trees in the uplands, World Agroforestry Centre (ICRAF) started in 1997 the domestication tree program focus on introducing trees on agrofororestry systems. Domestication is the naturalization of species to improve their use by human beings. It is defined as a human-induced evolution to bring species into wider cultivation through a farmer-driven or market-led process. Within development programs, genetic principles are taking into account but the key elements are human conditions and farmers’ preferences.

Since farmers have expressed a genuine interest in planting indigenous tree species for economic and conservation purposes and they have proved to be successful tree planters in many parts of the Philippines, the integration in existing agroforestry systems of economically-important Dipterocarps and other indigenous tree species may be a successful strategy for their conservation. However, there are several limitations identified with the domestication process. The main limitations are lack of available germplasm, lack of technical skills on the collection, germination and management of reproductive material, lack of knowledge about the species growth in agroforestry systems, lack of proper silvicultural management, difficult access to market and existence of national regulations that discourage timber tree planting.

This MSc Thesis is implemented in support of and within the context of a development

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\(^3\) A local term for a private forest manager by families with an area between 0.5 ha to 3 ha and comprised of secondary growth forest and associated commercial trees.
project entitled “Support for Decentralized Tree Seed Systems and Community-based Forest Management in the Visayas and Mindanao, Philippines”. The project is funded by the Spanish Agency for International Cooperation (AECI) and implemented by the World Agroforestry Centre (ICRAF). This study aims to propose a strategy to domesticate threatened timber value trees with conservation and profitability purposes. The strategy developed in this study aims to solve and propose alternatives to the aforementioned problems. The objective is to reach the most sustainable solution to conserve threatened species while ensuring food safety and improving farmers’ livelihoods. The integration of a wider array of indigenous timber trees in agroforestry systems will assist in satisfying farmers’ needs and increasing farmers’ income. Accordingly, their livelihood will be enhanced. In the same matter, a wider tree planting option will increase species richness contributing to species and genetic diversity conservation.

An analysis of the actual status of these timber trees, demand, germplasm handling, market and policies have been carried out. In the same way, alternatives to germplasm diffusion and distribution, tree management and tree breeding techniques are developed. Finally, early evaluations of the satisfaction that farmers present with the selected timber trees and the study of possible training activities and modes to extend the message are discussed.

2. CONTEXT OF THE STUDY AND RATIONALE

2.1. Biophysical context of The Philippines

The archipelago of the Philippines constitutes a total land area of 30 million hectares, and is located in the western Pacific Ocean, 1,210 km from mainland Asia and in between Taiwan and Borneo. It is composed of 7,107 islands; of which more than a 1000 are inhabited. The islands lie between 116°40' and 126°34' Eastern longitude, and 4°40' and 21°10' Northern latitude. They are bordered on the east by the Philippine Sea, on the west by the South China Sea, and on the south by the Celebes Sea.

The islands are divided into three groups: Luzon, Visayas and Mindanao. The Visayas island group is divided into three regions Western, Central and Eastern. Central Visayas region includes Bohol, Cebu, Negros Oriental and Siquijor and Eastern Visayas region includes Leyte, Southern Leyte, Biliran and Samar.

The Philippines is one of the greatest centers of botanical diversity in the world, with a higher level diversity than its surrounding countries. This rich biological diversity is attributed to the geological history of the islands. The main landmass in the Philippines uplifted 50 millions years ago because of the pressure that the north-ward moving Australian continent was generating against the Asian continent. About 25-30 millions ago, some islands arose above sea level independently of the mainland except Palawan and Mindoro that are the only islands that were originated as pieces of the Asian mainland.

About 140,000 years ago, during the Ice Age, sea level was 120m lower that it is today so many land bridges were established between some of The Philippines islands though they were always separate from the mainland, except Palawan which was connected to Borneo. Because of its independence from the Asian mainland, they had time and space to hide pioneer and rare fauna and flora that had to cross ocean straits to reach the Philippines.
Botanically, the Philippines are part of Malaysia (Flora Malaysiana), a floristic province that includes the Malay Peninsula, Indonesia, and New Guinea. Most of the Malaysian flora is derived from tropical Asia, including the dipterocarps (Dipterocarpaceae), which are the characteristic trees of the Philippine forests. Elements of the Antarctic flora, which originated in the ancient southern hemisphere continent of Gondwana, are also present, including ancient conifers like podocarps (Podocarpus, Nageia, and Sundacarpus) and araucarias (Agathis).

2.1.1. Forest types in The Philippines

The Philippines has two broad biogeographical regions: the east, which remains wet throughout the year, and the west, which has a dry season. The forests have been classified by climate and altitude into evergreen rainforest (81%), semi-evergreen forest (10%) and mountain forest (9%). Forest classification in this document is inline with Razal et al. (2003) that is based on species composition:

**Broad-leaved forests**

These are found at altitudes up to 800m above sea level and on well-drained soils along the lower slopes of mountains in areas where the dry season is not pronounced. Members of the family Dipterocarpaceae dominate this forest type. The species composition is based on Dipterocarpus validus, Dipterocarpus grandiflorus, Parashorea plicata, Shorea contorta, Shorea polysperma, S. almon, S. negrosensis, S. squamata, S. astylosa, and S. guiso. The Shorea and Parashorea listed before belong to the group known as lauan or Philippine mahogany in the trade.

**Mixed dipterocarp forests**

Five subtypes are recognized in the mixed dipterocarps forests:

**Lauan forest**: Dominant species are Shorea negrosensis, S. summates, S. polysperma, S. almon, S. contorta, Parashorea malaanonan and Dipterocarpus grandiflorus. This forest type occurs in
lowland areas and foothills up to an elevation of about 400m altitude where there is no pronounced dry season. Generally trees can reach 50m or more in height, however, in some areas like Mindanao, some grow no more than 25m with poor unbalanced crowns. In the eastern part of the country, where strong winds and typhoons normally cross, the upper canopy is uncharacteristically flat.

**Lauan-apitong forest:** Many species are deciduous and the forest type occurs in areas of low elevation where there is a pronounced dry season. Unlike the lauan subtype, the profile of this forest is not so tall, more open and has denser shrub and ground flora layers.

**Yakal-lauan:** Species are often deciduous to semi-deciduous and occur in areas with a pronounced but short dry season. This type is found mainly in narrow belts on low coastal hills of volcanic origin. The area covered by this forest type is small.

**Lauan-hagakhak:** Common in river bottoms and along streambeds; restricted to areas without a dry season and a high water table. *Dipterocarpus validus* is common.

**Montane forests:** Montane forests are located at elevations between 400-500m and 800-900m altitude with evenly distributed rainfall and high relative humidity. It is essentially a non-dipterocarp formation, *Shorea polysperma* and *Lithocarpus spp.* as main species with occasional *Hopea, Vatica, Agathis, Cinnamomum, Tristania* and *Eugenia* species.

**Mossy forests**

Mossy forests consist of stunted trees with trunks and branches commonly covered with mosses and liverworts and occur in areas with relatively low temperature, high and uniform humidity, short sunshine duration and strong winds. This forest type is found in high mountainous regions above montane forest. On the slopes and dry ridges of northern Luzon it is replaced by forests dominated by the indigenous pine species, *Pints kesiya*. Philippine oak (*Lithocarpus spp.*) is common but not commercially harvested.

**Molave forests**

Molave forests are dominated by *Pterocarpus spp.*, *Afzelia rhomboidea*, *Vitex parviflora* and *Dracontomelon dao*, and are commonly found in areas with very distinct wet and dry seasons and in the coastal areas on shallow and excessively drained limestone soils. Molave forests can be found in isolated patches or blend with the other forest types. The wood of the species listed is valued for its natural beauty and durability.

**Mangrove forests**

Mangrove forests are normally dominated by *Rhizophora apiculata*, *R. mucronata*, *Ceriops tagal*, *C. roxburghiana*, *Bruguiera gymnorrhiza*, *B. parviflora*, *B. cylindrica* and *B. sexangula*. Mangrove forests occur on tidal flat bordering coastal areas and along the rivers where water is saline. The forest is valued for its bark by the tannin industry and for fuelwood and charcoal making. In the upstream areas, where water is less brackish, nipa palm (*Nypa fruticans*) can be found as extensive and dense stands that are major sources of roofing materials in coastal areas.

**Coniferous forests**

Coniferous forests are found in the upper elevations of the Caraballo-Cordillera mountain ranges in northern Luzon, the Tarlac-Zambales mountain ranges in western Luzon, and the high mountains of Mindoro Island. Two pine species are found in The Philippines: *Pinus kesiya* (Benguet pine) and *P. merkusii* (Mindoro pine). The former is found at elevations ranging from 700 to 1800m altitude in northern Luzon, while *P. merkusii* is limited to 100 and 50 m altitude in
the northern Zambales and northern Mindoro. *P. kesiya* is valued as mining timber and tapped for resins.


<table>
<thead>
<tr>
<th>LAND USE TYPES</th>
<th>AREA (ha)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest</td>
<td>5,391,717</td>
<td>18.0</td>
</tr>
<tr>
<td>Old Growth Dipterocarp</td>
<td>804,900</td>
<td>2.7</td>
</tr>
<tr>
<td>Residual Dipterocarp</td>
<td>2,731,117</td>
<td>9.1</td>
</tr>
<tr>
<td>Closed canopy Pine</td>
<td>123,900</td>
<td>0.4</td>
</tr>
<tr>
<td>Open canopy Pine</td>
<td>104,000</td>
<td>0.3</td>
</tr>
<tr>
<td>Submarginal</td>
<td>475,100</td>
<td>1.6</td>
</tr>
<tr>
<td>Mossy</td>
<td>1,040,300</td>
<td>3.5</td>
</tr>
<tr>
<td>Mangrove</td>
<td>112,400</td>
<td>0.4</td>
</tr>
<tr>
<td>Brush-land</td>
<td>2,232,300</td>
<td>7.4</td>
</tr>
<tr>
<td>Other land use</td>
<td>22,375,983</td>
<td>74.6</td>
</tr>
<tr>
<td><strong>GRAND TOTAL</strong></td>
<td>30,000,000</td>
<td>100</td>
</tr>
</tbody>
</table>

### 2.1.2. Soils in The Philippines

In a brief and general mention, the Philippines has comparatively favorable soils in comparison to other tropical countries. They have volcanic, limestone or alluvial origin. The soils are generally not too weathered due to their relatively young age and origin even though nutrient wash exists. According to the USDA system Philippine soils are mostly classified as Ultisols and Oxisols. Oxisols are characterized by their low fertility and poor water retention. Their surface is poor in K, Ca and Mg because of the rain washing. Ultisols contain no calcareous material anywhere within the soil, have less than 10% weatherable minerals in their argillic horizon, and have less than 35% base saturation throughout the soil. Both soil groups can be very sensitive to compaction and are characterized by their inadequate supply of P, low pH, low cation exchange capacity and high exchangeable Al. Steep slopes, high precipitation, and frequent, extremely heavy rainfall over short periods due to typhoons cause serious soil erosion in some places.

### 2.1.3. Climate in The Philippines

The local climate is tropical humid. The average yearly temperature is around 26.5°C. The relative humidity averages at about 77%. The Philippine climate is generally characterized by four climatic types in terms of the relative duration and intensity of the wet and dry periods in different parts of the country.

- **Type I** climate has a pronounced wet period from May to November, and a dry period from December to April. Type II climate is characterized by no clear dry season, and maximum rainfall is experienced from November to January. Type III climate is characterized by no distinct wet and dry seasons but is relatively dry from November to April. Type IV climate has rainfall more or less evenly distributed throughout the year. The rainiest times are from June to October, with typhoons not uncommon during this time. The average rainfall in the lowlands is about 2030 mm per year.

The Philippines is visited by an average of 20 typhoons a year, which mostly occur in the eastern and northern portions of the archipelago. Typhoons, which are often accompanied by intense rainfall and strong winds, usually occur from June to October. These cause significant yield losses during the wet season, the growing period for most crops and occasionally they cause disasters as the typhoon Durian did recently. Also as a consequence of the Philippines position on the northwestern fringes of the Pacific Ring of Fire, frequent seismic and volcanic activities
causing earthquakes, tremors and landslides are experienced.

2.2. Socioeconomic context of The Philippines

The Republic of the Philippines is identified as a developing country with an agricultural base, light industry, and service-sector economy, according to the Human Development Index (comparative measure of life expectancy, literacy, education, and standard of living). The agricultural sector represents approximately 39% of the working population while industry and services represent 15% and 46% respectively. Rice, corn, and coconuts take up about 80% of all cropland. Sugarcane, sweet potatoes, manioc, bananas, hemp, tobacco, and coffee are also important as cash crops. Carabao (water buffalo), pigs, chickens, goats, and ducks are widely raised as livelihood support. Fishing is also a common occupation representing a big support to coastal families.

Table 2: Agricultural Production by Type of Crop. 2003 to 2005 (x '000 tons) Source: Philippine government (http://www.nscb.gov.ph)

<table>
<thead>
<tr>
<th>Crop</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quantity</td>
<td>Value</td>
<td>Quantity</td>
</tr>
<tr>
<td>Total</td>
<td>71,311.9</td>
<td>330,702.3</td>
<td>75,150.7</td>
</tr>
<tr>
<td>Cereals</td>
<td>18,115.5</td>
<td>150,529.2</td>
<td>19,910.2</td>
</tr>
<tr>
<td>Rice</td>
<td>13,499.9</td>
<td>117,989.0</td>
<td>14,496.8</td>
</tr>
<tr>
<td>Corn</td>
<td>4,615.6</td>
<td>32,540.2</td>
<td>5,413.4</td>
</tr>
<tr>
<td>Major Crops</td>
<td>49,779.5</td>
<td>148,872.7</td>
<td>51,808.6</td>
</tr>
<tr>
<td>Perennial</td>
<td>21,145.7</td>
<td>94,240.3</td>
<td>21480.7</td>
</tr>
<tr>
<td>Annual crops</td>
<td>27,924.5</td>
<td>45,997.9</td>
<td>29,599.4</td>
</tr>
<tr>
<td>Vegetables</td>
<td>709.3</td>
<td>8,634.5</td>
<td>728.5</td>
</tr>
<tr>
<td>Other Crops</td>
<td>3,417.1</td>
<td>31,300.2</td>
<td>3,431.9</td>
</tr>
</tbody>
</table>

The contribution of the industrial forest sector to the national economy has declined dramatically in recent years; in 2002, it only represented 0.05 % of the GDP (FAO, 2005). Nowadays the Philippines have become a net importer of timber from Malaysia, Indonesia, Sarawak, Papua New Guinea and the Solomon islands with the purpose of supplying local demand. According to ITTO, 2005, the country imported a significant volume of timber that represents 346.000 m$^3$ of logs, 338.000 m$^3$ of sawn wood and 93.000 m$^3$ of veneer.

Table 3: Evolution of the forestry sectors contribution to the GDP.

<table>
<thead>
<tr>
<th>Year</th>
<th>GDP</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>12.5%</td>
<td>PCARRD, 1994</td>
</tr>
<tr>
<td>1988</td>
<td>2.3%</td>
<td>PCARRD, 1994</td>
</tr>
<tr>
<td>1990</td>
<td>1.3%</td>
<td>ADB, 1994</td>
</tr>
<tr>
<td>2002</td>
<td>0.05 %</td>
<td>FAO, 2005</td>
</tr>
</tbody>
</table>

Besides the current low quantity of commercial timber, there are also other resources that help in increasing the GDP such as minerals like nickel, zinc, copper, cobalt, gold, silver, iron ore, and chromate and nonmetallic minerals including rock asphalt, gypsum, asbestos, sulfur, and coal. Limestone, adobe, and marble are quarried, and petroleum is also drilled.

Overpopulation is a reality in the Philippines. In July 2005 the population estimation was
87,857,473 inhabitants with a population density of 276 citizens/km² ranking the Philippines as the world's 13th most populous country. Population growth lies at a rate of 1.84%. Furthermore, the population is unequally distributed: according to FAO (2005), an estimated 18-20 million people are dependent on 7.2 million hectares of forest lands (not all of which are populated) for subsistence uses and traditional and customary life style. Rural-urban migration is clear, and 41% of the population is urban.


**Figure 3:** Demography in The Philippines (1961-2003). Y-axis represents the number of inhabitants in thousands and the X-axis the year. Source: Data FAOSTAT, year 2003.

### 2.3. Forestry history of The Philippines

#### 2.3.1. Traditional Forest Use

For thousands of people in The Philippines, the forest plays a crucial role in providing the local population with food, timber, fuelwood, ornamental plants, resins, construction materials and medicines among others. Historically, the forest use consisted of hunting, gathering fruits and edible forest products, pastoral activities and shifting cultivations. *Kaingin*[^4] is a land management system used for centuries in tropical and in temperate countries (Myers, 1980). It is based in a cycle of three steps: firstly, clearing and burning the forest; secondly, a cultivation period (often two or three years) and finally a long fallow period (often decades) to restore soil fertility and forest regeneration. This kind of system requires large areas for each farmer, as an individual site may be used for only 2-3 years during a period of 20-30 years (Kellmar, 1974) and it is characteristic of low population density with migratory behavior. Although forest vegetation is cleared and burnt, the practice also involves the selection and deliberate conservation of useful trees, roots and seed stock necessary to ensure re-growth during the fallow period (Conklin, 1957). Traditional shifting cultivation in The Philippines is shown to have hardly any negative side effects since it fulfills long fallow periods and maintains species biodiversity (e.g. Hanonoo tribes cultivate about 430 different crops, frequently intercropping 40 species at the same time).

Nowadays, due to socioeconomic and political changes, important modifications in the way traditional shifting cultivation is practiced are taking place. Due to the rapid population growth and sedentary behaviors, fallow periods get shorter and number of species used decreases, causing a continuous soil nutrient depletion and erosion process that reduces crops yields, increase weed infestation (e.g. *Imperata cylindrica*, *Saccarium spontaneum*) and eventually lead to the

[^4]: Local term for shifting cultivation or slash and burn practices.
abandonment of the field and the clearance of more forest (Ruthenberg, 1980). A migration caused by land settlement programs and the expansion of commercially oriented activities (e.g. logging, large-scale plantations or mining) is an additional component that increases unsustainable shifting cultivation practices.

In addition, most of the land in The Philippines is hilly mountainous; 53 % of the country or 15.8 millions ha is classified as uplands or lands with slope greater than 30 % (FMB, 2002). Increasing rate of population pressure, limited technical skills, unavailability of alternative livelihood, poor access to market and capital, and other form of public services among others, affect the upland communities, leaving them at the dilemma of conservation or destruction of the resources. Migrants started to move into the uplands as early as the late 19th Century but a massive influx began in the 1960s and peaked between 1980 and 1985, when a net migration rate of 14.5 percent was recorded (Cruz et al. 1992). Most migrants were driven into the uplands by landlessness and a dearth of employment opportunities. Limited knowledge of the upland ecosystem and limited land for cultivation prevents them from practicing appropriate farming techniques such as allowing for fallow periods. Moreover, insecure land tenure, given that main ownership of forest is the state having 89.5% over 10.5% of private property that mostly belong to landlords, is another key factor in aggravating the situation of the forest dwellers dilemma.

Consequently, currently shifting cultivation is a harmful activity that contributes to deforestation and environmental degradation. Kaingiteros are the direct elements that incite deforestation but there is no sense in blaming them since poverty, no land tenure and other sociopolitical situations are the final components that cause this situation.

2.3.2. Forest exploitation and deforestation

Extensive land use such as logging practices, expansion of monoculture plantations, shifting cultivation and increasing demand of land due to popular pressure, are the main causes of forest surface decrease. In developing countries the annual losses of forest exceed 14 millions of ha per year and most of them occur in tropical areas (UN, 2005).

Originally, few countries in the world were more covered with rainforest than The Philippines. When the Spanish arrived in The Philippines in 1521, scattered coastal and some interior areas had been cleared for human settlement but still the forest cover was about 90% of total land (Wernstedt and Spencer, 1967). The first study of forest resources, logging regulations and forest planning took place in the year 1863 when the Inspección General de Montes was carried out by the first Forestry Bureau under the Spanish administration. In 1887, logging even became a crime when the Spanish government set a total logging ban on forest resources, prohibiting any kind of operation within the forests without prior formal permission (Neuberg, 2005). According to Heaney (1998), the main factors of this deforestation process were: the arrival of large-scale export based plantation agriculture (especially sugar cane, abaca and tobacco) and the arrival of modern medicine (specifically the smallpox vaccination) allowed more people to live and increasing the population by 5,000 people since the arrival of the Spanish to the earlier 1800s. At the end of the Spanish occupation, rainforest covered 70% of the country.

During the American colonial period (1898-1945), the forest was cleared mainly by logging companies and the establishment of large-scale plantations. The government maintained centralized control over forest resources and large-scale commercial exploitation began with the allocation of concessions within the public domain (Lynch, 1986). The increase of the deforestation rate was identified as the result of shifting cultivation practices and the farmers were considered as destructive agents for the forest. The establishment of the Bureau of Forestry under the US military government strengthened the existing Kaingin Law and the Kaingineros and other forest dwellers were punished and driven out from forest areas, leaving them out of the
management of the forest resources on which they depended.

The most dramatic events took place after World War II, the rapidly growing and impoverished rural population expanded into the forest due to the surge in agricultural demand, causing vast exploitation of the Dipterocarp forests. During the war period 85% of the reforestation plantations that were established since 1910 were destroyed. In the 1950’s and 1960’s, the Philippines were the first producer of tropical woods in the world, until resources were exhausted and companies had to move to Indonesia (Marcon, 2001). According to Hurst (1990), the period of 1960-1970 represented the most intensive rate of timber extraction that has ever occurred in the world. The causes of these extractions were the increase of the international timber demand and the governmental corruption that facilitated it for an insignificant price. Large-scale, low-tax logging concessions were given to elite groups with influence over the government, which worsened the situation. During this period “Philippine mahogany” was a famous international trade name for high quality timber mainly of the genus *Shorea* within the *Dipterocarpaceae* family.

Between 1950 and 1980, forest cover declined from 50% of the country’s surface to less than 27% (Kummer, 1992). As a result of declining timber resources a log export ban was imposed in 1986 followed by a total logging ban implemented under *NIPAS law* leading to a gradual abandonment of large logging companies. By the end of the 1990s, the Philippine government estimated forest cover to be 5.4 millions ha, or a mere 18% of the country’s total area with only 0.8 millions ha of primary forest remaining (DENR, 2005).

By 1997, the percentage of the remaining forest had dropped to 7%. Its decline in old-growth forest from 70% to 7% in less than a century is likely the most rapid and severe in the world (Heaney, 1998). Deforestation at this scale increases the reduction of biodiversity, soil degradation and soil erosion. Furthermore it decreases productivity and supports the *Imperata* unproductive grassland.

### 2.3.3. Sustainable forest management and reforestation approaches

Reforestation is defined by the DENR-FMB (2003) as the act of planting trees on bare or open land which used to be covered with forest growth. It includes ecological reforestation and economic reforestation, new plantings, assisted natural regeneration and enrichment planting (RMPFD, 2003). The reforestation approach relies on the assumption that by means of man-made plantations, the pressure on natural forest can be reduced. Locally, planted trees help to conserve the soil of the fields providing farmers with tree products as a way to diversify on-farm income as the same time that reducing farmers needs for clearing forest.

The first reforestation in The Philippines took place in 1910, when the Forest school of the College of Agriculture in Los Baños, Laguna established a forest nursery to cultivate seedlings in order to reforest the degraded surrounding. By 1914 some species were tested for planting as is the case of *Swietenia macrophylla*, a species introduced from America. In 1916, modest reforestations were done in Cebu Island followed by three more projects in Ilocons and Zambales. Full scale

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5 *NIPAS* (National Integrated Protected Areas System) law was created and implemented by DENR in 1991. It is the classification and administration of protected areas according to categories to maintain their natural conditions as much as possible. It prohibited logging in areas above 50% gradient slope and 1000m of altitude as well as the exportation of semi-processed wood products as lumber.

6 *Imperata cylindrica* is a graminoid native from Southeast Asia. This grass is considered as an aggressive plant, it has invaded every continent except Antarctica and it is listed as invasive species in many areas. It is particularly a problem in high rainforest areas of South-East Asia and there are an estimated 35 millions ha of Imperata grassland in Asia (Garrity et al, 1997). Besides, it has ecological adaptations that make it difficult to eradicate it.
reforestation started within 1937-1941 given that the government had substantial funds for new reforestation projects. According to Agpaoa et al. (1976) prior to World War II, an area of about 28,000 ha had been reforested within 35 projects. In spite of this reforestation effort, the war brought enormous destruction to the reforested areas, mainly caused because people found refuge in the reforestation projects during the Japanese occupation clearing extensive areas to produce crops with the aim of ensuring their survival.

A vigorous reforestation program started in 1960 subsequent to the creation of the Reforestation Administration under the Department of Agriculture and Natural Resources. Reforestation efforts on logged-over and denuded areas were carried out by private and governmental initiatives. Even though in the early 60s tree planting increased 10,000 ha per year, neither private nor governmental-sponsored reforestation programs contributed significantly to the rehabilitation of deforested lands. The main cause of this was because even though detailed guidelines for forest management (Timber Licence Agreements7) were beginning to be adopted, the control of these TLAs was given to the political elite and they were hardly ever applied (FAO, 2005). Also, large scale industrial forest plantations have often created social conflicts due to the eviction of the rural population from areas they previously occupied. As a result, plantations were usually burnt or destroyed.

In the 1970s, the Industrial Tree Plantation Lease Agreement (ITPLA) funded by the World Bank, provided loans in support of farmers’ tree growing and forest plantation activities (Jurvélius, 1997). The first major industrial plantation initiative began in 1972 with the establishment of the Paper Industries Corporation of The Philippines (PICOP), established to supply a pulp and paper mill at Bislig, Surigao Del Sur.

**Community Based Forestry**

In 1974, with the formulation of the Forestry Reform Code social forestry programs started to take into account communities and dwellers of the forest. They attempted to abolish short-term permits to the industrial forestry sector, improve tenure security for settlers occupying public land, and grant 10 to 25 year licences for the establishment of forest plantations.

Between 1975 and 1980, the Forest Management Bureau (FMB) initiated 3 more social forestry programs:

- The Forest Occupancy Management (FOM) program which issued forest land occupancy permits for farmers and regulated land-use practices so farmers could not expand into the forest;

- The Communal Tree Farming (CTF) program promoted through cooperation between government agencies, local communities and private sector established tree farms;

- The Family Approach to Reforestation (FAR) where the FMB had short-term contracts with families to establish tree plantations with agricultural crops (agroforestry systems) on public lands with the aim of increasing farmers income generation (Bertomeu, 2004).

This approach to Social forestry was not successful since the key factors concerning farmers’ needs (e.g. secure land tenure) were not considered.

Another approach took place in 1982 with the creation of the Social Forestry Division by

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7 TLA (Timber Licence Agreement) required holders to reforest an area of denuded land equivalent to the selectively logged area and to engage in industrial tree plantation (ADB, 1994) and stipulated that logging operations should be conducted according to a system of selective logging (FAO, 2005).
the FMB. It was responsible for the implementation of the Integrated Social Forestry Program (ISFP), a program that addressed the issue of land tenure insecurity by providing individual and communal contracts for 25 years renewable to another 25 as certificates of Stewardship (CSC).

Some years later, in 1986, a new participatory reforestation program was initiated by the DENR. This National Forestry Programme involved rural communities, families, NGOs and corporations in reforestation activities. But the interest of local communities was quickly turned aside in 1992, because of the established logging ban. Private corporations and investors were encouraged to participate in sustainable forest management and reforestation through the Industrial Forest Management Agreement (IFMA) to ensure the sustainable supply of wood and other forest products.

The failure was that local populations were not directly involved in the process and their skills and capacities were not taken into account as key elements of successful strategies for the development, utilization and conservation of forest resources. Even without the direct support of the government, farmers have demonstrated interest in planting trees. The evidence of this is that there has been a spontaneous farmer-driven increase of tree cover on degraded grasslands, such as the planting of fruit and timber trees by farms in northern Mindanao (Garrity et al., 1995).

Furthermore smallholder farmers are producing substantial amounts of timber on private land outside the government purview. Farmers planted short-rotation trees such as *Gmelina arborea* and *Acacia mangium* among few others, and some medium-rotation premium timbers such as *Swietenia macrophylla* (mahogany), *Eucalyptus spp., Acacia spp.* (Schulte, 2002). A decade later, when planted trees started to reach harvestable age, small-scale timber processing and marketing flourished in many regions, supplying large-scale wood processors and industries with farm-grown timber (Garrity and Mercado, 1994).

Since farmers have proved to be successful tree planters, smallholder forestry has been proposed as a viable alternative to costly government-driven reforestation programs (Pascicolan et al., 1997). In 1995 the Community based Forest Management (CBFM) Program was initiated as a National Strategy where indigenous people play a crucial role in CBFM implementation in areas they claim as ancestral domain. DENR formulated guidelines and undertakes the identification, delineation and recognition of ancestral land and domain claims through Department Administrative Orders 93/02. Under CBFM, organized communities operate within allowable-cut limits set by the government. They harvest timber and other forest products to sell, use for their own needs, or to process. With this program DENR aims to place the 58% of the Forest National Area under community based management (DENR, 1998) as an attempt to bring about sustainable forest management. It seems that by 2007 the TLAs will be phased out and CBFM arrangements will become the norm, demonstrate by the fact that in December 2003, CBFM projects covered 5.97 million hectares (FMB 2005) while the 13 active TLAs covered 544,000 hectares in February 2005.

Currently, considerable efforts have recently been put into the development of community forestry, as an approach to deal with poverty (e.g. lack of economic development in upland and forest-dwelling communities) and restoring the country’s degraded landscapes (particularly on steep slopes) but according to FAO, 2005, the success of this approach remains to be proven. In the last decades, the establishment of private industrial forest plantations and reforestation with the involvement of the rural people has been the main goal of the forestry programs of the Philippine Government. Large-scale planting of timber trees is seen as an approach to rehabilitate degraded public forest lands, provide jobs and income to rural families and produce raw materials for the wood industry (DENR-ERDB, 1998). In spite of these efforts, reforestation success has been low. The Food and Agriculture Organization (FAO) of the United Nations (UN), in its 2003 report in The State of the World’s Forests, places The Philippines’ annual deforestation rate at -89,000 ha/year from 1990 to 2000 while the DENR, doubtfully, claim that from the same period the reforestation rate has been 68,379 ha/year.
Incentives\textsuperscript{8} for the establishment of tree plantations seemed to be designed for private firms and large plantation states. Contrastingly, small-scale farmers who just wanted to harvest and market their planted timber trees had to find their way through a labyrinth of registrations, rules, and regulations.

In 2003, the RMPFD, Revised Master Plan of Forestry Development, summed up the situation when it reported that “the main objective of past reforestation programs / activities before 1987 was unclear and focused only on watershed rehabilitation and protection. Areas reforested were both for protection and production purposes. There was no distinction between protection and production forests. By and large, past reforestation efforts before 1990 were considered a “total failure”.

Moreover, in terms of appropriateness of species, most of the reforestation approaches concentrated on exotics species. Exotic species were almost exclusively selected even though indigenous species were generally available. The usual reasons were: Ignorance of the propagation and silvicultural possibilities of native species; the (foreign) manager’s experience with certain exotics; and the promised high yield of the “miracle trees” (Schulte, 2002). It is obvious that these monoculture plantations were not a sufficient answer to the Philippine forestry problem as well as the wood quality of those species being inferior to that of the native Dipterocarp trees.

At any rate, nowadays, the government, industry and NGOs have recognized the need of raising the ratio of indigenous species plantations to exotic ones. But the real situation is that when looking at the Visayas region; it is very difficult to encounter large or even medium sized reforestations of native tree species (Schulte, 2002).

**Current forest situation**

In spite of all these programs and efforts, nowadays, The Philippines is one of the most deforested countries in the tropical world.

**Table 4**: Philippines forest cover comparison with diverse tropical countries, 2005.

| Country     | Area ha (x '000) | Forest cover 2005 ha (x '000) | % Primary forest cover 2005 ha (x '000) | % Total area % of 1990 Deforestation 90-05 |
|-------------|-----------------|-------------------------------|----------------------------------------|------------------------------------------|------------------------------------------|
| Malaysia    | 32.975          | 20,890, 63.6                  | 3,802, 11.6                            | -6.6                                     |
| Congo       | 34.200          | 22.471, 65.8                  | 7,464, 21.8                            | -1.1                                     |
| Nigeria     | 92.377          | 711,089, 12.2                 | 326, 0.4                               | -35.7                                    |
| Philippines | 29.897          | 7,162, 24                     | 829, 2.8                               | -32.3                                    |
| PapuaNG     | 46.284          | 29.437, 65                    | 25,211, 13.7                           | -6.6                                     |
| Peru        | 128.522         | 68,742, 53.7                  | 61,065, 47.5                           | -2.0                                     |
| Brasil      | 851,488         | 477,698, 57.2                 | 415,890, 48.8                          | -8.1                                     |

In The Philippines, estimates of the actual forested area in the country are 7,162,000 ha according to DENR and 5,790,000 according to FAO. Both agree on primary forest cover with 829,000 ha corresponding to 19.41% (DENR) and 11.57% (FAO) of primary forest cover over

\textsuperscript{8} According to (ITTO, 2001); in The Philippines forest plantation establishment enjoys the following incentives:
- Income tax holidays
- Tax & duty free importation of capital equipment
- Tax credit
- Deduction of labour expenses after the tax holiday
- Exemption from wharfage dues and export taxes and duties
- Exemption from contractor’s tax
total forest area. Philippine forest cover keeps decreasing since deforestation rises over reforestation rates. Currently annual deforestation runs at about 2.48% while according to FAO (2004) during the 90s the annual deforestation rate was 1.4%. The key factor that is increasing this rate is the widespread illegal logging activities throughout the country that started to be obvious after the establishment in 1992 of the current logging ban.

![Graph showing changes in forest cover over time.](image)

**Figure 5**: Changes on The Philippines forest cover rate, 2005.

Nowadays in The Philippines, areas with slopes greater than 18% are classified by law as forest lands and areas with gradients less that 18% are officially declared as alienable and disposable (A&D) land or suitable for agricultural purposes. This land will remain part of the nation’s permanent public forest estate according to Section 15 of the Revised Forestry Code of 1975. According to FAO, 30–35% of the Philippine territory that has slopes greater than 18% are presently classified as A&D land. Conversely, as much as 28% of the classified forest lands have slopes less than 18%. This ambiguity and confusion in the existing system of land laws is affecting the integrity and security of the forest.

Concerning species richness, The Philippines have around 1196 known species of amphibians, birds, mammals and reptiles according to figures from the World Conservation Monitoring Centre. Of these, 45.8% are endemic, meaning they exist in no other country, and 14.7% are threatened. The Philippines are home to at least 8,931 species of vascular plants, of which 39.2% are endemic and 5.1% of them are protected under IUCN categories I-V. An extension of 6.85 million ha has been established as protected area as represented in Table 5.

**Table 5**: Extent of protected areas in the Philippines, 2006. Source: www.fao.org

<table>
<thead>
<tr>
<th>Protected areas</th>
<th>6,850,000 ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>IUCN protected-area categories</td>
<td>1,540,000 ha</td>
</tr>
<tr>
<td>Lowland evergreen broadleaved rainforest</td>
<td>246,000 ha</td>
</tr>
<tr>
<td>Unclassified forest</td>
<td>835,000 ha</td>
</tr>
<tr>
<td>Not forested</td>
<td>4,229,000 ha</td>
</tr>
</tbody>
</table>

Currently, the government and nongovernmental organizations aware of the state of their resources are implementing and increasing national initiatives support on planting indigenous tree species.
**Rainforestation farming initiative**

As an alternative to the failed national reforestation programs the DENR adopted in 2004 the *Rainforestation* initiative to restore denuded forest areas. The Rainforestation approach is a farming strategy that was developed by Leyte State University (Margraf and Milan, 2004) through a joint research project of the Philippine-German Applied Tropical Ecology Program. Their aim is to imitate original forest structure and processes using native trees species, reforest and develop closed canopy and high diversity forest farming systems. It is a concept in forest restoration where only indigenous and endemic tree species are used as planting materials but not limited to dipterocarp species or premium timber. The goal is to preserve biodiversity and expand Philippine forest and simultaneously sustain human food production.

This program is a very laudable initiative where the ecological factors are well designed and developed, the only complexity is that the social approach is not always feasible and achievable when it is applied on farming lands, within populations that depend on agricultural products for their livelihood and subsistence. To ensure the continuance of projects it is essential to address the local economic needs and to provide for the involved farmers with viable economic returns.

### 2.4. Agroforestry initiative and tree domestication

Agroforestry is a good alternative in the reforestation approach. However, the government has not recognized these practises as a option to address the issue. It is defined by ICRAF as “A land-use system in which woody perennials (trees, shrubs, palms, bamboos) are deliberately used on the same land management unit as agricultural crops (woody or not), animals or both, either in some form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economic interactions between the different components”.

![Figure 6](image)

*Figure 6:* represents a classification of the Agroforestry systems based on the type of component: Agrisilviculture: Crops (including shrubs/ vines) and trees. Silvopastoral: Pasture/ animals and trees. Agrosilvopastoral: Crops, pasture/animals and trees. Source: Nair , 1985.

The key characteristic in agroforestry systems is the capacity to optimize the production in the territory across a diversified land-use in which the trees have a fundamental role. This role consists of providing diverse products (e.g. timber, food, fodder, fuelwood, organic matter, medicine, oils, resins, latex, and pulp for paper) and services (e.g. conserve soil fertility, increase sequester carbon, increase product diversity).
Agroforestry aims to be a poverty alleviation strategy. Recalling, this was the essence of the Brundtland Commission Report, 1987, which argued that poverty and environmental degradation are joint issues that should be on the agenda for development. This set of land-use practices that agroforestry propose are oriented to be a good alternative allowing profitable activities with degraded natural resources in areas that have been altered by human influence by means of efficient economic management that minimizes disruption to ecologic stability. Therefore the sustainability of the production system is reached with a consequent income increase in farmer’s livelihood. In The Philippines, agroforestry has been proposed as sustainable land use and an alternative to expensive and ineffective reforestation programs.

Agroforestry systems are efficient if they fulfill three principles: fertility restitution, permanent soil protection and diversification. Fertility restitution is reached when the existent vegetation contributes organic matter and nutrients. The soil in the forest is fertile due to the high biomass quantity given by the prominent vegetation. In non-forested areas without proper vegetation cover, nutrients and organic matter input decrease and the soils loose fertility. In an efficient agroforestry system, trees contribute with the maintenance of fertility. Permanent soil protection is achieved when the planted trees can intercept rain strength, excessive sun radiation and wind strength. Diversification is accomplished when varied species are utilized and consequently the production is based in different product. Diversity production leads to a risk reduction in terms of market saturation, pest and diseases.

ICRAF, in 2003, proposed the so-called *theory of the seven securities*, where ICRAF claims that the securities that a family needs to ensure their livelihood can be achieved by using the big five agroforestry trees (see Table 6).

**Table 6**: Farmers benefits for planted trees The seven Securities, ICRAF, 2004

<table>
<thead>
<tr>
<th>Big Five Agroforestry Trees</th>
<th>Fertilizer</th>
<th>Fruit</th>
<th>Medicinal</th>
<th>Timber &amp; Fuelwood</th>
<th>Fodder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Security</td>
<td>XX</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Nutrition Security</td>
<td>X</td>
<td>XX</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health Security</td>
<td>X</td>
<td>X</td>
<td>XX</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Fodder Security</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>XX</td>
<td>X</td>
</tr>
<tr>
<td>Shelter/Energy Security</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>XX</td>
<td></td>
</tr>
<tr>
<td>Income Security</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Environmental Security</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

The agroforestry systems practised in the research are mainly rice crops in the valley bottom and mixed gardens where coconuts and other perennial crops are mixed with trees, beneath them annual crops are also grown. The importance of these mixed gardens is huge representing an appropriate alternative in restoring degraded lands while providing farmers the securities they need.
In very broad terms *plant domestication* is the process of taking a wild plant species and bringing it under management and cultivation. *Tree domestication* as defined by Simons (1997) is “human-induced evolution to bring species into wider cultivation through a farmer driven or market led process”. Tree domestication is the naturalization\(^9\) of a species to improve its use by human beings.

Domestication of tree species is a multi-faceted process, a continuum of activities in which a progressive interaction between people and plant resources takes place. There is a need to emphasize the difference between tree breeding and tree domestication. Tree breeding is the application of genetic principles to the genetic improvement and management of forest trees, while tree domestication not only involves this, it also bears in mind social aspects such as human conditions and farmer’s preferences.

Recent concerns about tropical deforestation and loss of indigenous tree resources have increased the interest in tree domestication (e.g. IUFRO Conference, Edinburgh, 1992; World Congress of Agroforestry, Florida, 2004) and urgent measures need to be taken in order to ensure the sustainable utilization and conservation of the remaining genetic resources. These goals can be achieved by bringing economically important species, traditionally used by local people, into cultivation by the process of domestication.

Research programmes to domesticate agroforestry trees, particularly for the production of non-timber forest products, was initiated in the 1980s (Leakey *et al*., 1982; Okafor, 1980) and emerged as a global programme in the 1990s (Leakey and Newton, 1994; Leakey and Simons, 1998). A summary of tree domestication priorities appropriate for Southeast Asia, which were identified during a Regional Workshop in Yogyakarta, 1997 are:

- *Expand species and provenance choice, with emphasis on timber and fruit species, including both exotic and indigenous species.*
- *Germplasm quality and pathways to improve access to quality seed including farm-level.*
- *Seed production activities.*
- *Nursery management and tree propagation techniques, both seed-based and vegetative.*

\(^9\) To adapt to a new environment.
Marketing and policy issues that hamper smallholder domestication efforts. Lack of secure land tenure, marketing problems and policy disincentives are important constraints that can ensure the success or failure of the domestication process.

Training and information needs for various audiences – researchers, field workers and farmers.

Domestication priorities in Southeast Asia aim to counteract land and environmental degradation while meeting the basic needs of farmers. In response, ICRAF has initiated the tree domestication program specifically aimed at improving farm family income, diversify production and reducing at the same time the pressure over the natural forest through the incorporation of high value trees into their farming systems.

Faced with a domestication strategy, it is essential to consider two key elements; firstly, if your aim is to stimulate tree domestication for and by smallholders, they should be involved during the whole process and their needs should be treated with caution and secondly, a domestication strategy varies for individual species and also varies according to their functional use, contemporary priority uses, biology and environmental targets (Simons, 1996). In this study, each point of the domestication strategy with the differences amongst the selected species will be dealt with. I believe that with similar functional use and similar environmental targets for the selected premium timber tree species, they will allow the design of a common strategy with specifications for each species.

All the species discussed in the study are indigenous to The Philippines and according to DENR and Rainforestation program are of economic, social and conservation interest. Moreover, small-scale farmer’s plantations in agroforestry systems are one of the best initiatives to address the deforestation process and diversity loss. In addition, there are improvements related with these tree species (e.g. silvicultural management) that are not yet developed. I believe that the contribution of these species to the economy of the farmers and the forest sector can be enhancing through a well-designed domestication strategy where the potential difficulties of the approach are analyzed.

3. OBJECTIVES OF THE STUDY

The overall objective of this study is to design and propose a viable strategy for the domestication of indigenous timber tree species through their use in agroforestry systems. By proposing this domestication strategy the ultimate goal are:

1. To provide farmers with a wider range of timber products and services with the aim of improving farmers’ livelihood and income generation.

2. To contribute in genetic, species and agro-ecological diversification through the conservation of threatened indigenous tree species.

3. To contribute to the land rehabilitation and reforestation efforts of the Philippine government by proposing an alternative strategy, called “Agroforestation”, based on the principles of agroforestry science and tree domestication.

The domestication strategy to be proposed will be based on the accomplishment of the following immediate objectives:

10Dipterocarpus validus, Parashorea malaanonan, Hopea foxworthyi, Shorea contorta, Dracontomelon dao, Vitex Parviflora, Pterocarpus indicus, Terminalia microcarpa.

11 Ex-situ conservation.
1. Identification and analyzing the status, demand and limitations to the integration of selected indigenous trees on smallholder’s farms.

2. Understanding farmers’ decisions to integrate timber trees on farms (e.g. how do they plant trees?, where do they plant trees?, how do they manage trees?) to determine their preferences and perspectives on cultivating and improving the species.

3. Investigating and developing an approach to capturing and conserving wider genetic diversity by developing and establishment of hedge-gardens and germplasm production areas for the massive propagation of these species.

4. Developing an effective germplasm diffusion network of the selected trees based on the study of success factors of mahogany (*Swietenia macrophylla*) germplasm delivery pathways.

5. Characterize the timber-based agroforestry systems in the area.

6. Exploring the feasibility of growing these species in the conditions of agricultural land by studying survival and the influence of different factors (e.g. species, soil type, slope position, type of trial, planting system, weeding, mulching, fertilizing and location) in survival success. Studying initial performance of these threatened species in the different research areas under different agroforestry conditions.

7. Evaluating farmers’ satisfaction after experimenting with these species and future needs with the on-farm trials.

8. Studying policy regulations with regards to tree planting, harvesting and transport.

9. Studying the situation and actual demand on timber marketing.

10. Studying the possibilities of extension of the domestication message by trainings and activities with the local people.

The long-term objective is to contribute to ICRAF efforts on poverty alleviation by means of sustainable land use practices. Conclusions and results of this strategy will contribute to further projects and studies conducted by ICRAF as well as in the domestication process of indigenous trees that is taking place throughout Southeast Asia.

4. ORGANIZATION OF THE STUDY

The present study has been divided in different parts with the aim of identify and addressing the different limitation and bottlenecks that affect timber tree domestication.

In the first part, the study of the status of the selected indigenous species and its demand at local, national and international level has been developed. The methodology employed was has been farmers, lumber dealers and craftsmen interview, literature review and secondary data collection.

Secondly, the study of the survival and early growth of the selected premium timber species in agroforestry systems has been performed with the aim of documenting how indigenous trees grow in degraded land. This study has been conducted by means of ANOVA analysis and by height and diameter study and comparison with non-indigenous species that are growing in the area. Afterward, an evaluation of farmers’ satisfaction, when the selected premium timber trees
are planted on their plots has been conducted. This satisfaction has been assessed by means of short questionnaires and conversations.

Thirdly, germplasm access has been studied. Techniques about germplasm collection from the wild have been reviewed, at the same time, information about germplasm management and production has been gathered. In like manner, the study of the mahogany germplasm delivery network has been study. The objective is to develop a distribution network for our selected species but where considerations about genetic diversity are regarded. The methodology of this part of the study has been based on farmers’ interview and secondary data collection.

Fourthly, by means of interviews and farm visit, the identification of the different cultural treatments and characterization of the different farming systems that farmers perform with timber trees has been conducted. The timber species chosen for this study has been Swietenia macrophylla since it is one of the most management species though out The Philippines.

Subsequently, with the aim of addressing market limitations, a market study based on farmers and market stakeholders’ interviews has been carried out.

As governmental legislation has been identified as one of the main limitations that discourage farmers from planting trees, another section has been developed where regulations about planting, transporting and commercialization with timber trees are discuss.

With the results obtained, suggestions about the design of a domestication strategy have been developed.

5. METHODOLOGY

5.1. Description of the Study Site: Visayas and Northern Mindanao

The present study has been conducted in three municipalities; San Isidro municipality on Bohol Island, located in Central Visayas; and the Tabango and Hindang municipalities on Leyte Island, located in Eastern Visayas. Data from the Claveria and Lantapan municipalities, located in Northern Mindanao, has been gathered for survival and initial performance of the indigenous timber tree trials that were established. Selected municipalities and villages represent the characteristic bio-physical and socio-economic conditions in the degraded uplands of the Central Philippines. The average farm size in these municipalities is about one hectare and farmers have several farming options, which include coconut and lowland farming. Sloping areas are usually planted with corn or rice and followed by other crops like cassava. As the upland agro-ecosystems of the central Philippine islands are among the most highly stressed and degraded in the region, the rural population in this part of The Philippines are among the poorest in the country.

The areas of the study were selected on account of previous studies and research conducted by ICRAF. The World Agroforestry Centre initiated their program on Natural Vegetative Strips (NVS) and contour hedgerow farming in Claveria, Mindanao in 1994. The objective was researching soil conservation to prevent soil erosion in degraded uplands. The program was extended in 2000 and the research areas were expanded to the present areas. Currently programs focus on social forestry and tree domestication. The present study is being developed within the project “Support for Decentralized Tree Seed Systems and Improved Community-Based Forest Management in Central Visayas and Mindanao, The Philippines”.
Figure 11: Study areas of the research in Visayas and Northern Mindanao.

Table 9: A brief description of the research sites.

<table>
<thead>
<tr>
<th>Site</th>
<th>Population density (person/km²)</th>
<th>Altitude (m)</th>
<th>Climate</th>
<th>Soils</th>
<th>Farming system</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. Isidro</td>
<td>2.2</td>
<td>150-500</td>
<td>1,500 mm</td>
<td>Calcareous Shallow Low% m.o and P</td>
<td>Rice, coconut, banana &amp; root crops</td>
</tr>
<tr>
<td>Hindang</td>
<td>1.5</td>
<td>0-120</td>
<td>1,500 mm</td>
<td>Calcareous Shallow</td>
<td>Rice, coconut, corn, root crops &amp; fruit trees</td>
</tr>
<tr>
<td>Tabango</td>
<td>2.4</td>
<td>0-120</td>
<td>1,800 mm</td>
<td>Calcareous Shallow Low% m.o &amp; P Acidic soils</td>
<td>Rice, coconut, corn, root crops &amp; ipil-ipil</td>
</tr>
<tr>
<td>Claveria</td>
<td>0.36</td>
<td>390-2000</td>
<td>2,000mm</td>
<td>Deep Low% m.o High% Al Slightly acidic Low %m.o High% P Well drained</td>
<td>Maize, cassava, rice &amp; vegetables</td>
</tr>
<tr>
<td>Lantapan</td>
<td>1.3</td>
<td>600-2900</td>
<td>2,500mm</td>
<td></td>
<td>Corn, coffee, potatoes, vegetables &amp; sugarcane</td>
</tr>
</tbody>
</table>

¹All research areas are classified as climate Type IV under Coronas Climate Classification Rainfall evenly distributed throughout the year. No dry season with a very pronounced maximum rain period from November to January. Summertime usually experienced during the months of March to June

5.2. Species selection

The study is focused on four dipterocarp species (Dipterocarpus validus, Parashorea malaanonan, Hopea foxworthyi, Shorea contorta) and four other premium timber species (Dracontomelon dao, Vitex Parviflora, Pterocarpus indicus, Terminalia microcarpa) by their use in agroforestry systems. The selection of the chosen species was conducted taking into account the following criteria:

5.2.1. Farmer knowledge and farmer preferences
The opinion and preferences of the farmers is the most important criteria to consider since farmers are the beneficiary population. It is essential to ensure the success of the domestication approach. Many studies, meetings and conversations with farmers have been the base to select the species. The prioritization of species by farmers was analyzed by means of ICRAF studies and experience in the research area as well as DENR studies and priorities. In terms of farmers’ preferences, all of the selected species were in the top indigenous species selected for on-farm cultivation in the study Local Management of Indigenous trees and Marketing of Tree Products in the island of Leyte and Bohol, Philippines, conducted by ICRAF in 2002.

5.2.2. Economic value

As the main goal of this approach is to provide farmers with means to increase income, the potentiality of the species to be sold and used as well as the importance as an agroforestry product was selected as criterion. Bertomeu, 2004, recommended the use of quality timber species to improve productivity of smallholder timber-based agroforestry systems. Moreover, DENR classified this species as Premium timber because of its economic value. Previous studies about the monetary importance of the species, conducted by ICRAF and transmitted via the document Local Knowledge on Indigenous Trees in the Central Philippines, were also used to select the species.

5.2.3. Threatened state

Most of the selected species are mentioned in the World Conservation Union red list classification of threatened species as an attempt to contribute to Philippine diversity conservation. A table of the threatened state of selected species under IUCN classification can be found in this study within Status of the resource section. DENR is also greatly interested in the conservation of these emblematic species particularly within the Dipterocarpaceae family. Since a decade ago, the government has paid special attention to the propagation of Dipterocarps. Programs on clonal asexual propagation and genetic resource conservation are been conducted and enforced by the government.

5.2.4. Availability

The species are not abundant and are difficult to find due to the depletion of their habitat. They are usually found in isolated and inaccessible areas meaning that its collection is a complex and not always successful process. Also, the fact that Dipterocarpaceae is a family that does not bare seed every year sets hurdles in germplasm collection. Even though some farmers were interested in other different timber tree species within this family, the absence of mother trees baring fruit in the moment the project started made it impossible. Nowadays new reproductive material from these different species is being collected.

All the species are recommended and recognized by the Rainforestation program as economically and ecologically valuable and are also classified by DENR as premium timber species.

5.3. Data collection

Data collection included several research methods as farmers’ interviews, lumber dealers’ questionnaires, focus group discussions, establishment and monitoring of on-farm trials. The data was gathered from March 2006 to August 2006 except the on-farm trials that were established in 2005 and data has been gathered every 6 months till now. The adopted methods for the accomplishment of the objectives were the following:

5.3.1 Interviews, farm visits and focus group discussions
**General farmers’ interviews**

With the aim of documenting the different steps of the domestication strategy, the analysis and synthesis of farmer based ex-situ conservation of *Swietenia macrophylla* (mahogany) was conducted. This species was selected considering that it is one of the most managed and planted species in the area and taking into account that it is a farmers preference timber species to domesticate in the area. Mahogany is a threatened species in Central America that was introduced in The Philippines in 1913. It has similar characteristics to our selected species that are traded internationally as “Philippine mahogany” (Razal, 2003) and are also conserved ex-situ through agroforestry.

**Selection of the respondents:** Interviews were conducted in Baryong Daan, Candungao and Masonoy within San Isidro municipality, Bohol. The 34 participants were chosen using a systematic sampling. A census provided by the municipal office was used as the sampling frame. The total number of householders was divided by the required sample size. The obtained number represents the sampling interval. The sample size was determined using the variance and variation coefficient of previous studies in the research site and by comparing similar studies realized by ICRAF-Philippines personal in Lantapan, Claveria. As the magnitude of the population does not affect the magnitude of the sample, 7, 12 and 14 respondents were selected from Baryong Daan, Masonoy and Candungao respectively.

The interviews were conducted following PRA tools and trying to be close and friendly with the farmers. The individual questionnaire was done using open, structured and semi-structured questions. Semi-structured interviews are conducted with a fairly open framework which allow for focused, conversational and two-way communication. They can be used both to give and receive information. Farmers’ meetings and training sessions were suitable for our farmer group discussions and individual interviews were scheduled with the aim of always finding the farmer in his farm. Most of the interviews were carried out in Visayan, the local language, with the help of Filipino personnel from ICRAF as translators and cultural bridges and some interviews were led by me in English. The farmers felt comfortable since ICRAF has been working in the area for fifteen years. The plot visits were conducted in the farm plots where farmers had mahogany and information about the number of stems, planting system, species surrounding, niche, slope and management was taken in each plot.

The interview was divided in 3 parts:

1. General information about their livelihood and farm. The interview was conducted with the aim of understanding their current economic and social situation and their perceptions about their livelihood.

2. Information about the germplasm origin and delivery pathways of *Swietenia macrophylla* (mahogany). The objective is to understand the successful distribution and diffusion system that took place with this introduced species. Also this study helps in the identification of the advantages and disadvantages by comparing characteristics of the different species.

3. Information about the silvicultural management and cultural traits of mahogany. The purpose is to understand how farmers deal with mahogany aiming to recognize planting and growing limitations. It will help to identify where, how and within which agroforestry system the selected indigenous timber trees could be established.

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12PRA, Participatory Rural Appraisal technique was developed in the 1970s in response to the problems of outsiders’ miscommunication with local people. It is an exercise of communication and transfer of knowledge by learning.
Before the solid interviews were conducted, several interviews were conducted with the aim of improving the interviews by experiencing farmers’ understanding of the questions and by ameliorating relation and communication with the translators.

In order to study the indigenous premium timber tree species, a discussion of the farmers demand was carried out. The activity took place as a final part of the previous interview so the research site, sample and participants were the same.

**Satisfaction questionnaire**

**Selection of the respondents:** All the farmers that established on-farm trials with the objective species were interviewed in San Isidro. In Leyte Island the respondents were selected randomly, based on their availability and not all the trial’s participants were interviewed.

The evaluation of indigenous tree (*Dipterocarpus validus, Parashorea malaanonan, Hopea foxworthyi, Shorea contorta, Dracontomelon dao, Vitex Parviflora, Pterocarpus indicus, Terminalia microcarpa*) trial satisfaction was carried out using a short and simple structured questionnaire in the research sites. The interview was formed by four questions; mortality rate evaluation, growth, general satisfaction and additional comments. The answers were ranked from 1 to 5. Most of them were done during training sessions when all of the participants were easiest to reach. The objective of this questionnaire was to evaluate and assess farmers’ perception and satisfaction of these timber trees.

**Market survey**

To assess the actual market situation and to examine current market products, prices and demand, interviews were given to 13 wood processors, lumber dealers and lumber intermediaries between dealers and farmers. The respondents were found in Tagbilaran and Loboc watershed workshops. Only middlemen from San Isidro were interviewed. The survey technique was semi-structured questionnaires where the major topics of discussion were based on timber supply, demand, wood quality, marketing systems and mayor constrains were discussed. The interviews were developed with the aim of developing understanding of the market key issues. An overview of the interview can be found in appendix 3.

**5.3.2 On farm trials**

**Experiment design**

The germplasm utilized in the trials was collected from different National Parks and Natural Spaces within the Philippines. The objective is to gather seeds from different provenances with the aim of maintaining genetic variation. The collection was conducted by ICRAF personal, although mother trees were identified by experts from ITE (Institute for Tropical Ecology) and by experts and responsible of the Reserves or National Parks within The Philippines. Once the trees were identified, the selected mother trees were chosen using the following criterion. The ones that were not separated from the others by at least 30-50m were ruled out.

The stems were planted by seedlings cared in LSU (Leyte State University) nursery or wildlings gathered from the natural forest also cared in LSU nursery. The replacement mortally represents 25 % of the trials.

The farmer selection process was done by means of the farm planning workshop. The

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13 the geographical area and environment to which the parent trees and other vegetation are native, and within which their genetic constitution has been developed through natural selection.

www.for.gov.bc.ca/hfd/library/documents/glossary/P.htm
selection was done based on several criteria:

a. Ownership of a farm area or willingness to secure land by making arrangements with the owner.

b. Adopter of Natural Vegetative Strips (NVS)\textsuperscript{14} and/or Agroforestry practices.

c. Interest in tree farming and willingness to plant and maintain the trees

d. Interest in testing new species

e. Accessibility of farm area

f. Availability of time and willing to devote time for project activities.

g. Willingness to share research output, experiences and knowledge to others.

h. Membership to Landcare\textsuperscript{15} group.

Two different on-farm trials were designed: Type 2 trials were researcher-designed and farmer-managed (ICRAF provided extension planning assistance and design advice but the farmer managed the trial) and Type 3 trials were farmer-designed and farmer-managed. Type 2 trials are better for testing planting prototypes and to conduct economic analysis while Type 3 trials are better for studying farmer’s adaptation and possibilities and farmers niche and management preferences.

Table 10: Suitability of on-farm trial types to meet specific objectives. RD: researcher designed; FD: farmer designed; RM: researcher managed; FM: farmer managed; H: high; M: medium; L: low; 0: none. It is important to notice that due to technical reasons, Type 1 trials were not implemented. Source: Franzel and Scheer 2002.

<table>
<thead>
<tr>
<th>INFORMATION STUDIED</th>
<th>Type 1:RD-RM</th>
<th>Type 2:RD-FM</th>
<th>Type 3:FD-FM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Biophysical response</td>
<td>H</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>2. Profitability</td>
<td>L</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>3. Acceptability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td> Feasibility</td>
<td>L</td>
<td>M</td>
<td>H</td>
</tr>
<tr>
<td> Farmers’ assessment of a particular prototype</td>
<td>L</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td> Farmers’ assessment of a particular practice</td>
<td>L</td>
<td>M</td>
<td>H</td>
</tr>
<tr>
<td>4. Identifying farmer innovations</td>
<td>0</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>5. Determining boundary conditions</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

The trials are monitored constantly and survival and growth (diameter and height) measurements have been collected in intervals of 6 months. The last data measurement was performed on some of the trees at the age of 18 months. Information about tree health, tree management (e.g. weeding, mulching) and niche conditions was gathered. A trial monitoring form can be found in appendix 4.

Height measurements refer to the total height of the tree. Diameter measurements refer to collar root diameter since there was no other diameter measurement possible. Measurement of the diameter at breast height gives more accurate results, and as the trees grow taller this method will be used for further studies.

\textsuperscript{14} Natural Vegetative Strips (NVS) are narrow strips of naturally growing grasses and herbs intentionally left unploughed along the contours of slope land farms. These strips serve as buffers that prevent the soil from eroding during heavy rains and intensive cultivation.

\textsuperscript{15} Landcare movement in the Philippines started in 1996 to address the soil degradation and soil fertility problems in the uplands of Claveria, Misamis Oriental. This movement motivated the farmers to work together to combat the soil related problems particularly soil erosion, which affects farm productivity and income.
Survival data analysis

With the aim of documenting species survival and analyzing dependency of the different factors that affect on it, an analysis of variance (ANOVA) has been conducted. The ANOVA model splits total variation of the dependent variable on independent components that can be attributed to different causes. It examines the association between nominal predictor variables and a continuous outcome variable. It is an analysis of the variation in the outcomes of an experiment to assess the contribution of each variable to the variation. Analysis has been done by using Statgraphics V5.0.Plus.

### Table 11: Summarize of the statistical equations followed in this study

<table>
<thead>
<tr>
<th>SOURCE OF VARIATION</th>
<th>SUM OF SQUARES</th>
<th>DEGREE OF FREEDOM</th>
<th>VARIANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups (BG)</td>
<td>( \sum n_i (x_i - \bar{x})^2 )</td>
<td>( I - 1 )</td>
<td>( S_{bg}^2 = \frac{V(bg)}{I-1} )</td>
</tr>
<tr>
<td>Within groups (WG)</td>
<td>( \sum n_i (y_{ij} - \bar{x})^2 )</td>
<td>( N-I )</td>
<td>( S_{wg}^2 = \frac{V(wg)}{N-I} )</td>
</tr>
<tr>
<td>TOTAL</td>
<td>( \sum n_i (x_i - \bar{x})^2 )</td>
<td>( N-I )</td>
<td>( S_t^2 )</td>
</tr>
</tbody>
</table>

* Number of classes within a factor.

ANOVA is based on \( H_0: \mu_1 = \mu_2 = \mu_3 = \mu_x \). If \( H_0 \) is true, the sources of variation follows an independent distribution \( F \) Snedecor. When the \( H_0 \) is false, the variance between groups and within group will be different so their ratio increase considerably and the associated probability to the variation ratio will be very small.

\[
F_{(I-1,N-I)} = \frac{(I - 1) \cdot S_{bg}^2 / \sigma^2 \cdot (I - 1)}{(n - 1) \cdot S_{wg}^2 / \sigma^2 \cdot (n - 1)} = S_{bg}^2 / S_{wg}^2
\]

To determine either \( H_0 \) is true or false we use the so-called P-value that is a measure of probability that a difference between groups during an experiment happened by chance or can be explained statistically. The smaller the P-value, the more evidence we have against \( H_0 \) and the more likely it is that the difference between groups is significant. In this study a P-value of 0.05 is used to determine the statistical significance with a confidence level of the 95 %.

In the study, survival, as a dependent variable, will be explained in terms of dependency of the independent variables Species, Site, Soil type, Trial type, Slope position, Planting system, weeding, mulching and fertilization.

Initial growth data analysis

The data gathered from the trees were total height and root collar diameter. Both data, of the different species in the different farms and areas has been analyzed using Statgraphics V5.0.Plus. Graphs have been designed and adjusted to explain the growth of each species in each research site.

With the aim of obtaining more accurate results, root diameter data has been utilized to determinate the diameter that corresponds to the tree basal area following Nissen and Midmore’s (2002) suggestion to obtain accurate results.

5.3.3 Literature review

Collection of baseline information and secondary data was ordered in the following parts:
**Indigenous timber species**

The study of the actual status of selected indigenous trees, their biophysical and socio-economic characteristics, their biology and requirements, reproduction, germplasm management, conservation and collection, the limitations of the study sites and smallholder tree farming systems were carried out by literature review. The main information has been gathered from PROSEA, 1994. Secondary data collection was also gathered from the records and files of the municipalities and reports and manuscripts from DENR, national agencies, Leyte State University and Los Baños University.

**Mahogany origin and distribution**

To gather more information about the germplasm origin and delivery pathways of *Swietenia macrophylla* (mahogany), discussions were carried out with DENR officers, the Soil and Water Conservation Foundation coordinator, the Municipal Agriculture Officer of San Isidro and the director of the school in Poblacion (main village in S. Isidro). Baseline studies from the College of Forestry in the University of the Philippines and studies conducted by DENR were also very useful.

**Policies and legislation**

The review of national and local policies related to tree planting, harvesting and marketing was carried out through informal interviews, discussions with DENR officers in Tagbilaran and Talibon, Bohol and discussions with farmers and several members of Leyte State University. Literature reviews from ICRAF database and studies, DENR web pages, DENR publications and Leyte State University libraries were used as well.

**Market survey**

Secondary information about the market situation in The Philippines was gathered by means of the official Philippine websites such as DENR and NSCB Philippines statistics pages. Valuable information from ITTO and FAO reports and reviews was also utilized.

### 5.4. Limitations of the study

The short age of the measured trees, the oldest one being 18 months old, is identified as a limiting factor since only survival, initial performance and growth can be studied but no further conclusions can be obtained. I recommend continued measuring of the trials to obtain reliable conclusions about the long-term growth of the indigenous trees within agroforestry systems.

The lack of soil studies and lack of budget to conduct a soil sampling restrict the analysis and conclusions of the on-farm trial research. An agreement between ICRAF and a research institution could be a good solution to solve the problem.

Due to the importance of the market in this study, I consider that a longer term study should be conducted to ensure reliability and accuracy. I also believe that interviews with lumber dealers should be conducted in Mindanao since salesmen in this area deal with the objective indigenous species of this strategy.
6. RESULTS

6.1. STATUS AND DEMAND OF THE SELECTED TIMBER TREES.

6.1.1. Status of the selected native timber tree species

The dipterocarp forests of The Philippines, in particular those in the islands of Negros and Mindanao, were among the richest in the world in terms of species and volume of merchantable timber (Newman, 1996). Currently, these forests are no more than relics due to overexploitation and conversion of forest lands to agriculture. In spite of their delicate situation, Dipterocarps are still a preeminent timber family in The Philippines and their economic importance is tremendous.

Due to the deforestation process and the lack of support for indigenous species in The Philippines, the current state of many vascular plants is threatened. According to the Philippine environmental profile there are approximately 3000 native trees species and several of them are recorded in the IUCN red list; 46 classified as critical endangered, 35 as endangered and 134 as vulnerable. All the species considered in this study were classified and included under the IUCN red list.

Table 12: Threatened state of selected species under IUCN classification. Source: IUCN website.

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Local name</th>
<th>IUCN state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dipterocarpus validus</td>
<td>Apitong</td>
<td>Critically endangered¹ (2006)</td>
</tr>
<tr>
<td>Shorea contorta</td>
<td>White Lauan</td>
<td>Critically endangered (2006)</td>
</tr>
<tr>
<td>Parashorea malaanonan</td>
<td>Bagtikan</td>
<td>Critically endangered (2006)</td>
</tr>
<tr>
<td>Hopea foxworthyi</td>
<td>Dalindingan</td>
<td>Vulnerable² (2006)</td>
</tr>
<tr>
<td>Pterocarpus indicus</td>
<td>Narra</td>
<td>Vulnerable (2006)</td>
</tr>
<tr>
<td>Terminalia microcarpa</td>
<td>Kalumpit</td>
<td>Vulnerable (1994)</td>
</tr>
<tr>
<td>Dracontomelon dao</td>
<td>Dao</td>
<td>Vulnerable (1980)</td>
</tr>
<tr>
<td>Vitex parviflora</td>
<td>Molave</td>
<td>Vulnerable (2006)</td>
</tr>
</tbody>
</table>

¹ A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.
² A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.

Status of tree resources on farms

According to Lawrence, 1997, the current situation in Bohol and Leyte is characterized by relatively recently introduced fast growing exotic species such as Gmelina arborea, Swietenia macrophylla and Leucaena leucocephala, commercial (usually exotic) fruits such as citrus and mango and native forest species that regenerating naturally on farms.

Farmers in tropical countries use diverse trees that provide them with different groups of products to satisfy their basic needs. According to the tree portfolio (figure 21) that represents current tree diversification in San Isidro, Bohol, fruit trees are the main on-farm planted trees followed by timber trees. The focus of this strategy has been only on indigenous timber trees even though farmers are also interested in growing fruit trees. In order to complete farmers’ needs and demands, and in spite the project also promotes the utilization of these types of trees; another strategy should be conducted for fruit trees.
Regarding our research area, the timber trees portfolio in S. Isidro shows that Mahogany (*Swietenia macrophylla*) and Gemelina (*Gmelina arborea*) are the predominant trees followed by Molave (*Vitex parviflora*) and Antilopo (*Artocarpus spp.*). Mahogany and Gemelina are deliberate planted trees while Molave and Antilopo represent the last remaining wild stock that is being depleted and luckily for the farmers, is regenerating itself in the wild.

According to the conducted interviews, farmers have indigenous trees in their plots (68 %) but almost none of them have planted them intentionally. They usually occur in secondary growth forest plots and are regenerated naturally. Each of the farmers that possess native trees has Molave and only 17% and 8 % have one or two additional different species respectively. From the selected species list, the species cited by farmers were Dao (*Dracontomelon dao*), White lauan (*Shorea contorta*), Almon (*Shorea almon*), Bagtikan (*Parashorea malaanonan*) and Narra (*Pterocarpus indicus*). It is interesting to consider that many of the farmers, when asked about some of the indigenous species, admitted that they only knew the species by name having never come into contact with them.

The origin of the indigenous trees is diverse; the ones that grow on-farm were sourced from Rajah Sikatuna National Park (Bagtikan and White lauan) or were given by ICRAF (Dao and Molave) and the ones that grow in secondary forest or fallow land are regenerated from the wild. Lastly, it is important to consider that indigenous trees, as agroforestry resources, have not been widely used and that consequently, there is still lack of knowledge about the adaptation and the success of these trees when planted in with crops.
6.1.2. Assessing demand

Market demand

In less than 60 years, The Philippines has switched from being internationally a leading exporting country to becoming a timber import dependent country. The Philippines represents the second largest ITTO producer importer country with significant import volume of timber: 356,000 m$^3$ of logs, 338,000 m$^3$ of sawn wood and 93,000 m$^3$ of veneer in 2003 (ITTO 2005). According to ITTO, 2005, veneer from Malaysia, logs from Indonesia, Malaysia and Papua New Guinea and sawn wood from China and Taiwan are satisfying the current demand of The Philippines. The country relies on imports to support Philippine domestic wood needs.

![Figure 23: Production, trade and consumption of forest products in The Philippines, 2005. Source: Own compilation by using ITTO Annual Report, 2005.](image)

In terms of timber origin, The Philippines depend on tropical timber for a significant part of their imported wood needs even though the situation is starting to change and a substantial quantity of timber imports from non-tropical areas is taking place.

Data for The Philippines on export is ambiguous. It could be that The Philippines veneer production jumped from 385,000 m$^3$ in 2004 to 573,000 m$^3$ in 2005, but according to ITTO, The Philippines do not appear to have sufficient logs available to produce the amounts of sawn wood, veneer and plywood that they claim. This fact could be an indicator of errors in statistics and unofficial or illegal log sources.

Considering export species, Philippine Mahogany$^{16}$, Narra$^{17}$ and Molave$^{18}$ wood are widely considered among the finest wood in the world and when the product was abundant, the exports represented a huge income to The Philippine economy. Nowadays the exports of this wood are almost suspended. According to ITTO, 2005, The Philippines in the years 2003-2004 imported and exported dark red meranti, lauan and other species of Shorea but always in small amounts. Veneer export of Shorea spp. is illustrated in the following table.

**Table 13: Tropical veneer species (Shorea spp.) exported by The Philippines. ITTO, 2005.**

<table>
<thead>
<tr>
<th>Year</th>
<th>Latin name</th>
<th>Local name</th>
<th>Volume (m$^3$)</th>
<th>Avg. Price ($/m^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>Shorea spp.</td>
<td>Lauan</td>
<td>3,000</td>
<td>528</td>
</tr>
<tr>
<td>2004</td>
<td>Shorea spp.</td>
<td>Lauan</td>
<td>7,000</td>
<td>414</td>
</tr>
</tbody>
</table>

---

$^{16}$ Dipterocarpaceae family  
$^{17}$ Pterocarpus indicus  
$^{18}$ Vitex parviflora
According to ITTO statistics, The Philippines have been increasing sawn wood production since 2003. In 2003, The Philippines was the world’s third largest veneer producer but as The Philippines is also one of the highest tropical veneer consumers, veneer imports were still necessary. Its consumption in 2004 represented 10.7% of total ITTO veneer consumption. The production of industrial round wood in The Philippines peaked at 11.2 million m$^3$ in 1974 (FAO 2001) and by 2003, tropical industrial round wood production had fallen to 503,000 m$^3$ (ITTO 2005).

In 1977 there were some 325 sawmills and 70 wood-based panel manufacturing units, while in 2003 the number of processing units and their production had fallen to 31 active regular sawmills with an annual log requirement of 539,000 m$^3$ and 50 plywood and veneer manufacturing units (FMB, 2005). Many of the functioning mills have retooled and modified their operations to suit present conditions. Sawmills and woodworking mills mostly rely on plantation wood from *Gmelina arborea*, *Eucalyptus deglupta*, *Albizia falcataria*, *Pinus radiata* and *Pinus caribaea*. The first three of these are mostly produced locally and the last two are mostly imported.

Concerning Secondary Processed Wood Products (SPWP), traditionally, the major market (e.g. wood furniture) has taken place between the developed countries but during the last decade, the SPWP market production and export has been increasing rapidly in the origin regions. The Philippines, as well as other developing countries are nowadays big producers and exporters of SPWP that supply developed countries as well as other tropical countries. Timber consumer countries have increased the import of SPWP from tropical countries and at the same time they have reduced primary tropical product import.

![Figure 24: ITTO Consumer Imports of Primary and Secondary Tropical Timber Products. Source: ITTO, 2005.](image)

The Philippines is one of the major tropical SPWP exporters with exports around amounting to $586 million in 2004. The main SPWP exported products were furniture (36%), builder’s woodwork (32%) and cane and bamboo furniture (18%), the second largest supplier in the tropics after Indonesia. SPWP import in The Philippines corresponds to a value of only $50-51 million in 2004. The Philippines and other tropical developing countries should take advantage of the fact that SPWP could increase the final income because of the processing of the products. But this will make it more difficult to control illegal logging since dealing with processed products does not need any special permit.

Summarizing, in the last decade, The Philippines timber production has decreased substantially, currently being a net import dependent country. While national timber demand
keeps increasing, dependency on imports rises as well. The main reason is that national timber policies are based on banning log exports and also liberalizing log imports, aiming to sustain the country’s forest resource base. It seems that the government still does not realize that, sustainable use of their own timber resources is a promising and laudable initiative that can provide extra income generation to the primary producers at the same time as increasing the gross domestic product of the country in a sustainable manner. Moreover, as the number of on-farm plantations is increasing, small-scale plantations should be able to provide a viable alternative for developing a wood stock within the country and reducing dependency on timber imports.

**Local demand**

Since the remaining natural forest cover of The Philippines has declined to an approximate 18% within the last decade and considering that in parts of the Visayas, especially in the densely populated central islands of Cebu, Bohol and Leyte, the natural forest cover is below the national average, local people have the necessity to find their own ways in providing themselves with forest products such as wood and fuelwood. The most common practice is to acquire woody products by either gathering from the remaining forest or growing forest products on farms. Interest in growing trees on farms has started to increase since 1992, with the introduction of the NIPAS law that prohibits the occupancy and unregulated utilization of the forest resources.

Concerning timber tree plantations, it is recognized that as a consequence of governmental interest in achieving short-term objectives, tight regulation of logging of indigenous species and easy seed availability of exotic species, on-farm plantations have been traditionally concentrated on the fast-growing exotic species. In spite of this fact, many farmers are still interested in planting different tree species with higher market price or desirable characteristics but which are more difficult to procure, collect and propagate.

Accounting the interviews conducted in San Isidro, Bohol, nowadays, a majority of farmers identified the need to diversify their timber production. Sixty-four percent of the interviewed farmers (figure 26) have expressed interest in expanding their current timber production using different species. Timber plantations presently rely basically on two exotic species; *Swietenia macrophylla* and *Gmelina arborea*. Besides, 3% of farmers are interested in replacing their current plantation with a wider range of species. Most of them admit the need of having both exotic and indigenous trees while a minor number of farmers just want to invest in indigenous trees for timber supplies.

**Figure 26:** Farmers demand on timber production, S. Isidro, Bohol, 2006.

19 National Integrated Protected Areas System.
Most of the farmers recognize undoubtedly the economic and ecological superiority of indigenous over exotic species and they also distinguish the wood quality and durability of timber that indigenous species provide over exotics. Despite this fact, 18% of the farmers in the research area would like to increase their timber production but only grow Mahogany (*Swietenia macrophylla*). Another 18% of the interviewed farmers desire to maintain their current timber production area, without increasing it. The motives for these decisions are diverse. Most of them are just interested in managing the actual production and later to switch to fruit trees or crop production. Another group of farmers want to remove their Mahogany because it is affecting their coconut plantation, one of the main income generator products in the area. Some of the interviewed farmers cannot expand because of lack of planting area. There is another important group representing 3% that are not interested in increasing their production area but are interested in managing what they already have and substitute it for the same species once the trees are harvested.

All farmers that are interested in planting indigenous timber trees identify the lack of reproductive material as the main reason why they do not have certain species growing on their farms. In the research area, and in general everywhere else in The Philippines, *Dracontomelon dao*, *Terminalia microcarpa*, *Dipterocarpus validus*, *Parashorea malaanonan*, *Shorea contorta*, *Hopea foxworthyi* are almost extinct. *Vitex parviflora* and *Pterocarpus indicus* exist, but few remain of what existed before.

Most of the farmers (88%) are interested in growing indigenous trees. The main identified motivations are:

- Aim of diversifying their timber production.
- Interest in having quality (in terms of durability) products for their household consumption (it is interesting to mention that many of the farmers plant timber trees but not with the intention of selling the wood production).
- Income generation, capital accumulation and investment for future needs
- Environmental services. Surprisingly farmers appreciate environmental services such as erosion control and soil fertility improvement as a encouragement.

### 6.2. SURVIVAL AND EARLY GROWTH OF SELECTED PREMIUM TIMBER SPECIES IN AGROFORESTRY SYSTEMS

In the Philippines, there is little information about the growth and survival of indigenous species in agroforestry systems. They have been broadly studied growing in natural conditions but little research has been conducted when growing in open and degraded uplands. The goal of this section is to answer the following questions:

- Can this premium timber species survive and grow in agroforestry systems?
- How well do they perform as compared to timber species which are currently planted?

#### 6.2.1. Survival

The mean survival of the different species after the first year of life when established on agroforestry systems is high. *Vitex parviflora* (molave), *Pterocarpus indicus* (narra) and *Dracontomelon dao* (dao), represented the highest survival percentages. The reason of this high
survival may be the light-demanding temperament of these species. *Terminalia microcarpa* (kalumpit), even though it is considered a pioneer species, represented lower survival when compared with the former. Kalumpit trials were observed to be attacked by insect or fungus but always in less than 3% of the total trial.

The survival of white lauan and Mahogany is the lowest when compared with the other species while apitong has the best survival. In some of the plots where white lauan was planted, the survival has been very low caused mainly by water stress and animal damage.

**Table 14**: Survival of the different species in agroforestry systems. n = number of planted trees.

<table>
<thead>
<tr>
<th>Species</th>
<th># Farms</th>
<th>Survival mean %</th>
<th>$S^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narra (n=145)</td>
<td>3</td>
<td>89.9</td>
<td>14.64</td>
</tr>
<tr>
<td>Dao (n=1175)</td>
<td>24</td>
<td>91.8</td>
<td>10.76</td>
</tr>
<tr>
<td>Apitong (n=141)</td>
<td>3</td>
<td>90.0</td>
<td>9.95</td>
</tr>
<tr>
<td>Molave (n=931)</td>
<td>16</td>
<td>95.3</td>
<td>6.42</td>
</tr>
<tr>
<td>kalumpit (n=693)</td>
<td>16</td>
<td>93.4</td>
<td>25.07</td>
</tr>
<tr>
<td>W.Lauan (n=521)</td>
<td>5</td>
<td>73.7</td>
<td>9.01</td>
</tr>
<tr>
<td>Mahogany (n=97)</td>
<td>2</td>
<td>93.7</td>
<td>5.50</td>
</tr>
</tbody>
</table>

**ANOVA ANALYSIS**

**Table 15**: The different factors that have been studied in the ANOVA analysis and the statistical significance, represented by the P-value.

<table>
<thead>
<tr>
<th>FACTORS</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species</td>
<td>0.0075</td>
</tr>
<tr>
<td>Soil</td>
<td>0.017</td>
</tr>
<tr>
<td>Type of trial</td>
<td>0.0075</td>
</tr>
<tr>
<td>Slope position</td>
<td>0.0000</td>
</tr>
<tr>
<td>Planting system</td>
<td>0.0075</td>
</tr>
<tr>
<td>Weeding</td>
<td>0.0423</td>
</tr>
<tr>
<td>Mulching</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Fertilizing</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Site</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

Since the P-value of the F-test is less than 0.05, there is a statistically significant difference between the mean survivals from one level of species to another at the 95% confidence level. In the following table it is determined which means are significantly different from which others by means of a Multiple Range Tests. In this test, the pairs that show statistically significant differences at the 95% confidence level are represented by * and grey shading.
### Table 16: Multiple Range Test, species factor

<table>
<thead>
<tr>
<th>Contrast</th>
<th>Difference</th>
<th>+/- Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apitong - Dao</td>
<td>-1.75</td>
<td>9.45</td>
</tr>
<tr>
<td>Apitong - Kalumpit</td>
<td>-2.42</td>
<td>10.72</td>
</tr>
<tr>
<td>Apitong - Mahogany</td>
<td>-3.71</td>
<td>13.28</td>
</tr>
<tr>
<td>Apitong - Molave</td>
<td>-5.31</td>
<td>10.36</td>
</tr>
<tr>
<td>Apitong - Narra</td>
<td>0.2</td>
<td>15.01</td>
</tr>
<tr>
<td>Apitong - W.Lauan</td>
<td>*16.23</td>
<td>10.94</td>
</tr>
<tr>
<td>Dao - Kalumpit</td>
<td>-0.67</td>
<td>9.85</td>
</tr>
<tr>
<td>Dao - Mahogany</td>
<td>-1.96</td>
<td>12.58</td>
</tr>
<tr>
<td>Dao - Molave</td>
<td>-3.56</td>
<td>9.45</td>
</tr>
<tr>
<td>Dao - Narra</td>
<td>1.95</td>
<td>14.40</td>
</tr>
<tr>
<td>Dao - W.Lauan</td>
<td>*17.98</td>
<td>10.09</td>
</tr>
<tr>
<td>Kalumpit - Mahogany</td>
<td>-1.28</td>
<td>13.56</td>
</tr>
<tr>
<td>Kalumpit - Molave</td>
<td>-2.88</td>
<td>10.72</td>
</tr>
<tr>
<td>Kalumpit - Narra</td>
<td>2.62</td>
<td>15.26</td>
</tr>
<tr>
<td>Kalumpit - W.Lauan</td>
<td>*18.65</td>
<td>11.28</td>
</tr>
<tr>
<td>Mahogany - Molave</td>
<td>-1.59</td>
<td>13.28</td>
</tr>
</tbody>
</table>

According to species factor, White lauan survival differs significantly from the rest of species classes, with the difference with Kalumpit, Apitong and Dao being statically representative. The survival of these species is much higher than White lauan survival. Kalumpit and Dao are light demanding species while White lauan (*Dipterocarpaceae*) needs higher requirements for its establishment. Apitong, even though is also a shade species that belongs to the *Dipterocarpaceae* family, has higher survival rates that the other species.

Since the P-value of the F-test is less than 0.05, there is a statistically significant difference between the mean survivals from one level of soil to another at the 95% confidence level.

### Table 17: Multiple Range Test, soil factor

<table>
<thead>
<tr>
<th>Contrast</th>
<th>Difference</th>
<th>+/- Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acidic/Deep- Basic/Shallow</td>
<td>*-7.64849</td>
<td>6.24919</td>
</tr>
</tbody>
</table>

According to the Multiple Range Test this two classes show a statistically significant difference at the 95% confidence level. Survival depends on soil type factor representing a difference of 7.6 % survival success in basic and shallow soils over acidic.

Since the P-value of the F-test is less than 0.05, there is a statistically significant difference between the mean survivals from one level of type trial to another at the 95% confidence level.
Table 18: Multiple Range Tests in terms of type of trial factor.

<table>
<thead>
<tr>
<th>Contrast</th>
<th>Difference</th>
<th>+/- Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 - 3</td>
<td>*12.4512</td>
<td>8.1149</td>
</tr>
</tbody>
</table>

Type of trial factor has statistical significance to explain survival. Type 2 and type 3 designs difference clearly in a 12.45%.

Since P-value is lower than 0.05, the mean survival from the slope position factor is statistically significant.

Table 19: Multiple Range Tests in terms of type of trial factor.

<table>
<thead>
<tr>
<th>Contrast</th>
<th>Difference</th>
<th>+/- Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat land - Lower Slope</td>
<td>9.26</td>
<td>19.8889</td>
</tr>
<tr>
<td>Flat land - Middle Slope</td>
<td>6.34</td>
<td>19.9378</td>
</tr>
<tr>
<td>Flat land - Ravine</td>
<td>*94.0</td>
<td>24.0083</td>
</tr>
<tr>
<td>Flat land - Upper Slope</td>
<td>10.73</td>
<td>19.9761</td>
</tr>
<tr>
<td>Lower Slope - Middle Slope</td>
<td>-2.91</td>
<td>4.9550</td>
</tr>
<tr>
<td>Lower Slope - Ravine</td>
<td>*84.73</td>
<td>14.2631</td>
</tr>
<tr>
<td>Lower Slope - Upper Slope</td>
<td>1.46</td>
<td>5.1069</td>
</tr>
<tr>
<td>Middle Slope - Ravine</td>
<td>*87.65</td>
<td>14.3312</td>
</tr>
<tr>
<td>Middle Slope - Upper Slope</td>
<td>4.38</td>
<td>5.2943</td>
</tr>
<tr>
<td>Ravine - Upper Slope</td>
<td>*-83.26</td>
<td>14.3844</td>
</tr>
</tbody>
</table>

The Multi Range Test shows a clear difference between ravine position and the other class factors.

Planting system factor has statistically significance on survival at the 95% confidence interval.

Table 20: Multiple Range Tests in terms of type of trial factor.

<table>
<thead>
<tr>
<th>Contrast</th>
<th>Difference</th>
<th>+/- Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boundary - Contour line</td>
<td>*-15.7895</td>
<td>9.93167</td>
</tr>
<tr>
<td>Boundary - Cropland</td>
<td>*-20.0556</td>
<td>11.1777</td>
</tr>
<tr>
<td>Boundary - Fallow land</td>
<td>*-13.1522</td>
<td>10.6807</td>
</tr>
<tr>
<td>Contour line - Cropland</td>
<td>-4.2660</td>
<td>8.5819</td>
</tr>
<tr>
<td>Contour line - Fallow land</td>
<td>2.6373</td>
<td>7.9237</td>
</tr>
<tr>
<td>Cropland - Fallow land</td>
<td>6.90338</td>
<td>9.4386</td>
</tr>
</tbody>
</table>

The Multiple Range Test shows that the class boundary is significantly difference of the
rest of the classes. Plot boundary survival is lower in 13% compared with fallow land situation, 15% compared with contour line and 20% compared with cropland. On basis of the field experience, it can be hypothesized that this difference in survival can be explained by two factors: 1) Trees planted on the boundary with other farmers plots are more vulnerable to be damaged; and 2) The limits of the plot are sometimes far away from the cultivating land so the farmers does not go frequently to maintain (e.g. weeding) the planted trees.

There is a statistically significant difference between the mean survival from one level of weeding to another at the 95.0%. The difference is not as significant as species, trial type, slope position or farming system since the P-value is greater.

**Table 21:** Multiple Range Tests in terms of type of trial factor.

<table>
<thead>
<tr>
<th>Contrast</th>
<th>Difference</th>
<th>+/- Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>No - Yes</td>
<td>+/-7.67851</td>
<td>7.40722</td>
</tr>
</tbody>
</table>

Survival is dependent on weeding practice representing a 91% of survival when practiced over a 83% when weeding is not carried out.

With the designed ANOVA analysis location, mulching and fertilizing factor do not have statically relevance on survival for a confidence interval of 95%. It seen that this factors do not affect on survival or at least not in a significant manner. Data concerning fertilizing and mulching practices is confused since it was not possible to get good information from farmers due to the irregularity of these practices.

**Table 22:** Main statistical indicators for the different factors.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Classes</th>
<th>N</th>
<th>x</th>
<th>S^2</th>
<th>x - S^2</th>
<th>x + S^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species</td>
<td>Apitong</td>
<td>16</td>
<td>90</td>
<td>3.68</td>
<td>84.81</td>
<td>95.18</td>
</tr>
<tr>
<td></td>
<td>Dao</td>
<td>24</td>
<td>91.7</td>
<td>3.01</td>
<td>87.51</td>
<td>95.98</td>
</tr>
<tr>
<td></td>
<td>Kalumpit</td>
<td>14</td>
<td>92.4</td>
<td>3.94</td>
<td>86.89</td>
<td>97.96</td>
</tr>
<tr>
<td></td>
<td>Mahogany</td>
<td>7</td>
<td>93.71</td>
<td>5.57</td>
<td>85.88</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Molave</td>
<td>16</td>
<td>95.31</td>
<td>3.67</td>
<td>90.13</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Narra</td>
<td>5</td>
<td>89.8</td>
<td>6.59</td>
<td>80.57</td>
<td>99.06</td>
</tr>
<tr>
<td></td>
<td>W.Lauan</td>
<td>13</td>
<td>73.76</td>
<td>4.09</td>
<td>68.02</td>
<td>79.51</td>
</tr>
<tr>
<td>Soil type</td>
<td>Acidic/deep</td>
<td>47</td>
<td>85.87</td>
<td>2.23</td>
<td>82.73</td>
<td>89.01</td>
</tr>
<tr>
<td></td>
<td>Basic/shallow</td>
<td>48</td>
<td>93.52</td>
<td>2.21</td>
<td>90.41</td>
<td>96.62</td>
</tr>
<tr>
<td>Trial type</td>
<td>2</td>
<td>76</td>
<td>92</td>
<td>1.74</td>
<td>89.58</td>
<td>94.49</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>17</td>
<td>79.5</td>
<td>3.69</td>
<td>74.40</td>
<td>84.77</td>
</tr>
<tr>
<td>Planting system</td>
<td>Boundary</td>
<td>12</td>
<td>75.5</td>
<td>4.35</td>
<td>69.37</td>
<td>81.62</td>
</tr>
<tr>
<td></td>
<td>Contour line</td>
<td>38</td>
<td>91.28</td>
<td>2.44</td>
<td>87.84</td>
<td>94.72</td>
</tr>
<tr>
<td></td>
<td>Cropland</td>
<td>18</td>
<td>95.55</td>
<td>3.55</td>
<td>90.55</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Fallow land</td>
<td>23</td>
<td>88.65</td>
<td>3.14</td>
<td>84.23</td>
<td>93.07</td>
</tr>
<tr>
<td>Slope position</td>
<td>Flat land</td>
<td>1</td>
<td>100</td>
<td>9.86</td>
<td>86.13</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Lower slope</td>
<td>34</td>
<td>90.73</td>
<td>1.69</td>
<td>88.35</td>
<td>93.11</td>
</tr>
<tr>
<td></td>
<td>Middle slope</td>
<td>29</td>
<td>93.65</td>
<td>1.83</td>
<td>91.08</td>
<td>96.22</td>
</tr>
<tr>
<td></td>
<td>Ravine</td>
<td>2</td>
<td>6.00</td>
<td>6.97</td>
<td>-3.80</td>
<td>15.8</td>
</tr>
<tr>
<td>Weeding</td>
<td>yes</td>
<td>71</td>
<td>83.9</td>
<td>3.24</td>
<td>79.36</td>
<td>88.46</td>
</tr>
<tr>
<td></td>
<td>no</td>
<td>23</td>
<td>91.59</td>
<td>1.84</td>
<td>89.00</td>
<td>94.18</td>
</tr>
</tbody>
</table>
6.2.2. Initial growth performance

The results represent height and diametric growth of each species, in each research site. Height growth is represented by a tendency curve and diameter growth by the mean of diameter of all the research sites.
**Dracontomelon dao**

Simple regression of height growth (cm) in terms of age (months) showed that there is high growth variability of *Dracontomelon dao* within the same research site. Height growth in Claveria and Lantapan is similar. The stems are around 0.6 m at the age of 12. In Tabango and Hindang height growth showed to be higher adopting values around 1m for the same age. *Dracontomelon dao* in Tabango and Hindang showed to have exponential growth.

![Figure 28.a](image1.png) **Figure 28.a:** Height growth of *Dracontomelon dao* in agroforestry systems in Claveria, Misamis Oriental. (n = 50)

![Figure 28.b](image2.png) **Figure 28.b:** Height growth of *Dracontomelon dao* in agroforestry systems in Lantapan, Bukidnon. (n = 249)

![Figure 28.c](image3.png) **Figure 28.c:** Height growth of *Dracontomelon dao* in agroforestry systems in Tabango, Leyte (n = 200)

![Figure 28.d](image4.png) **Figure 28.d:** Height growth of *Dracontomelon dao* in agroforestry systems in Hindang, Leyte (n = 150)

Average diameters of *Dracontomelon dao* in Leyte Island showed to be higher than in Claveria and Tabango. At the age of 18 months the diameter growth of the species within Lantapan showed to be almost the double than in Claveria.

![Figure 29](image5.png) **Figure 29:** Diameter growth of *Dracontomelon dao* in agroforestry systems in the different research sites.
Vitex parviflora

Simple regression of height growth showed that there is high growth variability of Vitex parviflora within the same research site. Regression curve showed that height growth of Vitex parviflora is significantly higher in Lantapan than in Claveria and Tabango. Height growth value at the age of 12 months in Lantapan is more that the double than the growth in the other research sites. Growth in Lantapan can be predicted by a squared root-y equation.

**Figure 30.a:** Height growth of Vitex parviflora in agroforestry systems in Claveria, Misamis Oriental. (n= 139)

**Figure 30.b:** Height growth of Vitex parviflora in agroforestry systems in Lantapan, Bukidnon (n = 30)

**Figure 30.c:** Height growth of Vitex parviflora in agroforestry systems in Tabango, Leyte (n = 300).

Diameter growth of Vitex parviflora is also significantly higher in Lantapan than in the other research sites, where the diameter behaves similarly.

**Figure 31:** Diameter growth of Vitex parviflora in agroforestry systems in the research sites.
*Terminalia microcarpa*

Simple regression of height growth showed that *Terminalia microcarpa* performance is satisfactory in Lantapan and Hindang while in Claveria the performance is poor taking values lower than 60 cm for the year. The species height growth behaves exponentially in Lantapan and Hindang.

*Figure 32a:* Height growth of *Terminalia microcarpa* in agroforestry systems in Claveria, Misamis Oriental (n = 39).

*Figure 32b:* Height growth of *Terminalia microcarpa* in agroforestry systems in Lantapan, Bukidnon (n = 154).

*Figure 32c:* Height growth of *Terminalia microcarpa* in agroforestry systems in Tabango, Leyte (n = 200).

*Figure 32d:* Height growth of *Terminalia microcarpa* in agroforestry systems in Hindang, Leyte (n = 204).

Diameter growth showed that Hindang trees have the greatest growth in terms of diameter while diameter growth in Claveria was inappreciable. The small amount of data gathered in Claveria represents a limitation to this result.

*Figure 33:* Diameter growth of *Terminalia microcarpa* in agroforestry systems in the research sites.
**Dipterocarpus validus**

Height growth showed the best results and similar behaviour in Lantapan and Claveria. In Lantapan, growth is 120 cm at 12 months while growth is around 15 cm in Tabango and 80 cm in Hindang for the same age.

**Figure 34.a**: Height growth of *Dipterocarpus validus* in agroforestry systems in Claveria, Misamis Oriental (n = 138).

**Figure 34.b**: Height growth of *Dipterocarpus validus* in agroforestry systems in Lantapan, Bukidnon (n = 41).

**Figure 34.c**: Height growth of *Dipterocarpus validus* in agroforestry systems in Tabango, Leyte (n = 200).

**Figure 34.d**: Height growth of *Dipterocarpus validus* in agroforestry systems in Hindang, Leyte (n = 153).

Diameter growth showed better results as well as height growth for Claveria and Lantapan. The results, in terms of diameter growth, are not significantly different for any of the research sites at the age of 12 months.

**Figure 35**: Diameter growth of *Dipterocarpus validus* in agroforestry systems in Hindang, Leyte.
**Shorea contorta**

Simple regression of height growth (cm) in terms of age (months) showed that there is high growth variability of *Shorea contorta* within the same research site. The regression curve showed that height and diameter growth behaves similarly in Lantapan as much as in Claveria.

**Figure 36.a:** Height growth of *Shorea contorta* in agroforestry systems in Claveria, Misamis Oriental (n = 139).

**Figure 36.b:** Height growth of *Shorea contorta* in agroforestry systems in Lantapan, Bukidnon (n = 234).

**Figure 37:** Diameter growth of *Shorea contorta* in agroforestry systems in Claveria and Lantapan.
**Pterocarpus indicus**

Simple regression of height growth showed that there is high growth variability of *Pterocarpus indicus* within the same research site. Species growth both in terms of diameter and height is greater in Lantapan than in Claveria but even this way the difference of growth are less than 0.40 cm in terms of height and 1 cm in terms of diameter.

![Figure 38.a](image1)

*Figure 38.a:* Height growth of *Pterocarpus indicus* in agroforestry systems in Claveria, Misamis Oriental (n = 150).

![Figure 38.b](image2)

*Figure 38.b:* Height growth of *Pterocarpus indicus* in agroforestry systems in Lantapan, Bukidnon (n = 100).

![Figure 39](image3)

*Figure 39:* Diameter growth of *Pterocarpus indicus* in agroforestry systems in Lantapan and Claveria.

**Swietenia macrophylla**

Diameter and height growth analysis of *Swietenia macrophylla* as been also conducted with the aim of using it as a reference as well as to compare its performance with the performance of our selected timber trees species.

Simple regression showed that the height performance of *Swietenia macrophylla* is similar in Claveria likewise in Lantapan, having a value around 1.10m when 12 months old. The growth in both sites can be explained by a reciprocal-y and exponential curve.

*dracontomelon dao* (figures 28, 29) has similar growth with *Swietenia macrophylla* for all research sites except in Hindang where *dracontomelon dao* has greatest height growth.

*Vitex parviflora* in Claveria (figure30.a) performs a lesser growth than Mahogany while in Lantapan (figure 30.b) *Vitex parviflora* growth is greater by a meter when 12 months old. In
Tabango (figure 30.c) height growth is similar in both species.

*Terminalia microcarpa* in Claveria and Tabango (figures 32.a, 32.c) performs poorly. The performance of Mahogany is much greater than it but in Lantapan and Hindang figures 32.b, 32.d), Kalumpit grows better than Mahogany.

With regard to *Dipterocarpus validus*, its performance is similar to Mahogany in Claveria and Lantapan (figure 34.a, 34.b) while is much lesser in Hindang and Tabango (figures 34.c, 34.d) were Apitong does not perform well.

*Shorea contorta* performance (figures 36, 37), as well as *Pterocarpus indicus* (figures 38, 39), presented similar growth than *Swietenia macrophylla*.

![Figure 40.a: Height growth of Swietenia macrophylla in agroforestry systems in Claveria, Misamis oriental (n = 150).](image1)

![Figure 40.b: Height growth of Swietenia macrophylla in agroforestry systems in Lantapan, Bukidnon (n = 100).](image2)

With regard to the different research sites, a diameter comparison showed that in Lantapan, *Vitex parviflora* is the species that greatest performs by difference. It represents the best diameter performance in all research sites compared with all species. In terms of diameter, the rest of species behaves similarly without great difference between them. Therefore, in terms of height, *Shorea contorta* grows greater than the others.

![Figure 41: Diameter comparison of the different planted species in Lantapan, Bukidnon.](image3)

In Claveria, white lauan and Mahogany are the species that greater diameter growth presents. Kalumpit as well as in Lantapan, performs poorly when compared with the rest of species.
Figure 42: Diameter comparison of the different planted species in Claveria, Misamis Oriental.

In terms of Hindang research site, Kalumpit represents the greatest growth performance while the diametric performance that apitong is having is poorest. Dao grows similarly that Mahogany in terms of diameter and height.

Figure 43: Diameter comparison of the different planted species in Hindang, Leyte.

In Tabango, the species that greatest diametric growths perform are dao and Mahogany. It seems that apitong, both in terms of height and diameter does not perform well in Tabango.
6.3. SATISFACTION EVALUATION

A short questionnaire was conducted with the aim of evaluating the current satisfaction that farmers display about the indigenous trees that were set up on-farm trials as part of the current ICRAF project. This questionnaire, as part of the participatory domestication, aims to be a rapid appraisal of farmer perceptions, satisfaction, future views and necessities.

The questionnaire was carried out by ranking the different factors asked from 1 (bad) to 5 (good). Most of the farmers are up to now generally satisfy with the trees performance. The difficulty of assessing farmers satisfaction on terms of crown development, fertility, competition, production or other specify factor that can not be appreciated on that early stage of the tree growth, made us treat satisfaction on general terms (performance, uses, profitability versus other plantations) and on growth terms. The graph below shows the similar behavior of both suggesting that satisfaction in those early stages is mainly based on the growth.

Farmers’ classification, for all species, is good (higher that average) except for Hopea
Foxworthy. Farmers are not very satisfied, both in terms of growth and general satisfaction. The reason may be that this species is a low durability medium hardwood that performs with inferiority when compared with the other species. The reasons of these performance, may be, according to Newman, 1996, that this species is soil demanding, being absent from ultra basic soils and areas with a pronounced dry season. According to the questionnaire, farmers are greatly satisfied with Dipterocarpus validus, and Dracontomelon dao. Several interviewed farmers, in contrast with their expectations, were astonished by the performance that these species are having. Farmers are also satisfied with Terminalia microcarpa and Shorea sp growth. There is a big difference between general and growth satisfaction for Shorea sp, that could be explain by the high value that this heave hardwood has (when evaluating general satisfaction) in contrast with its slow performance (when evaluating growth). Farmers are also satisfied with Vitex parviflora growth even though it is not as well classified as the other species. The cause can be that it is a valued hardwood, well known in the area but its performance is poor.

**Table 23**: Mean (x), Standard deviation (S) and confidence interval (+1, 32 σ, -1, 32 σ).

<table>
<thead>
<tr>
<th></th>
<th>SATISFACTION GROWTH</th>
<th>GENERAL SATISFACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>x</td>
<td>4.62</td>
</tr>
<tr>
<td>D. dao (n=21)</td>
<td>S</td>
<td>0.27</td>
</tr>
<tr>
<td></td>
<td>1.32 σ- X +1.32 σ (α =90)</td>
<td>0.08</td>
</tr>
<tr>
<td></td>
<td>x</td>
<td>3.63</td>
</tr>
<tr>
<td>V. parviflora (n=19)</td>
<td>S</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
<td>1.32 σ- X +1.32 σ (α =90)</td>
<td>0.23</td>
</tr>
<tr>
<td></td>
<td>x</td>
<td>4.11</td>
</tr>
<tr>
<td>T. microcarpa (n=9)</td>
<td>S</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>1.32 σ- X +1.32 σ (α =90)</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td>x</td>
<td>4</td>
</tr>
<tr>
<td>Shorea. sp (n=5)</td>
<td>S</td>
<td>0.89</td>
</tr>
<tr>
<td></td>
<td>1.32 σ- X +1.32 σ (α =90)</td>
<td>0.61</td>
</tr>
<tr>
<td></td>
<td>x</td>
<td>5</td>
</tr>
<tr>
<td>D. validus (n=5)</td>
<td>S</td>
<td>0.52</td>
</tr>
<tr>
<td></td>
<td>1.32 σ- X +1.32 σ (α =90)</td>
<td>0.35</td>
</tr>
<tr>
<td></td>
<td>x</td>
<td>3</td>
</tr>
<tr>
<td>H. foxworthyi (n=5)</td>
<td>S</td>
<td>1.41</td>
</tr>
<tr>
<td></td>
<td>1.32 σ- X +1.32 σ (α =90)</td>
<td>0.97</td>
</tr>
</tbody>
</table>

In addition to the satisfaction query, farmers were asked about their interest in increasing the amount of trees of the same species (figure 46). The term *maybe* was introduced as a possible answer seeing that many farmers hesitated when answering. Farmers seemed to be interested in testing the species in a longer space of time before show concern over a specific one.

**Figure 46**: Farmers satisfaction with the indigenous trees planted on their plots.
6.4. GERMPLASM ACCESS: COLLECTION, PROPAGATION AND DISTRIBUTION

6.4.1. Germplasm collection

Over-logged forests with enough residual trees to raise a sufficient supply of seeds and wildlings are mostly found in Mindanao. In the Visayas region, residual mother trees are scarce and ephemeral wildlings stock no longer exists. Consequently and combined with the scarcity of dipterocarp trees baring seeds, germplasm collection is a very difficult activity that has to be very well study and organized before its realization.

It is essential to create a database were information about the different mother trees is recorded, with the aim of avoiding loss of knowledge while developing a production network based on germplasm from different provenances. As a minimum, the following data has to be
recorded: Species name, collection date, collection place, individuals carrying out the collection, location and direction of the research site, number of trees collected from each site, approximate average distance at each site, weight of fruit or seed collected, number of seed containers filled with seeds or wildlings and a unique identifier for each collected sample. Having a complete mapping of mother trees geographical procedence and location is fundamental for their further identification. Collection should be broad in geographic terms. It is important to collect different provenance with the aim of having different genetic origin seeds and wildlings.

The main problem associated with seed collection is that sometimes, the technique to collect seeds is not the appropriate because any guideline is followed (e.g. collect seed only for few trees and without regarding the healthy state of the tree). Some guidelines on how to select and collect germplasm from trees can be found in Dawson I and Were J, 1997. Collecting germplasm from trees: Some guidelines. Agroforestry Today, Vol. 9 No. 2, page 7-9.

**Dipterocarps**

Phenotypic characteristics from the mother tree serve as based for seed collection. Mother trees have to be healthy having balance canopy with straight and cylindrical bole with 40-80cm dbh and avoiding trees that are poorly developed or have symptoms of having disease.

Seeds of dipterocarps are normally collected from the ground as consequence that mother trees are inaccessible. Better quality is provided by the seeds that are still on the tree and if possible, they should be gathered, even though, good quality seeds can by find and collected directly from the ground.

Collection sometimes has to be an opportunist activity since farmers or National Parks or reserve responsible should inform about the phenological stage of the mother trees. Seed collection should be representative. According to Dawson and Were, 1997, seed collection should be done from at least 30 trees per species.

To collect the dominant wildlings, places were fruiting occurred in previous years should be revisited. Wildlings are usually gathered close to the mother trees. People with skills and knowledge should assume the identification of them. Ideally, newly germinated wildlings, or those with 2-4 leaves are easy to collect and raise in the nursery because their growing apical buds are active but according to Gianan, 1994 it is convenient to collect wildlings with more than 7mm diameter and 15-50cm height but probably difficult to find them. It is important to keep some roots in the pulled wild plant as well as to pick some soil for the natural area to ensure the success of the wildling growth. Wildlings are placed in individual plastic bags or banana sheet for the collection and watered before the transportation to the nursery. *Parashorea malaanonan* is mostly propagated by wildlings because their seeds have extremely very low viability.

**Molave, Dao, Narra and Kalumpit**

Molave, Narra, Kalumpit and Dao bare seeds every year, for this reason they have been reproduced exclusively by seeds. Ripe seeds were gathered also from the natural forest. Some of them were collected from the ground and others directly from the tree. Maturity is indicated by a colour change, from green to brown. Some seeds fall after maturing, but most remain on the tree for several months. It is preferable to collect mature fruits by climbing into the canopy and lopping fruit-laden branches or else shaking or beating with long poles to dislodge fruits. To make collection easier, nets or plastic sheet can be spread on the ground.
6.4.2. Reproductive biology and propagation

Dipterocarps

Dipterocarps are characterized for having a specific reproductive biology differentiate mainly for two reasons: Its irregular seed production and its low germination viability. The fruit is indehiscent, one-seeded with a woody pericarp. Most of dipterocarp species have seed that are desiccation-sensitive or recalcitrant so that moisture physiology is especially important for them. Dipterocarps start bearing fruits at the age of 10 to 20 years in natural forest and repeat it at irregular intervals that do not occur annually, it approximately occurs every 2-10 years. Flowering and fruiting depends on the climatic conditions of the area. Seeds usually shed off at the beginning of the wet season and start germination few days after the seeds have fallen on the ground. Seeds of Bagtikan (*Parashorea malaanonan*) germinate even before they fall on the ground. Flowering and fruiting season last longer in wet and intermediate climatic regions that in dry ones. Seeds have 2 long wings and thus seem to be adapted to wind dispersal but they generally fall directly below the mother tree. Most dipterocarps use a saturation technique to re-seed forests, producing seeds in unison every few years to ensure that predators cannot consume all of their seeds. But with fewer trees left to satiate predators, dipterocarps are increasingly unable to regenerate, according to Professor Lisa Curran, an expert on Indonesia’s dipterocarp forests at Yale School of Forestry and Environmental Studies.

*Figure 48:* Dipterocarp seeds.

Pollinators are not completely known. *Hopea foxworthyi* has been reported to be pollinated by thrips (*Thisanoptera*) while bees and thrips pollinate *Shorea* genus Thrips and bees are mostly the pollinators founded.

**DRAWBACKS IN NATURAL PROPAGATION**

Regeneration of dipterocarp at present is mainly through seeds and wildlings. Inherent problems of dipterocarps are associated with their natural regeneration. These are erratic flowering fruiting and short seed viability. Dipterocarpaceae viability of seeds under natural conditions is short. Seeds should be collected immediately after fruit fall. Their seeds are recalcitrant which remain viable for only 3-7 days after collection. Additionally good seed sources are only available in remote virgin forest of the country. Dipterocarps seeds germinate quickly under moist and warm conditions. According to Thomson, 2006 germination is reduced or does not occur at temperatures below 16º C for several dipterocarps species due to chilling damage. *Parashorea malaanonan* have very low viability and its seeds germinate even before they fall on the ground.

**VEGETATIVE PROPAGATION**

Vegetative or asexual propagation consist in producing offspring that are genetically identical that the mother source. Examples include grafting, layering\(^{20}\), inarching\(^{21}\), marcotting\(^{22}\), cutting and

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\(^{20}\) Propagation technique by a shoot or twig of a plant, not detached from the stock that is laid under ground for growth or propagation.

\(^{21}\) A method of in-grafting by which a short length of stem, without being separated from its parent tree, is joined to a stock standing near.

\(^{22}\) Also know as air-layering. Is a propagation method where a stem is induced to form roots while still on the parent
tissue culture. With clonal propagation the problems associated with erratic or uncertain flowering and fruiting are solved. The technology is no yet fully developed but studies are constantly being carried out by Government, scientific and NGO’s. The main identified propagation methods are mist propagation and non-mist propagation.

**Mist propagation.** Represents the ideal method of propagation where the shoots are placed in a greenhouse or spot with good circulation, using automatic misters with the appropriate conditions to obtain successful propagations. It is an expensive and un-convenient method for uplands nurseries.

**Non-mist propagation.** It is functional alternative to produce high quality planting material of species that have problems with natural regeneration as dipterocarps. This technique is economical and simple and it does not need new technologies not even electricity so can be used in the uplands. It is the most practical propagation technique that has been proven effective to root cuttings of most Philippine dipterocarps. Besides this success, the average unit cost price of producing a clone through non-mist method is estimated as 8 PHP (operational price). Mass production of dipterocarp clones can be achieve using two different methods, a long term approach that produces genetically superior material but takes about 12-15 years because of the need of a clonal test and the short term approach that produces, without a clonal test, relatively good clones within 1-2 years.

**Dracontomelon dao**

There is no information availability about Dao phenology, however Dao is reported to bear flowers almost throughout the whole year. *Dracontomelon dao* has bisexual flowers. The species is regarded as having fruit adapted for dispersal by bats as it has a strong musky odour. The fruit ripens on the tree and is held at some distance from the foliage to facilitate visits by bats.

**PROPAGATION**

Propagation of *Dracontomelon dao* is usually done by seed. 1 kg of seed contains 520-620 seeds or about 70 fresh fruits. Seeds are recalcitrant and should be extracted from the fleshy fruits to avoid fermentation and heating. Pulp and seed can be separated by maceration. Using conventional methods, Dao germination is around 30 % (Oporto and Garcia, 1998). In Malaysia, 85-95 % of fresh seeds germinate after 28-67 days. Trees can also be established by direct sowing as it regenerates easily. In trial plantations in Java, where direct sowing has been practiced, 70% of the sown spots were present after 5 years. Some research have been conducted on clonal dao propagation, Oporto and Garcia, 1998, demonstrated that asexual propagation of dao using no mist propagation can be adopted by anybody interested in the genetic conservation of this species.

![Figure 49: Dracontomelon dao seed.](image)

Plant. The stem is cut partly through and a rooting hormone often applied. Then it is wrapped with moist sphagnum peat moss and ties in place with plastic sheeting. When roots are well formed, the branch is cut below the roots to make a new plant. It is important to bend vertically stems to get orthotropic growth of the future clon.
**Vitex parviflora**

*Vitex parviflora* flowers in the rainy season and fruits ripen within a few months. Planted trees start flowering 5-6 years after planting. Vitex species are hermaphrodite and report to bear seeds every year.

**PROPAGATION**

Molave is mainly propagated by seeds. It has been observed that natural seed germination under mother trees is a failure because it is seldom when the wilding can arise and be gathered. Propagation by stumps and wildlings can be done but the production of stem cuttings is not very successful.

Vegetative propagation has not been developed since seed propagation is rather successful without any sophisticated treatment In the Philippines, *V. Parviflora* is generally planted using bare-rooted seedlings at 2m x 2m, Survival of young trees is enhanced by removing weeds 3-4 months after planting and from then on annually up to 10 years.

![Vitex parviflora flowers.](image)

**Pterocarpus indicus**

**PHENOLOGY**

Seeds mature three or four weeks after flowering. The time to bearing fruit depends on the planting material. When cuttings gathered from mature trees are planted, they flower and fruit within 2-3 years. Trees established from seedlings may take many years (e.g., probably more than 5–7 years) before producing useful quantities of seed. Seed dispersal is mainly by wind. Pods can float consequently water dispersal is likely also be significant for riverine populations.

**PROPAGATION**

Narra can be propagated from seeds, cuttings, grafting, and tissue culture. Seedlings and large branch cuttings are the most common methods of propagation.

Seeds are flattened, and with a seed coat. The pod or seed coat is divided by cross-walls into for or five seed chambers of which only one or two may contain developed seeds.

Stem cuttings can be taken from trees of any age and size, but cuttings of diameter 6 cm or larger will root better than cuttings of smaller diameter. In the Philippines, according to Pollisco, 2001 it was found that
30-cm-long cuttings taken from 20 years old trees, planted in plastic bags under shade, without hormone treatment, rooting of cuttings, the survival is 75% successfully. Plants established from large branch cuttings have the fastest growth, e.g., averaging 2.5cm diameter at breast height growth per annum up to a 4cm dbh annual increment. According to J. Thomson, 2006, this practice should be avoided if timber production is a major objective of planting. According to Zabala, 1979, buds on scions were observed to develop 5 days after grafting, at which time callus formation at the point of stock-scion union was also observable. The species can be successfully propagated through tissue culture, but there is minimum research since propagation by seed and conventional vegetative cuttings is easy.

**Terminalia microcarpa**

*Terminalia microcarpa* has an effective system of self-incompatible. The flowers are pollinated by various insects *Coleoptera, Diptera, Hemiptera, Hymenoptera* and *Lepidoptera*. Some *Terminalia* species are dispersed by water.

**PROPAGATION**

*Terminalia microcarpa* can be propagated by seeds, wildlings, cuttings and grafting. Seeds are edible, severely attacked by insects and other animals, even before the fruit falls. Little information about *Terminalia* propagation was available.

![Figure 52: Terminalia microcarpa fruits.](image)

**6.4.3. Germplasm sourcing, distribution and dissemination: A case study of *Swietenia Macrophylla* in Bohol, The Philippines**

There are two main constraints preventing tree planting in the tropics. On the one hand, germplasm (seed, seedling, or cuttings) availability represents a significant bottleneck in tree planting (Simons, 2004). On the other hand, when germplasm is made available, the genetic material from the original stock was not broaden enough which results in the continuous use of germplasm with a narrow genetic base.

These two problems feed each other, mutually reinforcing themselves. For this reason, it is essential to develop a technically sound robust production and distribution network where genetic quality and appropriate distribution channels are accounted. We should avoid to deliver bad quality germplasm to farmers at the same time that avoiding having quality germplasm only in research centers and universities.

In The Philippines, Mahogany was introduced a century ago. Now it can be found over and wide the island evidencing the successful of the spontaneous development of a production and distribution network. In this section, we lay out a robust germplasm production and distribution
network based on the successes and failures of the production and dissemination of Mahogany germplasm in Bohol.

This species represents a good example in order to develop our delivery network given that, firstly, Mahogany represents an exotic species that has been successfully introduced and spread all over The Philippines and that, secondly, the problems found in this delivery network (e.g. it is believed that Mahogany has narrow genetic base) will help us in the development of a robust delivery network.

6.4.3.1. Introduction

Swietenia macrophylla is a species native of Central and South America that was firstly introduced into the Philippines in June 1913 from the Royal Botanic Gardens in Calcutta, India (Ponce, 1933). The origin of these trees planted in India is reported to be from Honduras. From India, 880 seed were planted in 1913 in Los Baños University. The following year another planting was made between small leaf Mahogany (Swietenia Mahogany) and molave (Vitex parviflora). From this small amount of trees, a regular plantation in pure was made in Boot Valley Makiling National Park in 1933 and also seed from these trees were used in the reforestation project in Camp 7, Minglanilla, Cebu in 1928-1929. Afterwards, more Mahogany stems were planted in the Caniaw Reforestation project, Ilocos Sur. The origin of the reproductive material used in this reforestation is unclear due to the lost of documents during WWII.

In Bohol, according to a key informant from Bilar, Bohol 2006, Mahogany was first introduced in Bilar by the Japanese in 1920. After WWII, a municipal nursery was established in the locality from which Mahogany started to be disseminated.
In 1960, the diffusion started to get consolidated: During the mandate of governor Lino Chatto, thousands of Mahogany seedlings were planted on a tract of Imperata grasslands covering 857 ha in Bilar and Loboc towns. Moreover, during the 60’s-70’s, as an attempt to combat the fuelwood crisis, the Bureau of Forest Development (BFD) provided farmers with seedlings for free and seed collections from College of Agriculture, Forestry & Technology, Billar, Bohol and the Municipal Hall in Bilar were also organized. Private individuals collected seeds in the plantation by their own initiative.

![Figure 54: Density of Mahogany plantation in percentage according to DENR, 2004, Bohol. Source: List of Mahogany plantations, DENR, 2004.](image)

Within less than 90 years Mahogany has been successfully domesticated and is widespread all over Bohol and throughout the country. The combination of factors that contributed to the current abundance of the Mahogany are treated subsequently.

### 6.4.3.2. Factors affecting the spread of Mahogany within the Philippines

**a. Promotion and encouragement of its use**

Since the implementation of reforestation programs in the Philippines, Mahogany has been broadly encouraged by the government mainly because of its rapid growth and its quality timber with a high international market value. It has been considered as a miracle tree. Several projects and government programs encouraged and wide-spreading on-farm tree adoption process in Bohol:

1985-1992: the Central Visayas Regional Project, a World Bank assisted project with tree planting component in selected LGUs.

1989-1992: the DENR-ADB/OECF Contract Reforestation. This project had Family Approach Contract component wherein farmers within timberland were contracted for three year to reforest their farms at P16,000 /ha.

1993-1996: the Volunteerism for Irrigation Project, as part of the nationwide tree planting program Clean & Green Program as a special project on tree planting in watershed and farm lots for water conservation in support to irrigation.

1996, the Training on Silvicultural Practices, as part of the Clean & Green Program as well, where Mayor Digal of Loboc sponsored a training on Silvicultural Practices for the farmers, conducted
by PENRO Bohol in support to the flourishing furniture of the municipality. The mayor had also encouraged all barangays to establish at least a hectare of tree plantation for the furniture industry (GOLD, 1995, Yao unpublished).

1997 up to the present: the Bohol Tree Enterprise Program. It was initiated within the province under Bohol Environmental Management Office (BEMO), which promote tree enterprise for self sufficiency in lumber/livelihood and improved environment through training on silvicultural practices for optimum tree growth at the earliest possible time. The program was assisted by the Governance on Local Democracy (GOLD), a USAID assisted project (Yao et al, 1998).

2002-2005: the Community Based Resource Management Project. The second World Bank assisted project in selected LGUs with tree planting component.

b. Reproductive biology and seedling temperament

Mahogany can grows easily in diverse climatic situations: It grows at altitude near seashore up to 1000 m above sea level. It grows well with mean annual rainfall ranging from 750-4,500 mm, it grows in difficult types of soil (even though thrives best well-drained sandy clay slopes and shallow alluvial soils).

Mahogany reaches maturity (diameter 15-20 cm) at the age of 15 years approximately. The main advantage is that it bares seed every year and in great amounts. Mahogany seed do not need any treatment to stimulate germination and even though seeds maintain its viability only for few months, germination is usually high. The seed bank is easily stimulated by rain or water.

During its initial performance, Mahogany can tolerate completely either sun exposure or shade exposure. Even though, for a considerable growth rates and survival and to reduce pest risk it is better to provide partial shade for young seedlings.

c. Demonstrative effect

The demonstrative effect that pioneer Mahogany adopters within communities and neighbours meant a significant aspect in the Mahogany diffusion by encouraging other farmers to planting trees. Several farmers declare that they were interested in planting and planted Mahogany after observing the success of some of the Mahogany adopters after the successful sale of their timber production.

The effect of the programs above mentioned also stimulates Mahogany utilization. Accordingly to Yao, 1998 where 45 farmers from 10 municipalities within Bohol were interviewed, a majority of the Mahogany growers (80%) recognized they have been influenced or encouraged to plant timber trees because of the demonstration effect of the programs above mentioned.

6.4.3.3. Farmers’ practices regarding reproductive material

Germplasm supply is mostly conducted by seedling and wilding rather than seed. As represented in figure 54, 59% farmers in S. Isidro utilize wildlings as the main planting material, mainly gathered from the neighbor’s mother tree. Once the neighbor tree is mature and starts bearing seeds, seeds germinate naturally under the shade of mother tree and are transplanted and usually planted direct bare-rooted in the farm or sometimes cared for some days in a nursery. 26 % of the farmer plant seedlings that were given from a nursery, generally potted seedlings and rarely bare rooted seedlings. The seedlings are never bought and always given for free by the DENR, LGUs or NGOs within specific projects. Another 6 % of farmers plant seedling themselves, by their own
initiative gathering and rising seeds by growing them in plastic bags. Few farmers, just a 9% of them, plant by directly seeding with the common risk of being eaten by mammals and birds. It is important to notice that planting by cutting is never complete by farmers.

![Type of planting material used by farmers in S. Isidro, Bohol.](image)

**Figure 55:** Type of planting material used by farmers in S. Isidro, Bohol.

### 6.4.3.4. Mahogany germplasm origin

Moreover the questionnaire conducted in San Isidro, another questionnaire was conducted to 76 farmers, owners of Mahogany plantations; throughout the island with the aim of learning about the organization and development of the Mahogany seed production and distribution network in Bohol. The farmers were asked about the origin of the seed or seedlings they used to establish the trees they planted. Most of the farmers, 52% of the interviewed got seed, seedlings or wildling from Bilar Municipality, placed in the central part of the island.

![Germplasm origin of Mahogany plantations, Bohol.](image)

**Figure 56:** Germplasm origin of Mahogany plantations, Bohol.

The different origins of the germplasm within Bilar municipality are four (figure 55). DENR has been the promoter of all of them, fact that suggest that procedence of these origins may be the same.

*Rajah Sikatuna Protected Landscape* and *Man-made forest* are protected pure Mahogany plantations. They were established at the same time, bordering each other, one is within Rajah Sikatuna National Park and the other is in the buffer part of the Park. This *man-made* plantation is easily accessible since the main road of the island cross the plantation. CVSCAFT (*Central
Visayas State College of Agriculture, Forestry and Technology was formed in 1989. During its establishment, several Mahogany trees were planted in the campus and nowadays its students gather and deliver germplasm to their municipalities. The last identified origin in Bilar was the DENR nursery, established with the aim of delivering reproductive material.

### 6.4.3.5. Study of germplasm distribution and diffusion networks: an application of principles of network theory to the production and distribution of tree germplasm

Going over networks, recently, investigators have discovered that many networks are dominated by a relatively small number of nodes that are connected to many other sites (in contrast with random networks that have not defined pattern). This networks that contain such important nodes (also called hubs) tend to be call scale-free. Scale-free in terms that some hubs can have a fairly unlimited number of links and no node is typical to the others. The main characteristic of scale-free network is that some nodes have a tremendous number of connections to other nodes; this guarantees that the system is fully connected, whereas most nodes have just a handful of connections. Another attribute is that they are extraordinarily resistant to accident failures. Failures which occur randomly consequently their very connected nodes, which are statistically unlikely to fail under such conditions connectivity in the network is maintained. It takes quite a lot of random failure before the hubs can be wiped out, and only then, the network stop working. The main problem of scale-free networks is that they are extremely vulnerable to coordinated attacks. In an organized attack or natural event, the scale-free network fails catastrophically. Taking out the very connected nodes will make the whole network stops functioning and it will completely disrupt the network isolating nodes by blocking the links.

The disposition, nature and characteristics of the distribution and diffusion scale-free networks will determine the success or failure of the process and the understanding of the characteristics may help in developing strategies for preventing the network to fail. The failure of this network will lead either to lack of planting material or to lack of quality planting material (e.g. some scientific believe that the quality of Mahogany is disputable since it is believed that all the reproductive material comes from a small seeds stock) consequently it is desirable to developed firm initiatives and actions to build up a robust and extensive germplasm production and distribution network.

The scale-free model assumes that the network continually grows by the addition of new nodes. A new node connects to two existing nodes in the network at time $t + 1$. This new node is much more likely to connect to highly connected nodes, a phenomenon called preferential attachment. The dynamism of this scale-free networks is characterized by a constantly growth by preferential attachment. A scale-free system favors the rich nodes and the rich get richer over time.

In the design of a Scale-free network the key element is the identification and establishment of strong hubs that will emowers the whole network and ensure the success of the strategy. Subsequently, by means of farmers, neighbours and farmers organizations, links with the hubs will be developed and establish by their own initiative. Hubs identified on the Mahogany delivery network are performed in the following section. Also, new possible hubs and transformations in the already existing ones are suggested in the section 8.

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23 It is important to distinguish clearly between distributions as the process of supplying goods from dissemination as the act of dispersing or diffusing something once it has been introduced. Distribution is conducted basically by LGUs, NGOs, community based organization and private sector while dissemination is accomplished by farmers and farmers groups. Both processes are extremely important in domestication strategy. The first, as the supplying process while the second to ensure sustainability and the continuity of the activity.
6.4.3.6. Identification of Hubs

From the interviews conducted throughout Bohol we identified the main hubs of the Mahogany delivery network on a regional level. These hubs from which the interviewed farmers gathered the seeds are presented in the next figure.

![Diagram showing the distribution of Mahogany germplasm hubs in Bohol.]

**Figure 57:** Germplasm distribution hubs within Bohol.

As previously mentioned the procedence of these four origins within Bilar could be the same. The procedence may come from the 880 seeds that were introduced in the Philippines since there are not records of further introductions within the islands.

According with the interviews conducted in S. Isidro, Bohol the origin of the reproductive material from which farmers obtained, in a municipal level, the germplasm is represented in Figure 58. The diffusion of the material once it has been introduced is successful as we can observe since 38 % of the farmers acquire the germplasm from their neighbours. Also 74 % of the interview farmers affirmed they gave germplasm to their neighbours and relatives meaning that farmers are not reluctant in delivering or providing seeds or seedlings to other people.

![Diagram showing the origin of Mahogany germplasm in S. Isidro, Bohol.]

**Figure 58:** Mahogany germplasm origin in S. Isidro, Bohol.
The different distribution nodes identified in the *Swietenia Mahogany* delivery network are explained in detail:

- **San Isidro Elementary Central School (Municipal hub 1):** Placed in Poblacion, the main barangay of the municipality, represent the only school of the whole village. In 1990, as an approach to accomplish reforestation activities that were been carried all over the country, DENR established 1 ha Mahogany plantation. According to Lourdes Samoya, Master teacher of the school the process of germplasm distribution within the school consist mainly on a program in which student of several courses are required, once provided Mahogany seeds from the school plantation, to plant them somewhere. Another action that enforces the use of Mahogany is that in every official event, the school celebrates it by planting trees. Lastly, the fact that many students gather seeds voluntary to plant in their farms also favoured the distribution.

- **Municipal nursery (Municipal hub 2):** This nursery is currently on unused. It is placed in Poblacion. It was established for first time in 1976 by the mayor of S. Isidro municipality. The nursery was settled with the aim of delivering Mahogany seedlings within the farmers of the municipality as part of a municipal project. The seeds where provide by the DENR and rose within the collaboration of the LGU and the Municipal Agriculture office that were the responsible of delivering the seedlings. The activity had specific character and once the seedlings where raised all where delivered within 4 months. There is no data about the amount of delivered seedlings. A program of temporal germplasm delivery can be conducted by using the area where the nursery was placed. Firstly for some months and after a plantation should be established from which in the future vegetative reproduction and seed collection can be performed by instructors and the own farmer.

- **Barangay captain temporal nursery (Barangay hub1):** As initiative of a subsequent mayor, another activity in addition of the previous one was conducted. The activity consisted in providing barangays officers with a wildling (collected from neighbors’ trees) or seedling stock. They were encouraged by means of monetary help to establish the nursery to provide smallholders with seedlings. The activity, as well as in the other project, was specific but some of the nurseries are still on use.

- **College of Agriculture, Forestry & Technology, Bilar, Bohol (Regional hub 1):** The College is placed close to the big above mentioned Billar plantation. Students from the college where encouraged to gather seeds and wildlings and their contribution in the spread of Mahogany was of importance. They brought seed to their respective places to plant and to harvest in the future. The demonstrative effect of successful harvesting acted as an incentive to encourage other farmers in planting Mahogany as well. Close to the college, there is riverside dipterocarp woodland planted in 2001 by the Haribon foundation that can be used to gather seeds and develop vegetative propagation once the technique had been developed in the hedge-garden. Currently there is an initiative been carried out in the developing of the hedge-garden planed by DENR, Water and Soil Conservation Foundation and ICRAF ensemble project. Haribon plantation is placed close by one of the main roads of the island so its accessibility its not identify as a collection problem. This action increases the amount of reproductive material from other origin.

- **Neighbors’ mother tree (Barangay hub 2):** Once some farmers have adopted Mahogany in the barangay or municipality the diffusion of the seeds or wildlings is easy by gathering for the mother tree. The farmers with more social relationships will be the better contributors to the seedlings and seeds diffusion acting as main nodes.
In figure 59, the scale-free delivery germplasm network based on the identified nodes of San Isidro is represented. Red nodes represent indigenous timber tree plantations were germplasm can be collected while blue nodes represent less linked nodes. These distribution nodes, in the design of the strategy, should be implemented by an improvement program with the aim of ensuring an appropriate genetic quality of the germplasm.

Figure 59: Diagram of scale-free delivery germplasm network based on the identified nodes of San Isidro, Bohol. The codifications of the hubs are BP: Billar plantation, BC: Billar agriculture collage, SPA: Seed production area, HG: Hedge-garden, IOF: ICRAF on-farm trials, BN: Barangay nursery, CP: Church plantation; CN: Capitan nursery, SC: San Isidro school, MN: Municipal nursery.

6.5. SILVICULTURE AND TREE MANAGEMENT WITH TIMBER TREES

Building on what farmers know and practice is a valuable mean of ascertaining strategies. In this study different Mahogany farming system and management practices are regarded and characterized according to the 43 interviews conducted in S. Isidro, Bohol. The aim of the study is to determine future management possibilities of indigenous timber trees under the assumption that farmers conduct similar management practices with the different timber trees. Considerations of the differences of temperament and requirements will be also considered. Afterwards, an analysis and evaluation of the survival and initial performance of selected species will be conducted.

Before beginning to discuss tree management and silviculture, it is important to consider some aspects:

- Traditionally, farmers do not have a strong forestry culture. As inhabitant of the forest, farmer have gather forest products in small scale to satisfy their household needs and just on grounds of environment change, they have seen the need of adopting forestry practices and accumulating knowledge about timber trees and how to cultivate them.
• From 30 years to now, country politics and legislation focus on forest management and conservation has significantly shifted from highly technical industrial forestry towards landholder-based forest management and social forestry. Farm forestry is more closely aligned with small-scale forestry than with industrial forestry since the average size of the managed area is relative to farmers or communal property. Mangaoang, 2002, suggests the appropriate term “smallholder forestry” as an expression that includes farm forestry, agroforestry and community forestry as practiced by families who have ownership or control over small parcels of the barangay land and sometimes a share in the use of common property land. As an incentive in the shifting of these practices, International organizations as Asian Development Bank and World Bank are assisting small communities in establishing production and conservation plantings on common property lands.

• Timber tree silviculture, management and utilization are conditioned by limiting forces as food security and the need of quickly income. Poor upland farmers’ livelihood, as consequence of their limited economic opportunities, depends on crops and cash income. This is the reason why growing timber trees is not a main source of income and consequently is not a first priority for them, even though farmers regard timber as a valuable product.

6.5.1. Farm characterization

As it is shown in the below graph, it is important to consider that most of the farmers in San Isidro have small size farms (<3 ha) and that the number of trees for most farmers is within 100 and 1. All farmers interviewed have planted Mahogany.

According to a study conducted by CENRO, Tagbilaran, 2005, most of the tree farms in Bohol are small size (< 1ha) representing 73 % of the tree farmers in Bohol.

Table 24: Percentage of small tree farms in Bohol (Source: CENRO Tagbilaran, 2005)

<table>
<thead>
<tr>
<th>Farm size (ha)</th>
<th>No. of tree farmers</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1ha</td>
<td>1,045</td>
<td>73</td>
</tr>
<tr>
<td>1–5ha</td>
<td>351</td>
<td>24</td>
</tr>
<tr>
<td>&gt;5ha</td>
<td>45</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>1,441</td>
<td>100</td>
</tr>
</tbody>
</table>

The tree density found in the characterized farming systems of Bohol is diverse. While the average number of Mahogany trees per farmer is 31, high tree densities have been recorded in woodlot plots where the density moves in high ranges of 53 trees/ha and 399 trees/ha. In The Philippines, high tree density and close spacing have been typically promoted whether the programs were concerned with plantation forestry or smallholder agroforestry (Agapaoa et al., 1976; Valdez, 1991, Gacoscosim, 1995; DENR-ERDB, 1998).

6.5.1.1. Mahogany Tree Farming Systems Characterization

The main tree farming systems identified in the research area of Bohol and Leyte are the following:

Tree fallow

Represented by a portion of land that is not been currently cultivated. The reasons of this status are either because it is a secondary growth forest or because the land as been abandoned to let the land recover while planting trees on it. Secondary growth forest is composed mainly by the last remnant of secondary forest. It is formed by the residual indigenous trees were few planted trees mostly timber are included (e.g. antipolo, caimito). Planted tree fallow is also an uncultivated land
that is planted with diverse practical trees for their day by day livelihood mainly fruit, fodder, timber and medicine trees. The distinction among both groups is not obvious because of the usual combination of secondary growth forest with planted trees.

**Figure 60**: Planted tree fallow land where timber and other purpose trees grown together.

**Figure 61**: Secondary growth tree fallow where planted Mahogany stems grown together with natural regeneration.

**Tree intercropping**

Tree intercropping is an agroforestry system characterized by the combination of banana, buri (*Corypha elata*), coconut palms (*Cocos nucifera*) and root crops (e. g. cassava, finger lady) intercropped with Mahogany. In this system, timber trees are established under palm or banana shade. Once trees mature, they can receive full sunlight. The main problem associated with these systems is that once timber trees reached maturity, they are shade the tree intercropping system. This is a good system when coconut palm needs to be replaced when they are too old. In field observation, as consequence that timber trees were shading coconut palms, some Mahogany stems were cut at breast height.
Trees on contour-lines intercropping

In this agroforestry system, trees are planted on a contour grass strip, 6-8 m far to the next one. In the alley between the trees, crops are planted for long periods. In this situation, as consequence of the most intensive management, lower management cost and light conditions, trees can grow faster and farmers can benefit from the reduction of area lost. Additionally thinning and pruning avoids shade to the intercrop. This system is mainly practiced in steep slopes as the combination of the grass strips and trees are effective in controlling soil erosion and researches demonstrate that facilitates control erosion. It is also demonstrated that the stems of the contours, benefited from the fertilization that is given to the crops (Garrity & Mercado, 1994).

Woodlots

It is particular case of tree fallow were only one species is planted and it is arranged in 2 x 2m or 2 x 3 m. Represent a small scale plantation were trees are planted for an intensive management.
Most of the woodlots are always planted and configured by blocks. The main problem found in this kind of management was the close stem establishment and the reluctance of some of the farmers in practicing thinning. As consequence, fast growing light demanding species as Mahogany grow poorly and unhealthy.

![Figure 64: Mahogany woodlots in San Isidro, Bohol.](image)

**Trees on boundaries**

Trees on boundaries are an agroforestry system consisting of grassland (generally used for livestock grazing) and few generally mature palms. In this system, timber trees are usually planted as living fence boundary in one, two or sometimes three lines to delimitate property.

In pure crop systems composed by rice paddy fields and pure crop lands, farmers usually do not plant timber trees because of the decreasing yield that shade of crown would cause. If trees are planted, it is always done at low densities, either on the farm boundaries or in the contours lines of the plot.

For higher tree densities and if crop production is a priority, trees are usually planted in other farm niches away from the crops, such as home-gardens, farms boundaries or fallows rather than on cultivated land.

![Figure 65: Mahogany on a farm boundary in San Isidro, Bohol.](image)
Table 23: Main farming systems where Mahogany trees were founded

<table>
<thead>
<tr>
<th>Farm System</th>
<th># Interviews Farmer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree intercropping</td>
<td>16</td>
</tr>
<tr>
<td>Trees on boundaries</td>
<td>5</td>
</tr>
<tr>
<td>Trees on contour-lines intercropping</td>
<td>2</td>
</tr>
<tr>
<td>Tree fallow (planted trees)</td>
<td>20</td>
</tr>
<tr>
<td>Tree Fallow (secondary forest)</td>
<td>5</td>
</tr>
<tr>
<td>Woodlots</td>
<td>4</td>
</tr>
</tbody>
</table>

Farm niche

The distribution of planted trees has been categorized according to three aspects:

1. **System of planting or arrangement**: It has been classify on
   a) Mixed planting: Trees planted scattered with different species.
   b) Line planting (e.g. contours, plot boundaries)
   c) Woodlots planting: Small-scale monoespecific plantation.

2. **Farm Niche**: Determine the position and subsystem in the plot where the trees are planted.
   a) Cropland
   b) Pasture land
   c) Fallow land
   d) Farm boundary

3. **Slope niche**: Determine the position of the trees regarding to gradient of altitude.

**Figure 66**: Distribution of the planted trees accordingly to these aforementioned factors is represented in the following figures. Y exes represent an adjustment of the different slope niche classification for every system of planting within each farm niche.
6.5.2. Culturing treatments

Tree farming is a new practice for most farmers in San Isidro and in the Philippines in general. With a limited knowledge about silvicultural practices and weak extension system, farmers must learn about tree management by trial and error. The main tree management practices are:
**Pruning:** In San Isidro, Bohol, 66% of the respondents practice pruning. It is primarily done in order to obtain fuelwood or to reduce shading to farm crops. For this reason, farmers usually practice excessive pruning that sometimes compromises tree survival. There are many conditions in this practice: some farmers exercise it only the first years, until reach or if the plot is far away whenever they go to the area. All farmers identify as the main reason to practice it straight growth, shade reduction and use of the pruning products.

**Thinning:** It is not commonly practiced by farmers. Only 18% of the interviewed farmers in San Isidro have practice thinning while 9% see the necessity of practice it. The objective of this practice is to liberate over-crowded stems, redistributes total growth of the stand to a few larger stems increasing the growth of the remaining trees. Generally, farmers are very reluctant to carry it out. The cause is that farmers identify thinning practices as activities that decrease timber production instead of increasing timber quality. The main reason to carry out this practice is the identification of poor growth as consequence of the really close spacing (e.g. 1 x 1 m). The reasons farmer plant with such a close spacing is to maximize timber production in a reduced area. The result of thinning is the increase of the future timber production. Once trees start growing and competition between trees and branch crass thinning is identified by farmers as a need to increase future timber production. Some farmers with higher forest culture plant close spacing with the aim of having straight boles and afterwards practice severe thinning (50%).

**Fertilization:** Most of the farmers (88%) do no add any kind of fertilizer to increase tree growth. The objective of fertilizing is to obtain higher growth decreasing yield time. Lack of resources contributes in the fact that only 6% of the farmers practice organic fertilization by gathering branches, bamboo mulching and crops litter. Other 3% of them add compost as fertilizers. Even though farmers do not practice generally tree fertilization (only for a few higher-valued fruit tree species) they do use (N, K, P) fertilization for the crops. This fertilization, except in secondary growth forest or when planted by blocks, affect positively to the planted trees.

**Weeding:** Weeding is a very common practice among farmers, 94% of the interviewed farmers practiced it. The objective of this practice is to avoid competition supporting trees growth. The way to carry out this practice is predominantly by ringing around the tree stem or in the whole area when other crops are near by. This practice takes place only in the first 2-4 years and the frequency depends on the location of the farm being none if the plot is far or isolate. Farmers usually practice it when weed reach a considerable size and compete with tree growth. The results of weeding identified by farmers are mainly higher survival and performance rate.

### 6.5.3. Harvesting

Undersize harvesting below 25 cm dbh is very common in Bohol, resulting to very low percentage in lumber conversion. Harvested trees are also under age: below 20 years old for Mahogany. The medium harvesting age is 14, 1 year while the optimum age considered by farmers is 15, 7 years old. This premature harvesting age and ignorance in relation with the optimum harvesting age affect directly to wood quality with the overall effect on lowering price of lumber.

### 6.6. MARKETING

Nowadays, The Philippines is a net timber imported. In 2003, 356,000 m$^3$ of logs, 338,000 m$^3$ of sawn wood and 93,000 m$^3$ of veneer were imported (ITTO 2005). Accordingly to Orejas, 2002 this importation is exhausting the foreign country currency reserves at rate of 14 billion PHP per year. Currently, the low resource availability of commercial timber in the remaining forest is increasing the need of trees planted on farms to sustain regional industry. The use of agroforestry
and other systems outside forest is becoming the most important source of wood across the countries since the past two decades. Presently, large amounts of the timber traded comes from trees grown on small farms in the sloping uplands. The timber products obtained from these trees outside the forest contribute to meet household requirements and satisfy market demand, generally in a local level as a result of the magnitude of the current production but sometimes as regards to Mahogany timber, is raised to an international level. Now, when trading with indigenous species, the current police (discuss in the next section) discourage timber planting and timber trading.

Analysis of actual timber market and market potential of domesticated species are essential process that should be study in the national level as well as in the international. Identification of the marketing players, product pricing and competence analysis should be also conducted for a better understanding of the market process. In this approach general information about the current market situation in Bohol Island is studied and recommendations for the future market are done.

6.6.1. Elements of the current market system

The market structure or players identified in Bohol is represented in the following figure.

![Marketing channels in Bohol](image)

Figure 67: Marketing channels in Bohol.

Upland farmers and lumber dealers are connected by the middleman, known for everyone. Both, middleman and farmer contact whenever there is a need to sell or to buy lumber. Farmers sell their trees on stump by an estimation of the board feet \(24\) contained in each stem. The stock that each farmer sells is small-scale but middleman makes transportation profitable by means of

\[1m^3 = 424 \text{ bdft}^{-1}\]
joining the scattered production of the same municipality. Also the use of light trucks makes easy
to charter the vehicle. Transporter descend the lumber to the city where they are sold or export to
the closest commercial island Cebu. Craftsmen buy their products from the lumber dealer but in case of illegal wood, the whole tree is delivered directly or transported directly for him.

**Infrastructure**

Market places are found in the main cities within the island. Logs and planks all over the uplands
go down the cities, to the main shops. The access to the upland is by a un-pavement and rocky road that it does not allow the use of heavy tracks. Carabao or men are the means used to move the logs to the main road where it is stored until the amount of timber in the area is enough to charter the truck. Usually timber piles do not stay longer than fifteen days.

**Demand and supply**

Accordingly with the interviews that were conducted thought Bohol, furniture craftsman, lumber dealers and transporters, stated that the main timbers trees that are been traded currently are Mahogany, Gemelina and illegally cut Molave.

Gemelina is considered as a rather hard lightwood valued because of its resistance to termites attack. It can be used for the construction of plain material. The main limitations founded in the species are its lack of carving qualities, its warping tendency and the propensity to be damaged by weathering. Gemelina is mainly traded within the island as lumber supply and when harvest old is used as a poor substitute of the expensive and high quality molave timber.

Mahogany timber is a hardwood appreciated because of its nice color and facility to export due to its famous and historically market use. This timber is mainly export to Cebu Island, the second largest and commercial important city in the country. In Bohol, is not high appreciated and the price is decreasing because of market saturation. The main limitations of Mahogany wood are the tendency to warp and to be attacked by termites and other borer animals. The early timber harvesting joint with the lack of timber drier factories and facilities to treat the wood are the main reasons that are leaving out Mahogany of the local market, been only the biggest lumber dealers that exports to Cebu the interested party of the whole Mahogany market in the island.

The hardwoord timber that is highest in demand in Bohol nowadays is molave (*Vitex parviflora*), and is currently a very rare species. The raw supply is very low but its high durability, nice colors, high market value and capability to curve make it highly demanded. It was singled out as highly valued for its durability and high quality for furniture, construction materials and farm tools. The farmers also noted that lumber from molave is highly water resistant. Home furniture made from this tree are highly appreciated. The single problem that this timber presents is the existence of knots in some of the stems. Presently molave is being logged illegally. The market structure of this product lack of transporters since this activity associated to this product is illegal. The own seller (usually farmer) is the responsible to transport the stems generally one by one, furtively at night time. This way the processor can do away with problems in the legalities of buying and transporting raw materials from the timber suppliers or sources. Because of the policies that permit the sale of processed timber materials is only found in furniture craftsman shops.

According to the respondents there is a suitable supply of Mahogany within the island and Gemelina within the country. The entire interviewed furniture craftsmen agree that Molave, Narra and other indigenous trees supply is not enough to satisfy the demand.
Other timber species that are minor traded are Acacia (*Acacia sp*), Narra (*Pterocarpus indicus*) and Jackfruit (*Artocarpus heteropyllus*). They are hardwood exclusively traded by craftsman. Another minor traded species is Malay lauan, coming from Malaysia. This species was found only in IDEAS, a high quality furniture shop of the capital of Bohol.

**Prices**

The price of farm-grown timber is influenced, aside from the demand and supply by its size and quality of the log. Usually trees are harvested too young consequently the quality is not good. Trees are sold estimating the board feet (bdft\(^{-1}\)) that the stand tree comprises. The current stumpage price of Mahogany and Gemelina are correspondingly 7-10 PHP\(^{25}/\)board feet and 5-8 PHP/board feet. The price that lumber dealers or furniture craftsmen pay to Mahogany and Gemelina transporters for this timber is around 17-20 PHP/ bdft\(^{-1}\) and 12-16 PHP/ bdft\(^{-1}\). This 10-11 PHP of different is the amount to divide between the chainsaw man, the transporters to the main road (only 1 PHP/ bdft\(^{-1}\)) and mainly to the final transporters. The final price paid for Mahogany is 25-26 PHP/ bdft\(^{-1}\) and for Gemelina 20-23 PHP/ bdft\(^{-1}\).

The price that furniture craftsmen pay for Molave and Narra is 30-35 PHP/ bdft\(^{-1}\) and when the stems are not sufficiently big 25 PHP/ bdft\(^{-1}\). Acacia and Jackfruit are sold for around 25 PHP/ bdft\(^{-1}\) while Malay lauan cost 28 PHP/ bdft\(^{-1}\).

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\(^{25}\) 1 Euro = 66 PHP (Philippine peso), June 2006.
Table 25: Uses and market value of species to domesticate are showed in. Source: PROSEA, 1994.

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>USE</th>
<th>MARKET VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apitong</td>
<td>Medium hardwood. Construction and interior works</td>
<td>Trade name: Keruing. One of the most important exports timbers of Southeast Asia. Second only to meranti.</td>
</tr>
<tr>
<td>(D. validus)</td>
<td></td>
<td>Trade name: White seraya. Small amounts of this timber were sported and mostly to USA.</td>
</tr>
<tr>
<td>Bagtikan</td>
<td>Light hardwood</td>
<td>Trade name: Merawan sometimes sold as meranti. One of the more exported in P. N. Guinea</td>
</tr>
<tr>
<td>(P. malaanonan)</td>
<td>Veneer, inexpensive cabinet,</td>
<td></td>
</tr>
<tr>
<td>Dalindingan</td>
<td>Light and medium heavy construction.</td>
<td></td>
</tr>
<tr>
<td>(H. foxworthyi)</td>
<td>Medium hardwood</td>
<td>Exportations within the Philippines never significant but it has high prices.</td>
</tr>
<tr>
<td>Dao</td>
<td>Veneer, furniture.</td>
<td>Mostly used locally and export in P. N. Guinea.</td>
</tr>
<tr>
<td>(D. dao)</td>
<td>Hardwood</td>
<td>Trade name: red meranti or Philippine light red Mahogany.</td>
</tr>
<tr>
<td>Molave</td>
<td>Carving, furniture, house building.</td>
<td>Constitutes the economically most important timber group in Southeast Asia.</td>
</tr>
<tr>
<td>(V. pariflora)</td>
<td></td>
<td>Well known in the international timber trade, and there are established markets in Asia, Europe, USA and Australia/NZ.</td>
</tr>
<tr>
<td>W. Lauan</td>
<td>Light hardwood</td>
<td>One of the major exporter timbers in P. N. Guinea.</td>
</tr>
<tr>
<td>(S. contorta)</td>
<td>Construction, cabinet and furniture works.</td>
<td></td>
</tr>
<tr>
<td>Narra</td>
<td>Hardwood</td>
<td>Trade name: Kalumpit.</td>
</tr>
<tr>
<td>(P. indicus)</td>
<td>Carving, cabinet, furniture.</td>
<td>One of the major exporter timbers in P. N.</td>
</tr>
<tr>
<td>Kalumpit</td>
<td>Hardwood</td>
<td>Trade name: Kalumpit.</td>
</tr>
<tr>
<td>(T. microcarpa)</td>
<td>Furniture, cabinet, interior work.</td>
<td></td>
</tr>
</tbody>
</table>

According to our respondents, the demand of dealing with the trees species that this strategy proposes is high. The main restriction that they identified is the low availability of such products and the difficulties bureaucracy that means work under the legality. Current laws permit to cut trees whenever the logger/cutter has been the one to plant it but the maze of registrations and regulations discourage farmers. A decreasing trend in the supply of raw materials especially for premium timber (e.g. molave and narra) is acknowledged by furniture makers, while the demand especially for quality furniture products is very high. Even the supply of exotic timbers is insufficient. A 14% of the respondent did not know the name of the trees we where interviewing and that are not growing nowadays in their area, mainly because they have been short time working in their occupation or the isolated of the place. Cause of the well-known high quality timber that this indigenous trees provide there is no doubt that the market acceptability of then will be high. Moreover, currently Molave and Narra timber have a ready existing market and are highly demanded even within the illegality.

6.7. LEGISLATION AND REGULATIONS

The current applied legislation in forested areas is complex. On the one hand, the government aims to control the great amount of illegal loggings throughout the natural forests and on the other wants to encourage smallholders’ timber plantations. The fact is that much more attention is focus on stopping illegal loggings and on avoiding timber commercialization that on promoting indigenous timber trees plantations.

The current required timber registration process dissuades farmers on planting trees. Poor understanding by smallholders of DENR polices related to tree registration, harvesting transport and marketing, discourage farmers. They feel tree registration as a costly and laborious mission.

The main considerations related with tree harvesting are the following:
6.7.1 Tree registration

According to DENR (*Sec. 1b, DMC No. 9-20*) all private tree plantations before given the approval for their timber harvesting should be registered independently of the tree species. The requirements needed to register a tree plantation are: 1. Letter of intent, 2. Certified of Land Ownership Award, Land title or Tax declaration of untiiled Alienable and Disposable lands (A&D) with pending application form titling, 3. Certification of tree plantation ownership from the Barangay Captain or Municipal Mayor, 4. In case where the tree planter/applicant is not the sole owner of the land, an authorization from the co-owner shall be secured.

The steps that tree registration process (*Sec.2.1, DMC No.97-09*) involves are:

1. Visit to the CENRO office concerned. Submit all the required and previously cited documents for tree registration to the person in charge.
2. Arrange schedule of inspection by CENR personnel, where a CENR officer travels to the site recording the planted trees (Tree Plantation Record Form) and prepares a sketch map showing the extent of the plantation, and certifies the plantation record (copies of the certification being held by the DENR).
3. Issuance of Certificate of Tree Plantation Ownership (CTPO). That will prove the ownership of the planted trees.

All tree plantations can be registered any time, if it is a newly established, fully established or even if the trees are reaching maturity and ready to harvest. The assistance should help in the acquisition of harvest and transport requirements easily. Mangaong (2005) has reported that in some CENROs there are fees collected for tree registration. It should be noted that there is no regulation in the DENR that requires fees to be charged for tree registration, but tree registration is not consider as a ‘regular activity’ of the CENRO office. Currently, the interested tree planter is requested to shoulder the cost for the transportation and the field time of the inspector who goes to his area and prepares the sketch map even though these fees are not clear. That is the only expense that the tree owner would have to bear, other than perhaps a small certification fee of 30 PHP. There are no other fees that should be collected by the CENRO. Tree registration is a process that provides the benefit of free technical assistance from DENR and related agencies, especially on tree growing technologies and marketing.

Concerning recording and reporting, the CENRO should always keep a record of all registered tree farms (*Sec.3, DMC No.97-09 & Sec. 1c, DMO No.99-20*), and maintain a database of the Tree Plantation Record, to submit it to the regional office and the Forest Management Bureau (FMB), which maintains a database of tree plantations in the Philippines. Periodic reports of activities undertaken within private tree plantations have to be submitted in order to update the DENR database on the development status of the said plantations.

6.7.2 Harvesting requirements

There is no requirement of cutting permit for ordinary species that are the ones that are not premium hardwoods (*DMC No.97-23 & DMC No. 99-20, Sec. 2*). For harvesting tree plantations of premium species and naturally growing trees (they are controlled under the same legislation) on private titled lands a Special Private Land Permit (*Sec. 2, DAO No. 2000-21*). Special Private Land Timber Permit is a permit issued to a landowner specifically for the cutting, gathering and utilization of premium hardwood species. The documents needed are: 1. Letter application of landowner, 2. Authenticated copy of land title with approved sketch map of area applied for, 3. Development plan, if application covers ten hectares or larger with at least 50% of the area covered with forest trees, 4. Endorsement from any of the following LGU officials: a) Barangay

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Chairman, b) Municipal/City Mayor, or c) Provincial Governor concerned, 5. Endorsement by Local Agrarian Reform Officer for areas covered by CLOA, 6. Inventory based on existing regulations, 7. Initial Environmental Examination (IEE) as basis in issuance, 8. Certification from the CENRO concerned that the land subject of PLTP/SPLTP application is within a certified A & D land.

6.7.3 **Transporting requirements**

Before transporting harvested products, an accomplished Self-Monitoring Form\textsuperscript{26} (SMF) must be submitted to the concerned CENRO. The approval of the SMF requires a previous check of the tree products by CENRO personnel, where the officer checks the products to be transported. The original copy of the SMF and photocopy of the tree plantation ownership certificate shall be always carried during the transport of the tree products. In case the transporters is not the owner of the tree plantation, a Special Power of Attorney (SPA) is needed. If a vehicle is hired to transport the tree products, the vehicle owner has to accomplish a Certificate of Transportation Agreement (CTA). For

For premium hardwood species \textit{(Sec. 11, DAO # 2000-21)}, in addition to the foregoing requirements, it is necessary to have: 1. Certificate of Timber/Lumber Origin, 2. Tally Sheet and 3. Auxiliary Invoice. An important factor is that if the timber volume to be transported is \(10\text{m}^3\) or less, then the Regional Executive Director (RED) can issue the approval, but for a greater volume, approval from the Secretary of the DENR, in Manila, is required. This may mean a long period interval since the request is send waiting to its approved.

6.7.4 **Marketing**

According to \textit{DAO No. 1999-20} there shall be no restriction in whatever manner, on the disposition and marketing of plantation species, provided it is supplied to legitimate buyers. All the farmers interested on planting indigenous trees, before harvesting them, they should free-registered them in CENRO. During the time trees are growing any document is required, is only when the trees are going to be harvested when a permits needs to be issued by the DENR. Even though, it is a single activity the amount of papers needed to obtain the license is big. In spite of all the complex of these regulations, DENR is conscious of the problematic of the process and policy is to remove impediments to timber production, harvest and transport, and it is predicted that in the future further simplifications to the approval processes will take place.

7. **DISCUSSION: CURRENT CONSTRAINTS AND OPPORTUNITIES FOR THE DOMESTICATION OF PREMIUM TIMBER SPECIES**

**OPPORTUNITIES**

7.1. **Real farmer demand**

There is a real demand of timber products, especially hardwood within the Philippines identified

\textsuperscript{26} The SMF manifest the timber or forest products to be transported are needed.
by farmers, timber dealers, processors and other stakeholders involve in forestry activities. Even though it was previously assumed that farmers are not willing to plant indigenous timber trees on their farms, according to the results, farmers in San Isidro, Bohol are interested in expanding their on-farm tree production using the selected indigenous timber trees proposed in this strategy. The main identified motivations for planting indigenous trees were: interest on diversifying their seed stock to increasing the range of planting options and interest on having quality products for their household consumption or future investment (e.g. wedding, medical intervention). In addition, for most farmers, growing trees is identified as an effortless activity but that is mainly limited by the crop competition caused by the lack of space.

In San Isidro, Bohol, there is a main farmer demand of Molave (*Vitex parviflora*). Molave is also a very highly demanded species for furniture works, so processors and buyers are greatly interested in working with them. Narra (*Pterocarpus indicus*), White Lauan (*Shorea contorta*), Dalingdingan (*Hopea foxworthyi*) and Apitong (*Dipterocarpus validus*) were also in the top demanded timber species selected by farmers.

### 7.2. Identification of planting trees as an effortless activity

It is interesting to consider that growing trees does not involve any extra-effort to farmers. Ninety-four percent of the respondents are satisfied with the growth and performance that Mahogany is having. The cares that trees need are minimal compared with crop production. The main limitations recognized by farmers when growing Mahogany were competition (roots and crown), poor and shallow soil, weed maintenance, need of water when planted in dry season, presence of pests when growing on open areas and *carabao* disturbance if a tree guard is not built. When farmers were asked to enumerate the main difficulties, 24% of the interviewed farmers were not able to list any of them.

<table>
<thead>
<tr>
<th>FACTOR</th>
<th>% OF INTERVIEWED FARMERS</th>
</tr>
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<tbody>
<tr>
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<td>none  23.8%</td>
</tr>
<tr>
<td>shading</td>
<td>7.1%</td>
</tr>
<tr>
<td>shaded</td>
<td>23.8%</td>
</tr>
<tr>
<td>root competition</td>
<td>2.4%</td>
</tr>
<tr>
<td>poor soil</td>
<td>11.9%</td>
</tr>
<tr>
<td>water</td>
<td>4.8%</td>
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<tr>
<td>pest</td>
<td>2.4%</td>
</tr>
<tr>
<td>weeds</td>
<td>11.9%</td>
</tr>
<tr>
<td>carabau</td>
<td>11.9%</td>
</tr>
</tbody>
</table>

### 7.3. Marketing demand

The current local market situation is characterized by a lack of options and the poor supply to sustain local demands. Legal and greatest supply relays basically in Mahogany and Gemelina, species that are not greatly appreciated by lumber dealers and furniture craftsmen. Nevertheless, high valued timber traded relays on illegal supply of few indigenous species that are greatly demanded and appreciated indicating that the market acceptability of the selected premium trees species would be high.

The main element of the current market system is the middleman that is identify as a key element for linking farmers with marketing structures solving the problem that the bad access to
the area represents. Middlemen make small-scale timber transportation by means of joining scattered individual farm production when chartering the truck.

Considering the scarcity of this species, their high quality and their international renown together with the low diversity of products currently founded at markets levels, in the current market suggest that the selected premium timber species would not have great competition at markets level. Also, as consequence of the resource shortage and trends of today market saturation is not an inconvenient for the domestication of this species.

7.4. Marketing prospects

The transportation problem that lack of large stock in each farm generates could be solved by the creation of cooperatives. These farmers groups could organize themselves harvesting periods with the aim of having an adequate production to be transported. It would also help to reduce the dependence on the middleman. In many parts of the Philippines there are farmers organized in associations. Also, within a cooperative system and by the creation of a communal workshop, the value-added of processing products on-farm could be increased. At the same time, transportation legislation would be release since the product that is been transport is already manufactured.

Even though some indigenous trees have been recognizing of having outstanding timber qualities, in general little information about growth and performance in smallholder plantation is available. There is a need of estimate financial performance information of indigenous trees species so farmers would have reliable ways to know whether forestry is financially feasible or viable. Positive financial estimates would encourage smallholders to engage in forestry at community level as well as individuals growers.

The implementation of a FSC certification system would help to increase the add-valued of small-scale plantation at international levels. The problem that is always associated to certification systems are the cost related with the certificated agent. This cost could be reduce if the activities that the government need to carry out of supervising tree plantations and emitting permits is delegate on the certificated agent and cost are share by government and interested party.

Another alternative that may increase market benefits is the commercialization of the reproductive material. The plantation tenure of valuable species provides the opportunity to sell seedlings and cutting that are independent from forest sources. As consequence of the lack of quality germplasm throughout the Philippines market acceptance of the products may be high. This activity should go within training and workshop activities of the tree planting and breeding process and should be design once production areas and delivery network are completely developed.

7.5. Farmers experience in managing timber trees as mahogany

According to the results, farmers in San Isidro are currently managing high quality timber trees species. *Swietenia macrophylla* is present in all farms visited, with 32 trees/ha as average. This fact confirms farmers’ interest on growing non-extremely quick growth species but that have not market limitations.

Tree farming systems identify in San Isidro Bohol are based on two strategies. Planting timber trees where only other trees or woody crops grow or planting them intercropped with annual crops. In the first strategy, identify by lack of space, trees are planted in a mixed systems but in the second, interviews suggested that they plant them in lines aiming to avoid sun
competition with crops. For higher tree densities and if crop production is a priority, trees are usually planted in other farm niches away from the crops, such as home-gardens, farms boundaries or fallows rather than on cultivated land.

Some of the silvicultural management techniques that farmers are currently conducting in San Isidro Bohol could be improved with the aim of increasing timber conversion. Most farmers practice pruning with the objective of getting straight boles, reducing on-crop shade and utilizing pruning products. But results show that sometimes pruning can be excessive threatening tree survival. Farmers are reluctant to practicing thinning and it is seldom done. They are not aware of the benefits that thinning can provide to their timber productions and it is identify with a lost of resources. Fertilizer is not commonly used on sloping land (mostly due to lack of the necessary capital among poor farmers) and soil fertility maintenance is based on natural fallowing and utilization of crop residues. However, weeding is a common practice among farmers. Results show that farmers are aware that during trees performance, this practice reduces weed competition improving tree survival and performance.

**CONSTRAINTS**

7.6. Lack of knowledge on growth, survival and satisfaction of the selected species in agroforestry systems

There is little information about the survival and performance of the selected timber species when growing in degraded uplands as agroforestry systems. In this study initial investigation are presented. There is a need of conducting further studies and research about growth and performance with the aim of strengthened documentation and information.

7.6.1. Survival

Accordingly to the results, the mean survival presented by all the species is satisfactory. ANOVA analysis showed that species, slope position, planting system, type of trial, soil and weeding factors have statistical significance on survival.

*Shorea contorta* survival presents significant lower survival when compared within species. This lower survival can be as consequence of cattle damage motivated by the palatability of these species.

The Multi Range test of slope position showed that survival is low when the timber trees are planted in ravine position. Even though the amount of elements in the ravine class is not representative statistically, slope position may be a decisive factor since ravine position involves a wash of nutrients caused by the running water run at the same time that the difficult seedlings establishment.

Results showed that the survival success is significantly lower when trees are planted on boundaries. Further studies should be conducted to determinate the reasons of these lower survival since represent one of the farmers preferred areas to plant trees. A possible hypothesis of these lower survivals could be the distribution of fertilizers that are applied to the crop production within the plot. Another hypothesis is that as the limits of the plot are usually far away from the cultivated land, trees are not frequently maintain (e.g. weeding) and they are more vulnerable to be damaged by cattle or farmers.

Type of trial factor affects significantly on the survival. This may show that we should be aware of the fact that it may be possible that when the trial is design by researchers, the success is higher than when the trial is design by farmers.
According to the results, survival success is affected by soil acidity representing higher survival values when timber trees are growing in calcareous soils. This result should be dealt with caution and further studies must be conducted since other variables can affect the results (e.g. water requirements).

Weeding practices factor showed to affect positively the survival when the practice was conducted.

7.6.2. Initial performance

The young of the trees and the small size of the measurements, do not allow obtaining conclusive affirmations on terms of growth. Even though, the results allow documenting how the undocumented selected premium timber trees species perform in agricultural lands within agroforestry systems. These species have been traditionally considered as high demanding species (PROSEA, 1994) and its adaptability to degraded conditions was believed to be low. However, accordingly to the results, the initial performance of our species is success in the different agroforestry research sites. Moreover, when the initial growth of the selected species is compared with the performance of *Swietenia macrophylla* for each research site the growth of our species is similar and even higher for *Vitex parviflora* and *Dracontomelon dao*. Moreover, field observation suggest that *Dracontomelon dao* is better adapted to degraded soil conditions that the exotic *Swietenia macrophylla*. *Dipterocarpus validus* has been the only species that has showed significant lesser growth when compared with *Swietenia macrophylla* in Tabango and Hindang research sites.

According to the results, *Vitex parviflora* grows outstandingly when planted in agroforestry systems in Lantapan. *Dracontomelon dao* seems to be more suitable, having better grows, in Leyte, especially in Hindang. *Terminalia microcarpa* grows vigorous in Lantapan and Tabango while in Claveria and Hindang initial performance is slower. *Dipterocarpus validus* seems to be more adapted to Lantapan and Claveria agroforestry systems than to the ones established in Leyte. *Shorea contorta* performs well in Claveria and Lantapan but there is lack of data in the other research sites.

The results show that there is a great variability within the measurements. This variability is caused by the great diversity of situation on which these trees are planted in terms of planting system, slope position and niche.

7.6.3. Satisfaction evaluation

The results showed that farmers are greatly satisfied with their current indigenous species trials that they have on their farms. In spite of this satisfaction, for most of the species, not interest on growing more amount was showed indicating that timber trees are planted but in small quantities (around 20-50 trees /year). Seldom, farmers plant more at once. The low satisfaction that farmers expressed with *Shorea sp*, could be motivated, according to the results for the lower survival rate when compared with the other species planted on the trials.

*Dracontomelon dao*, *Vitex parviflora*, species that grow moderately quick and that are currently, although illegally, founded in the market. These species are well know and appreciated because of their high quality lumber (*Dipterocarpus validus*), durability (*Vitex parviflora*) or quick growth (*Dracontomelon dao*). In terms of other species that are not current in the market and that growth may be slower, farmers are just satisfied by having the current amount of them as a reduction risk activity but not as a worthy one. The main objections proposed by farmers on increasing their number of stems were mainly the lack of space (average farmer size in S. Isidro is 1 ha), need of increasingly labor and mainly interest on fruits trees.

Farmers’ tree portfolio will eventually be composed of a higher percentage of fruit trees
and Jackfruit (*Artocarpus heteropyllus*), is a good alternative as a long-term timber high quality timber provider. The use of this species should be encouraged and promoted in future domestication strategies.

In spite of the fact that farmers are not high scale timber producers; this small scale timber production is enough to supply timber industry. As a demonstrative example, if a group of 80 farmers in one Barangay plant only 10 trees/ha and harvest the tree when is 0.4 m\(^3\), the volume of 320 m\(^3\) would be good enough to make harvesting profitable for the timber industry.

7.7. **Lack of knowledge on tree management**

Results exhibit that undersize harvesting is a common practice in Bohol, resulting very low percentage in lumber conversion. This premature harvesting age affect directly to wood quality with the overall effect on lowering price of lumber. With the aim of improving premium timber trees management, workshops, training activities and demonstrative trials should be developed.

7.8. **Lack of access to germplasm**

Currently there is a lack of on-farm indigenous timber species in San Isidro, Bohol. All the timber production relies in mainly two species, Mahogany (*Swietenia macrophylla*) and Gemelina (*Gmelina arborea*). Even though most farmers have indigenous timber trees in their farms the richness and evenness of them is very small. Among the species proposed in this strategy, farmers only have Molave (*Vitex parviflora*) and Narra (*Pterocarpus indicus*). Resources are almost gone since natural regeneration is not successful enough and artificial regeneration with indigenous species does not occur. Knowledge and germplasm of the selected species is getting lost.

Lack of reproductive material is the main motive why farmers do not have these species growing on their farms. Therefore, it is important to develop a strategy based on the domestication of these timber species to provide farmers with a quality seed stock. Moreover, as Philippine is a developing country that depends on imports to support its national timber demand, increasing the number of small-scale agroforestry plantations will be a viable alternative for increasing a wood stock within the country and reducing dependency on timber imports.

7.9. **Reproductive biology**

The reproductive biology that Dipterocarps presents is one of the main restrictions in the design of this strategy. It limited mainly due to two characteristics: Its irregular seed production and its low germination viability. Dipterocarps start bearing fruits at the age of 10 to 20 years in natural forest and repeat it at irregular intervals that do not occur annually, it approximately occurs every 2-10 years. Flowering and fruiting depends on the climatic conditions of the area. The fruit is indehiscent. It has seed that are desiccation-sensitive or recalcitrant so that moisture physiology is especially important for them. For this reason, it is essential to develop vegetative mass propagation programs, rootstock gardens and hedgegardens with the aim of solving the problematic that the reproductive biology of these species present.

The reproductive biology of Molave, Dao, Narra y Kalumpit represent less limitations in the development of a domestication strategy. The reproduction of these species is mainly conducted by seeds and vegetative propagation is not necessary as it is with the Dipterocarps. The main limitation identifies on the production of these species is the germination difficulties that
these species present. Narra seeds present low viability success while Molave and Dao present recalcitrant seeds therefore its germination should be enhance.

7.10. Policies and legislation limitations

Current policies on indigenous timber trees harvesting is one of the main identified limitations in the domestication process. DENR require that all plantations, before been harvested, must be registered in the DENR database. This law is applied for all tree plantations. The additional limitation that premium timber trees plantations present versus non-indigenous timber trees is that when harvesting and transporting a long-term bureaucracy process is required to work under legality. Arduous process that discouraging and prevent farmers for harvesting.

It had significantly decreased woodcraft production while the demand for its finished products had apparently increased over time. The strict implementation of DENR policies against those who illegally cut timber has made it difficult for wood processors to procure raw materials. As consequence that this species are classified under IUCN and are considered as threatened their commercialization is identify as an undesirable process for their conservation. Nevertheless, sustainable commercialization of them would contribute to their survival by the stimulation of their use.

Concerning transportation is interesting to emphasize that when the timber volume to be transported is $10\text{m}^3$ or less, the bureaucracy process is deal in a municipal level while in case the volume is greater an approval for the regional DENR is required. This may mean a long period interval since the request is send waiting to its approval. The final result of these legislations is that illegal logging keeps taking place and regulations discourage tree plantations.

Slowly, government and DENR is beginning to be conscious of depress effect that this regulation involve and is starting to make an attempt of change. I consider that changes in registration and regulation procedures should be conducted within a clear differentiation among natural forest and private land. Also, I consider that the requirements that are needed to deal with premium timber species should be releases and move to the same regulation that the other species in case they are planted on farm. This activity would active the commercialization of this threatened species with the aim of incentive their plantation and germplasm movement as a strategy to conserve them. Government should realize that sustainable use of their own timber resources is a promising and laudable initiative that can provide extra income generation to the primary producers at the same time as increasing the gross domestic product of the country in a sustainable manner.

8. TOWARDS AGROFORESTATION WITH PREMIUM TIMBER SPECIES IN THE PHILIPPINES: A PROPOSAL FOR A TREE DOMESTICATION STRATEGY

A proposal for the domestication of the selected timber species in agroforestry systems has been developed with the aim of promoting and encouraging its utilization. The different parts of the strategy are proposed and developed successively. At the end and by way of illustration a sketch of the whole process is represented.
8.1. Priority species selection

The first step in the development of a domestication strategy is to select the species, depending on the objectives and goals that the strategy aims to reach. Farmers’ surveys should be conducted with the aim of gather, exchange and share knowledge about the species. Literature research, documentations and data base search are the steps to start the domestication strategy. Inventories about the stocks of these species on farm and marketing surveys are also useful base information.

8.2. Exploration of the species and its domestication possibilities.

After the species selection is important to identify properly the species to domesticate. To determinate its botanical nomenclature is essential since sometimes, at local level, species are identified by its use or qualities leading to confusions and a incorrect distinction among species. It is also necessary to study procurement possibilities of the selected species, places that can supply germplasm and areas where resource can be collected. Information about origin, natural distribution and requirements of the species is also needed. The aim is to identify the possible areas or centers where these species can be domesticated and collected.

8.3. Germplasm collection

Due to the low resource availability of the selected timber species germplasm it is needed to develop seed and seedlings collection from the wild population to provide farmers with these trees planting options. Moreover, special awareness should be given to the conservation of the current genetic diversity.

Domestication implies the collection of seeds or wildlings ideally from the entire natural range of species (Leakey et al, 1982). Nevertheless, several factors (e. g. species distribution, species phenology, access to genetic resources) would determine the process. Nowadays, ICRAF is undertaking the first phase of the process. Seeds and wildlings are been gathered throughout different natural geographical areas within the country. Special attention should be placed in the collection from the different biogeographical regions. Moreover, germplasm collection activity should be conducted constantly with the aim of generating a continuous input of new germplasm from the wild population.

The germplasm collected in these areas would be utilized in the establishment of the production systems. The aim of these production areas is conserving the different provenances at the same time that propagating them massively consequently the resource is available to everyone interested in planting it.

During the whole domestication process, continuous collections of germplasm from the wild population should be conducted with the aim of always increasing the genetic material utilized.

8.4. Evaluation of the species, research and demonstrative trials

Once the germplasm that will initiate the strategy has been collected, and with the aim of evaluation and identification the germplams, laboratory, on farm and on station trials should be carried out. It is essential to ensure the species can grow and perform in the area and situation
where it is going to be established before developing a production, improvement and delivery systems. In these trials different factors (e.g. growth, survival, preference, compatibility with other species) will be tested with the aim of documenting the success or failure of these species before the development of the whole process.

8.5. Participatory germplasm production and tree improvement system

Since the availability of the selected timber species germplasm is limited and the demand of them is high, there is a need to develop a germplasm production system. These production systems will be based in the developing of different plantations and productions areas with two main objectives: 1) to conserve and maintain genetic diversity, 2) to provide farmers with quality germplasm.

The general objective of a genetic improvement program should be the sustainable management of genetic variation to produce, identify and effectively multiply plants of well-adapted genotypes of the desired quality. Tree improvement should support the collection of data on reproductive biology and genetics necessary to maintain an effective breeding process. In developing programs, where social aspects are considered and the objectives of tree breeding are diverse (farmers have different requirements), tree improvement activities concentrate on the establishment of a few well adapted seed sources based on progenies from a number of phenotypically selected mother trees and non genotypes.

The proposed production and tree improvement strategy consists on the following activities:

8.5.1. Provenance identification and trial

The term provenance refers to the geographical area and environment in which parent trees grow and within which their genetic constitution has been developed through natural selection. The idea of provenance implies that genetic patterns of variation are associated with the ecological conditions in which the species evolved (Turnbull and Griffin 1986) and that morphological or other traits can be recognized to characterize them. Ideally, each provenance should be composed of a community of potentially interbreeding trees of similar genetic constitution and of significantly different genetic constitution from other provenances, and where possible may be defined by means of boundaries (Barner 1975). It is generally accepted that the boundaries of provenances are set in an arbitrary way during initial sampling of a given species. Provenance identification can be done by their genotype, using molecular techniques (e.g. isozyme analysis) providing estimates of the amount of genetic variation within populations and the extent of genetic diversity between them. When the budget is limited, studies on differences in seedling or seed morphology in experiments provide reliable early information on the extent of the geographic variation in forest tree species. An appropriate number of seeds per provenance according to ACIAR are around 100-400 even though in our domestication this number would be conditioned to the resource availability.

8.5.2. Hedge gardens establishment

Now that dipterocarps and indigenous trees are almost gone, and the current illegal logging is reducing the resources, the conservation of the genetic information of each provenance is an essential process. The establishment of hedge-gardens of around 1-2 ha where different provenances are planted on blocks as genetic bank ex-situ conservation has to be done in the three different research areas that ICRAF has within the Philippines (LSU, Leyte, CVSCAFT, Bohol and MOSCAT, Claveria) in the research facilities of State Collegues and Universities and
Vocational Schools. In a future, from seeds or vegetative propagation, grown in the hedge-gardens, Seed Production Areas plantations and nurseries will be established. Once we identify the best provenance within the base population the hedge gardens are the non inbreeding source of the quality provenance that will be establish in the progeny trials.

With the aim of involving farmers in the aforementioned activities, small seed orchards and hedge-gardens should be established, as part of the nodes of the distribution network at barangay or municipal level.

8.5.3. Base population establishment

Setting up base populations for tree improvement is an important stage in the domestication process. It has the objective of observing their growth, selecting the best individuals and starting the breeding process by progeny test. The term ‘base population’ is used to describe a representative genetic sample of the useful provenances (those which have displayed positive traits in trials or other plantings). In our process, provenance trials were not established so the best individual from all the provenances are selected for the base population set up by multiplication. Normally, such populations will include progeny from more than a hundred parent trees. This base population is the key population for the breeding process.

8.5.4. Progeny test

Progeny test are used to help predict an individual's breeding values involving multiple mating of that individual and evaluation of its offspring. This process when well designed with replication provenances trials at multiple locations is a good process to asses the species. The lack of time and budget did not allow the establishment of progeny trials but it is an activity that needs to be conducted. Instead, on-farm trials to study species adaptability to agroforestry conditions were designed. In the progeny trials, inferior progenies will be removed and the selected population will be the stems to be established. After the progeny test, the offspring that have the best characteristics and sufficient quality are selected as breeders (breeding population) to take part in the recurrent breeding cycle. If the progeny test gives quality stems we can select the best of each provenance and use them for plantations (propagated population).

8.5.5. Clone bank and seed orchard

The best trees of each provenance are elected by vegetative propagation into a clone bank (propagation population). A clonal bank is a living collection of selected asexually propagated plants that is managed for breeding purposes. The clones are propagated for clone testing on the field or target areas of the research. The selected trees from the clone bank are used to establish a seed orchard. Seeds from the seed orchard and cuttings from the clonal bank are the reproductive material can be gathered and used on-farm for production purposes.

Results of the study conducted by DENR, 2003, on clone performance when out-planted indicate that clonal propagation has been successful in producing planting materials that can cope with the relatively difficult conditions in the field. Results are not conclusive but they are encouraging in the struggle of forest environment conservation.

In figure 68, a sketch present the improvement process, for each objective, a different tree improvement process should be conducted. (e.g. higher timber production).

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27 A seed orchard is a plantation created for the production of genetically improved seeds to create plants or direct seeding for creating new forests. Seed orchards are a common method for mass multiplication for transferring genetic improvement to the production population (forests). Often a seed orchard is comprised of grafts (vegetative copies) of selected genotypes. wikipedia.org/wiki/Seed_orchard.
It is necessary to avoid the delivery of poor quality germplasm to farmers at the same time that avoiding having quality germplasm only in research centers and universities. Accordingly, the development of these germplasm production and improvement systems needs to be supported by, on one hand Universities and research centres responsible for the investigation (e.g. provenances identification) and on the other by NGOs, local institutions and LGUs responsible for the production and dissemination of the germplasm.

It is important in the development of tree improvement technology to consider farmers, if farmers are to be the main agents of this domestication low technology options are desirable. (e.g. non mist propagation). Farmers should be involved in the whole process from the beginning to ensure the sustainability of the process. Training and diverse formative activities should be conducted. Hedge-gardens should be maintained by the NGO and trying to involve DENR and communities on the cited process, more and more. Genetic diversity is the building block of future selection and breeding consequently its conservation should be including in conservation programs. Also international organizations should contribute to this process. In the future establishment of on-farm plantations would be important to source farmers with clones from difference origin to ensure the genetic diversity within the plantations.

8.6. Distribution network development

With the aim of ensuring that reproductive material is not only utilized in research centers, it is essential to develop a technically sound robust production and distribution network where genetic quality and appropriate distribution channels are accounted. The design of a scale-free seed production network will be the most suitable network according with the results obtained in the successful Mahogany germplasm delivery network. In the design of a Scale-free network the key element is the identification and establishment of strong hubs that will empowers the whole network and ensure the success of the strategy. Subsequently, by means of farmers, neighbors and farmers organizations, links with the hubs will be developed and establish by their own initiative. Hubs identified on the Mahogany delivery network are performed in the recommendations section. Also, new possible hubs and transformations in the already existing ones are suggested.

The network should be designed in different administrative levels with the aim of reaching the different level requirements. The proposed production and distribution hubs for the different
administrative levels are the following:

8.6.1. Farmer’s level

- **Barangays nurseries**: The development of Barangay nurseries supported by Mayors and Municipal Officers could be a great alternative to provide farmers quality germplasm. Currently ICRAF is working with the implementation and management of nurseries within each barangay. Communities’ nurseries are managed and cared by an association of farmers that distribute the work and the benefits. Barangay captain is in all nurseries a member of the association. He is a key element to link farmers and germplasm. Captain is usually close to farmers and has good relationship with most of the farmers. The joint to this association is free and the requirement needed is only related to offering volunteer work. The profits of the nursery are share among the participants. Seedlings are raised and cared by the farmers and they are the benefits. Currently the future possibility of seedlings commercialization is been studied by meetings and conference among farmers and people involved in the seed and seedlings commercialization process.

- **Public areas plantations**: Road-sites, river banks, gardens and other public areas frequent by the inhabitants of the barangay should be planted with the selected species. Mayors and Municipal Agriculture Officer should be responsible for the establishment of these small scale plantations.

- **Spontaneous on-farm adopters**: As is typical of scale-free networks, new indigenous timber tree adopters will joint the system and will increase the number of links of the whole network. As an example, ICRAF on-farm adopters represent a group of farmers engaged in tree farming. Data from Claveria places the number of timber trees found on farms within 90 to 220 (Bertomeu, 2004). The on-farm trials in addition to suppose a demonstration of success in terms of growth of the different agroforestry systems where farmer can plant their trees it will also represent mother trees to supply indigenous trees seed demand an adopters farmers will mean an important node in the diffusion.

8.6.2. Municipal level

- **School campuses**: Schools represent a strategic area that can be utilized as a hub in the distribution network by planting 0.5-1 ha with the selected indigenous trees. Besides being a meeting point where adults and student can gather wildlings, school can help in delivering the germplasm by implementing on-farm planting programs involving pupils.

- **Church**: As consequence that The Philippines is a very catholic country with immense religiosity believes, small-scale plantations can be established on land owned by the church can be used as a minor hub in the germplasm distribution network. To plant few indigenous trees close by this assembly points could improve the collection of seeds and reproductive material at a municipal level.

- **Municipal nursery**: In many municipalities within the Philippines, LGU (Local government units) together with DENR and the Municipal Agriculture office have developed successfully tree-planting programs. The establishment of temporal nurseries, where in a short period of time germplasm from the selected indigenous trees is delivered to farmers, is a good alternative to provide farmers with a diverse of planting options. After, a plantation could be established from which in the future vegetative reproduction and seed collection can be performed by instructors and the own farmer.
8.6.3. Regional level

- **Academic institutions (Universities, research centres DENV centres and NGOs):** In these centers, conservation plantations should be established. Hedge-gardens will be the main and earliest attempt of dipterocarp vegetative propagation in the area. These production areas will also be a source of improved genetically reproductive material. These areas should be managed by qualified labourers and assume the improved material according to the different objectives that farmers want to reach in the domestication process.

As an example of Bohol Island, in Bilar municipality, there is riverside dipterocarp woodland planted in 2001 by Haribon foundation and CVISCA. This plantation can be used to gather seeds and develop vegetative propagation in the hedge-gardens. Currently there is an initiative been carried out in the developing of the hedge-garden planed by DENR, Water and Soil Conservation Foundation and ICRAF ensemble project. Haribon plantation is placed close by one of the main roads of the island so its accessibilty its not identify as a collection problem. This action increases the amount of reproductive material from other origin. Students from these institutions and organized visitors, would help in the distribution of improved quality germplasm.

It is important to avoid that the germplasm origin comes only from a slightly amount of mother trees by developing an extensive and strong network. The importance of the hedge gardens and SPAs is high as production and distribution nodes of high quality germplasm. These plantations also work as conservation of genetic resource meaning that if human action or hazards (e.g. fire or land slide) devastates one particular precedence there is still seed and plant available. Universities in the Philippines have land allocations wide enough for plantations. For example, CVSCAF has been allocated with more than 3,000 ha of forest lands by the DENR. They need a good management plan for these areas. Part of the plan could be the establishment of plantations with dipterocarps on those degraded areas so that these can be the source of germplasm in the near future.

- **Mahogany plantation by enrichment into a Dipterocarp forest:** The man-made Mahogany plantation that was settle in the strategic Billar and Loboc municipalities was established with reforestation and conservation purposes and not harvesting can be conducted within it. Since Mahogany is an introduced species that currently is widespread all over Bohol, it seems reasonable to promote the creation of a dipterocarps natural forest instead of a mono-specific Mahogany plantation. The establishment of dipterocarp and other shade demanding indigenous trees seedlings under the current Mahogany canopy may ensure their survival and performance success. Once the seedlings increase the growth and their sun demand gets higher, Mahogany trees can start to be harvesting. The seniority of the stems could suppose a great income generator. As a difficulty, extra care with Mahogany fall should be taking into account to avoid excessive lost of seedlings. Depending on the quality of the stems and their economical value of the stem, girdling can be conducted. More over, the plantation is close to the Rajah Sikatuna National Park that represent with its 90 km² the largest remaining natural forest within the island where the few dipterocarps stems that remain in the island can be found.

Once several farmers have adopted premium timber species in their farms, the diffusion of the network will be spontaneously succeed as well as has occurred with Mahogany. Farmers are not reluctant to exchange germplasm by providing and delivering reproductive material to other neighbors.

Usually, as there is a quick need to satisfy immediate seed requirements for donor, NGOs and government-led projects, seed production is typically given away to farmers and communities for free. A negative consequence that could be identified is that farmers can undervalue seed because they have been given for free. Accordingly to Mahogany experiences, farmers did not
under-valued the given material but the problem is that small-scale seed producers have not been able to expand, as they cannot compete against a free good. However, in this strategy where tree cultivation is considered desirable for society and environment, tree establishment should be subsidized at the same time that small-scale community-based nursery should be promoted.

### 8.7. Management

The establishment of the on-farm and on-station trials and plantations takes place after the propagation, multiplication and distribution of the germplasm. In the on farm plantations, farmers start growing their trees with economical purposes, even though is still an experimental process. On the other hand, on-station trials are utilized to research with the aim of learning about growth, economic profitability, the appropriateness of the different management activities and culturing treatments. These trials will contribute in the documentation and will support the on-going research of these, usually slightly known species. These plantations, both on-farm and on-station should be continuously monitored. University and governmental local centers should be the responsible of supporting these activities with international agencies and local associations support.

### 8.8. Adoption

Adoption is the last and final step of the strategy. The objective is to consolidate the farmers’ utilization of the selected species.

This section of the system has to be developed in interaction with different organizations, research centers and associations. All the matters that will have an influence on the implementation of the domestication have to be deal by means of collaborations and connections of the involved parts. Information about the market possibilities, processing opportunities should be gathered. Likewise, policies and legislation that influence the utilization of the products needs to be considered. Promoting the adoption is also an essential factor in this section. Organization of farmers’ visits and demonstrations will reinforce the strategy by incrementing the number of adopters.

The development of a strategy or a project will be sustainable and will continue after the project execution and external funding just if the community is directly involve in the whole project. The beneficed people should by the owners of the project understanding and promoting each activity that takes place avoiding being just mere receptors of what other people has plan for them. By the involvement of local people, the impact of the project may be wide by the extension of information, skills and germplasm to other communities and farmers. Subsequently, the continuity of the process will by ensure.

With the objective of ensuring the success of these domestication activities several participatory initiatives are proposed:

- **Brochures delivery.** Spreading knowledge and practices by means of brochures is a good initiative to inform stakeholders. As an example, currently Leyte University together with ICRAF and ACIAR support have developed a primer on tree registration, harvesting, transportation and marketing policies in private lands with the aim of clarify and explain farmers in a simple manner the intricate of the process. Brochures about quality nurseries practices on selecting quality germplasm should be also developed to ensure the success of the germplasm establishment and diffusion. The spread of appropriate silviculture techniques for timber trees production can be also showed by means of brochures.
• **“Trainers of farmers” network development.** A very important activity is the creation of a network of farmer groups in charge of training and capacity-building activities for fellow farmers. With some logistical and technical backup from ICRAF, the group of trainers interested on conducting this activity, will be responsible for the provision of training to other farmer and CBFM groups from the target municipalities and other areas.

• **Community associativism.** The development of farmers association will facilitate and improve harvesting, developing a certification system and selling the timber product. Individual farmers’ production is slight, but when group of farmers organized the returns are higher. As an example of the associativism success and the trainers’ network development, there are a farmer group, established in 1998, “The Agroforestry Tree Seed Association of Lantapan” ATSAL, active in the commercialization of tree seed and the adoption of conservation farming and agroforestry techniques. The association has been instrumented in training thousands of farmers in seed collecting handling and marketing of quality agroforestry seeds. To date, ATSAL has sold more than 800,000 kg of assorted (exotic and indigenous as Dipterocarp) tree seeds and thousands of seedlings to buyers from Mindanao, Visayas and even in Nairobi, Kenya. Since its foundation, ATSAL has earned P 3 million (US$ 60 000), which was distributed among farmer members and for the support of the organization. This example highlights the significant roles of upland farmers in contributing on genetic conservation of important forest resources.

• **Farmer group formation.** It is important to create and develop a network of farmers interested in participating in the process. Farmers should be organized in different groups with different tasks and assignments. It is needed a group of trained farmers that notice in each plantation or SPA when trees are bearing seeds. Also when trees have not bear seed, they should be the en charged in collecting and preparing the reproductive material that subsequently will be transferred to the nursery or directly to some farmers. An income of new reproductive material from the remnant natural forest would be also appropriate to provide genetic diversity. It is also needed a group of trained farmers that once the vegetative material or seed are gathered, take care and manage seeds and seedlings for their correct development (e.g. pottering, watering). A group of farmers should be responsible of informing people of the activities that are been conducted and recording the families interested in the process to ensure a correct supply.

• **Workshops.** Several successful workshops and training sessions have been organized by ICRAF, but in the future, trained farmers will be the en charged of conducting these activities with support of the LGU and DENR. Workshops approach to farmers with the aim of understanding the problems and difficulties that farmer faces during the domestication strategy. Also workshops are focus on developing training activities focused on the interested farmers of the communities. Activities should be concentrated on: seeds and seedlings handle, nursery cares and management, propagation and reproductive techniques activities, silvicultural treatments and management and farming practices. It is also important to awareness people about the lost of genetic diversity that domestication process can cause and encourage germplasm exchange and different cultivars collections among others.

• **Contests.** The execution of contests where farmer effort is recognized by a small donation is a good alternative to incentive farmers.

• **On-farm research trials.** With the aim of increasing timber productivity, trials should be used as a demonstrative training ground for farmers and technicians. It will support visually the benefits of some practices (e.g. pruning, thinning, partial shade for shade-demanding species). As a research ground, it is necessary to keep studying the growth and adaptability of these species in agroforestry system.
8.9. Domestigram

The present sketch aims to link and combine all the aforementioned parts that the proposed strategy should contain.
9. REFERENCES


9. References


Muncipal Socio-economic Profile of San Isidro, Bohol. 2000.


9. References


INTERNET


