INTEGRATION OF TREE PLANTING IN FAMILY-BASED SOCIAL FORESTRY AS AN EFFECTIVE TOOL FOR THE CONSERVATION OF ENDANGERED TIMBER SPECIES FOR KINGDOM OF CAMBODIA

BY

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LIST OF ABBREVIATIONS

a.s.l.	:	About sea level
dbh	:	Diameter breast height
AOP	:	Agro-forestry Outreach Project
CBNRM	:	Community-Based Natural Resource Management
CBNRMLI	:	Community-Based Natural Resource Management Learning Institute
CNMC	:	Cambodia National Mekong Commision
CTSP	:	Cambodia Tree Seed Project
DANIDA	:	Danish International Development Agency
DFSC	:	Danida Forestry Seed Center
DFW	:	Department of Forest and Wildlife
FA	:	Forestry Administration
FAO	:	Food and Agriculture Organization
GDP	:	Gross domestic product
G &Y	:	Growth and Yield
ITTO	:	International Tropical Timber Organization
IMF	:	International Monetary Fund
IUCN	:	International Union for Conservation of Nature
NTFP	:	Non-Timber Forest Products
TFAP	:	Tropical Forest Action Plan
UN	:	United Nation
UNFF	:	United Nation Forum on Forests
UK	:	United Kingdom
USAID	:	United States Agency for International Development

INTEGRASI PENANAMAN POKOK DALAM PERHUTANAN SOSIAL BERASASKAN KELUANGA SEBAGAI SUATU KAEDAH BERKESAN UNTUK PEMULIHARAAN SPESIES BALAK TERANCAM UNTUK KERAJAAN KEMBOJA

ABSTRAK

Kemboja telah mengalami penyahhutanan dan degradasi hutan sejak lewat 1990an lagi ekoran daripada pembangunan ekonomi yang pesat dan peningkatan kadar pertumbuhan penduduk yang tinggi. Ini telah mengakibatkan banyak spesies-spesis balak telah disenaraikan dalam kategori terancam. Pemuliharaan spesis-spesis balak ini merupakan prioriti utama yang diberikan perhatian. Dalam projek ini, tiga buah perkampungan di daerah Rattanakiri telah dipilih. Projek ini menggunakan kaedah agro-perhutanan berasaskan keluarga sebagai alat dalam memulihara spesies-spesies pokok ini. Pokok-pokok ditanam sepanjang sempadan kebun petani dan berfungsi sebagai pagar hidup. Empat corak penanaman telah digunakan untuk menilai keberkesanan integrasi penanaman pokok dan operasi pertanian semasa oleh pekebun. Tiga spesis telah dipilih: *Hopea odorata, Tarrietta javanica* dan *Afzelia xylocarpa.* Pokok-pokok ini telah ditanam pada tahun 2005 dan diukur sehingga tahun 2010. Para petani daripada tiga buah kampung telah ditemubual berkenaan latar belakang sosio-ekonomi mereka dan perspektif mereka terhadap penglibatan di dalam projek ini. Hasil kajiselidik projek ini menunjukkan kadar kemandirian pokok-pokok yang ditanam dianggarkan pada julat 40% hingga 60%. Pertumbuhan diameter *Afzelia xylorcapa* boleh mencapai pada julat 5.7 ke 8.9 cm, *Hopea odorata* pada julat

9.0 ke 12.7 cm dan *Tarrieta javanica* pada julat 5.9 hingga ke 9.1 cm. Penduduk tempatan memperoleh tanah pertanian daripada pembersihan tanah hutan dan saiz tanah purata ialah 4.3 ha. Sekitar 43% - 60% kawasan ditanam dengan tanaman komersial, 21% - 25% untuk penanaman padi dan sayuran, dan terdapat 30% baki kawasan yang tidak digunakan untuk apa-apa penanaman. Memandangkan penduduk tempatan yang hidup di bawah garis kemiskinan mencatatkan peratusan tinggi, pendapatan alternatif daripada hasil penanaman pokok adalah penting bagi mereka. Maklumbalas daripada kaji selidik mencadangkan bahawa penanaman spesies pokok balak terancam di bawah program agro-perhutanan berasaskan keluarga diterima secara meluas oleh penduduk tempatan daripada segi kepentingan penanaman pokok-pokok balak untuk generasi akan datang. Secara kesimpulannya, penanaman spesies pokok balak terancam dalam program agro-perhutanan berasaskan keluarga boleh digunakan sebagai alat yang berkesan untuk tujuan pemuliharaan dan meningkatkan bekalan kayu balak di masa nadapan. Penduduk tempatan dalam kumpulan-kumpulan berikutnya akan memberi tumpuan dalam meningkatkan bilangan spesies yang akan ditanam dan memikirkan aktiviti-aktiviti lain untuk menjana pendapatan bagi mendapatkan kehidupan yang lebih mampan.

INTEGRATION OF TREE PLANTING IN FAMILY-BASED SOCIAL FORESTRY AS AN EFFECTIVE TOOL FOR THE CONSERVATION OF ENDENGERED TIMBER SPECIES FOR THE KINGDOM OF CAMBODIA

ABSTRACT

Cambodia has experienced deforestation and forest degradation since late 1990s due to rapid economic development and fast growing population. As a result, timber species are now under the endangered list. The conservation of these timbers is given higher priority. In this project, three villages in the province of Rattanakiri were selected. The project adopted the family-based agroforestry as a tool to conserve these species. Trees were planted along the boundary of farmers' farms as live fences. Four layout planting designs were used to assess the effectiveness of integrating the planting of trees and the current operation of farmers. Three species were selected: *Hopea odorata*, *Tarrietta javanica*, and *Afzelia xylocarpa*. The trees were planted in 2005 and measured until 2010. Farmers from the three villages were interviewed on their socio-economic background and their perspective of participating in the project. The results of the project showed that the survival rates of species are in the range of 40 to 60%. Growth diameter of *Afzelia xylocarpa* was in the range of 5.7 to 8.9 cm, *Hopea odorata* 9.0-12.7 cm, and *Tarrieta javanica,* 5.9-9.1cm. Local villagers obtained agricultural land through land clearing and the average land size is 4.3 ha. About 43-60% was planted with cash crops; 21-25% planted with rice and vegetables, and about 30% was not utilized. As high percentage of farmers live below the poverty line, alternative incomes from planting trees are important. Results from the survey suggested that planting of endangered timber

species using the family-based social forestry program is widely accepted by farmers in terms of the importance of planting timber trees for future generation. It is therefore concluded that planting of endangered species of timber, using family-based social forestry program could be an effective tool for the purpose of conservation and increased supply of timber in the future. The subsequent batch of participants will focus on increasing the number of species to be planted, and will think of other activities to improve their income for their sustainable livelihood.

CHAPTER ONE

INTRODUCTION

1.1 Introduction

Cambodia is a country located in Southeast Asia bordering Thailand to the north-west, Laos to the north, and Vietnam to the south-east and the Gulf of Thailand to the south-west. The country with a total land cover of 18.1 million ha, a population about 14.8 million and an annual growth rate of about 2.5%. A country that experienced several decades of civil war, Cambodia has now made great efforts to improve its economy through various initiatives to attract investments, improve its infrastructures, and develop its human capital through increase skills of its manpower.

Similar to many countries with a fast growing population, issues of food and other basic needs of the population has become a national agenda. As the country is still categorized as a poor country, its capability to attract foreign investments to propel its economy in the 21st century will be a great challenge. Pressures from population in many sectors of economy will need an intelligent response as a balancing act in managing the economy in a sustainable way.

The pressure to natural resources due to a rapid increase of population in Cambodia and its economy is best reflected on declining areas of forest resources. Table 1.1 shows that the forests covered about 73% of the total land areas of 18.1 million ha in 1965, it was reduced to about 57% (Forestry Administrarion, 2010). It

was estimated that the average deforestation rate from 1973 to 1993 was about 70,000 to 90,000 ha/year. The deforestation rates showed significant increase beginning in the mid 1990's (McKenney *et al.*, 2002).

Deforestation experienced in all forest types, i.e. evergreen, semi-evergreen (mixed), deciduous, and others forests. The forest cover of different forest types is shown in Table 1.2 and its distribution is shown in Figure 1.1. Forests in Cambodia can be categorized into four (4) broad categories as follows:

(a) *Evergreen Forests*; An evergreen forest is a forest consisting of evergreen trees that retain green canopy all year round. They comprise of lowland tropical rain forests, hill evergreen forests, the dry evergreen forest and those along streams and rivers comprising about 19% (3.4 million ha.) of total land area in 2010. Evergreen forests are usually found in areas receiving more than 2,000 mm of annual rainfall. This type of forests is found mostly in the south-western, northern and north-eastern parts of Cambodia. These tropical forests are dense, multi-layered, emergent, understory and canopy layer, and harbour many types of plants and animals. They are mostly tall hardwood trees with broad leaves that release excess water through transpiration. Main species composition at the canopy layer includes *Dipterocarpus alatus*, *D. costatus*, *Hopea odorata*, *Tarrietia javanica*, *Shorea guiso*, *Irvingia malayana*, *Terminalia nigrovenulosa* and *Dipterocarpus intricatus.*

(b) *Mixed Forests* or semi-evergreen forest, on the other hand, contains variable percentages of evergreen and deciduous trees, of which the percentage of evergreen trees varying from 30% to 70%. Semi-evergreen forests cover about

1.2 million ha or about 7% of the total land area in 2010 (Forestry Administration, 2010). The indicator for distinguishing semi-evergreen forest from evergreen forest is the presence of *Lagerstroemia* spp. of the Lythraceae family. Main species composition in the semi-evergreen forests are *Lagerstroemia caliculata*, *Sindora cochinchinensis*, *Irvingia malayana*, *Dipterocarpus alatus*, *D. intricatus, Hopea recopei*, *Terminalia nigrovenulosa*, *Cratoxylon prunifolium* and *Xylia xylocarpa*. Some patches of evergreen and semi-evergreen forests (including gallery forest) are mainly found along the streams. These forests are home to commercial timber species, such as *Dipterocarpus alatus*, *Hopea odorata* and *Shorea guiso*. It is observed that when the forests are disturbed by human activities, there are presences of invasive species like *Mimosa diplotricha* (the giant sensitive plant) and *Chromolaena odorata* (Siamese weed).

(c) *Deciduous Forests*: The deciduous forests cover about 24.7 % (about 4.4 million ha) in 2010 as compared to about 26.6 % (4.6 million ha) in 2002. Deciduous forest is a type of forest in which the dominant trees species and other woody vegetation that make up the forest composition shed their leaves during the dry season and re-grows new leaves in the early wet season. The trees are typically not as close together as in the evergreen forest, so more light can reach the forest floor, especially when the trees have dropped their leaves. The availability of sunlight on the forest floor results in dense undergrowth, such as *Arundinaria pusilla* (bamboo grass) and *Imperata cylindrica* (*Imperata* grass). The dominant family in deciduous forest is *Dipterocarpaceae*. The dominant species in deciduous forest are: *Dipterocarpus obtusifolius*, *D. tuberculatus*, *D. intricatus*,

Shorea obtusa, *Pantacme siamensis*, *Terminalia tomentosa*, *Hopea recopei, Canarium subulatum, Careya sphaerica* and *Xylia xylocarpa.* Most of the tree species drop their leaves in the dry season. The forest floors become very dry in the dry season, so it is very easy to get fire. Many species in the deciduous forest have the capacity to regenerate by suckers (Rollet, 1972). The forest floor is usually covered by grasses and small bamboos (*Gramineae/Poaceae*). In the flood plains there are *Deschampsia cespitosa* (tufted-hair grass), *Bambusa* sp., *Themeda* spp. of the *Poaceae* family (grasses) and many other species like *Fimbristylis* spp., *Cyperus* spp., *Cladium* spp. of the *Cyperaceae* family (sedges). Deciduous forests differ from place to place in term of species composition and density of the trees depending on soil types, water availability and soil fertility. Mixed deciduous forests are found where soil is relatively fertile, with high percentage of clay, and the number of species per unit area is relatively high. Tree species in the mixed deciduous forest that can be identified include *Dipterocarpus obtusifolius*, *D. tuberculatus*, *D. intricatus*, *Shorea obtusa*, *Pantacme siamensis*, *Terminalia tomentosa* and *Xylia xylocarpa*. Sometimes, on a relatively fertile soils, are found a few species, *Shorea obtusa*, *Terminalia tomentosa* and *Pantacme siamensis*, dominating the forest canopy. On sandy soils with low moisture content and low fertility, the number of species per unit area drops significantly, and in some places single species is found in the canopy layer, *Dipterocarpus obtusifolius*.

(d) *Other Forests;* which includes mainly mangrove forests, inundated forests, and forest plantations. Other forests cover about 1.1 million ha or about 6.1 % of the total land area in 2010, compared to about 1.9 millions ha or 6% in 2002.

Mangrove forests are found on sheltered coastlines and river deltas, along the coastal areas of Cambodia from Kampot to Koh Kong province. The forests grow in brackish wetlands between land and sea where other plants can not grow. They protect the coastline and prevent erosion by collecting sediment from the rivers and streams. The mangrove forests of Cambodia are of major ecological and cultural importance, as the human population relies heavily on the crabs and fish that live in the roots. Mangrove forests are home to fewer tree species compared to the inland forests. The dominat tree species of the mangrove forests are *Rhizophora mucronata*, *Rhizophora conjugala* and *Bruguiera gymnorhiza*. Along the rivers toward the inland, there are narrow strips of mixed species of mangrove forests. The species composition include *Herritiera litoralis, Sonneratia* sp.*, Carapa obovata* and *Hibiscus tiliaceus*.

Flooded forests are found mainly around Tonle Sap Great Lake. Small flooded forests are also found in the upper parts of Mekong River, in Stueng Treng and Kratie provinces. Trees and shrubs are seasonally flooded from August to November, but remain dry during the rest of the year. Flooded forests are home to a wealth of biodiversity mainly birds and fishes. About 200 higher plant species have been recorded in the Tonle Sap area (Cambodia National Mekong Commision, 1998; Triet, 2002). The main species composition of the flooded forests include *Barrintonia acutangula, B. micrantha, Coccoceras anisoporum, Hydnocarpus saigonensis, H. authelminthica, Crudia chrysantha, Acacia spiralis, Salacia verrucosa, Cudrania cambodiana* and *Terminalia cambodiana.* The flooded forests of the Tonle Sap Lake are considered to be essential for maintaining the existing of fishery production in Cambodia (Csavas *et al*., 1994).

Forest plantation covers a total area of about 69 000 ha by 2010 (FAO, 2010). A variety of tree species have been used including exotic species, such as *Acacia* spp., *E camaldulensis* and *Tectona grandis*; and indigenous tree species, such as *Afzelia xylocarpa*, *Anisoptera costata*, *Aquilaria crasna*, *Dalbergia cochinchinensis*, *Dipterocarpus alatus*, *Hopea odorata*, *Pinus merkusii* and *Tarrietia javanica* (Forestry Administration, 2009). However, in term of planting area, plantation of indigenous tree species cover much smaller areas compared to the fast-growing tree species (Forestry Administration, 2009). The slow growth habit of some indigenous species at the early stage of development (Tsai and Faridah-Hanum, 1992; FAO, 2005) is the main limitation for promoting indigenous species in reforestation.

(e) *Non Forest:* This category merges agriculture areas, urban areas, water bodies, grass land, barren land, rock, wood shrub land evergreen and wood shrub land dry. Wood and shrub land is a mixture of shrubs, grass and trees with the trees cover, however, remaining below 20%. This forest type can be found mainly on shallow soils, on the top of mountains under climax conditions or as a result of non-sustainable land use. Theoretically there is a chance of becoming forests again (Penman *et al*., 2003).

Table 1.1 Cambodian forest cover estimates (1965-2010)

Assessment by year	Forest land	
	Ha	%
1965	13,227,100	73.04
1992/93	10,859,695	59.82
1996/97	10,638,209	58.60
2002	11,104,293	61.15
2006	10,730,781	59.09
2010	10,363,789	57.07

(Source: Forestry Administration 2010)

Table 1.2 Forest types and forest cover areas in Cambodia

No	Forest types	Forest cover area					
		2002		2006		2010	
		Ha	%	Ha	%	Ha	%
1	Evergreen forest	3,720,493	20.49	3,668,902	20.2	3,499,185	19.27
2	Semi evergreen forest	1,455,183	8.01	1,362,638	7.5	1,274,789	7.02
3	Deciduous forest	4,833,887	26.62	4,692,098	25.84	4,481,214	24.68
4	Other forests	1,094,728	6.03	1,007,143	5.55	1,108,600	6.1
5	Non forest	7,056,383	38.85	7,429,893	40.91	7,796,885	42.93
	Total area	**18,160,674**	**100**	**18,160,674**	**100**	**18,160,674**	**100**

(Source: Forestry Administration 2010)

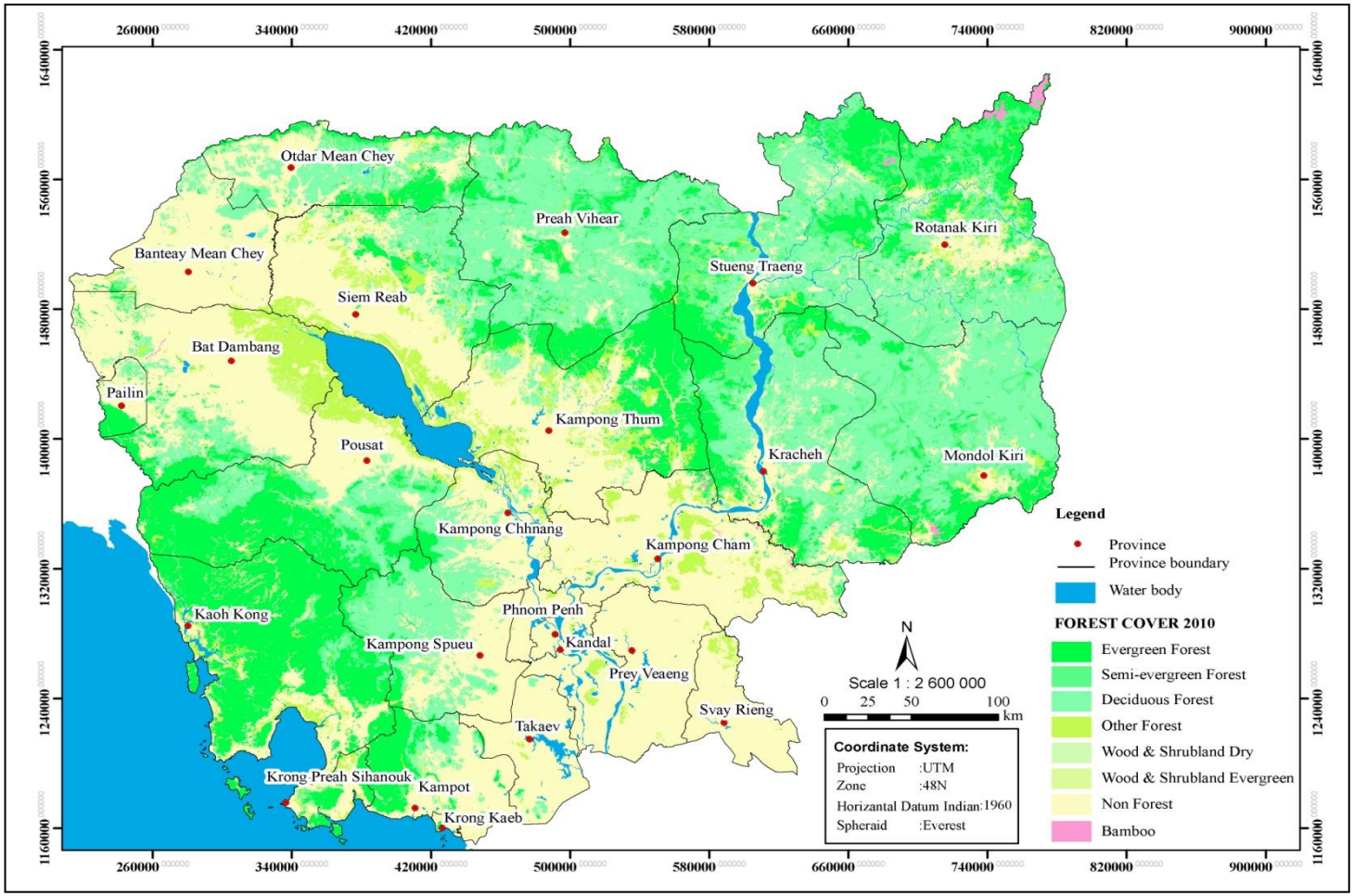

Figure 1.1 Forest cover in Cambodia (Source: Forestry Administration, 2010)

1.2 Main concerns of the deforestation and forest change

All forests in Cambodia are government-owned. For the last several decades, the production of timber in Cambodia had been largely from natural forests. In order to manage forests on a sustainable basis, a forest concession system was introduced in Cambodia in early 1991. By 1997, the government had entered 28 agreements affecting 6.8 million ha of total forest area, of which over 3 million ha were well-stocked with commercially operable forests (Barney, 2005).

Two types of selective cutting cycles are practiced in Cambodia; first, the long system with a 25-30 years cycle, for evergreen and semi evergreen; and second, 12-15 years cycle for deciduous forests. For the cutting cycle of 25-30 years it means that the forests should have enough residual stands after logging to regenerate and ready to be harvested in the next 25-30 years. Many countries in the tropical regions including Malaysia, Indonesia, Ghana and Brazil (Amazon) are adopting quite similar cutting cycles for their tropical evergreen forests (Cannon *et al.,* 1994; Vanclay, 1994; Bertault and Sist, 1997; Sist *et al.,* 1998; Sist and Saridan, 1999; Sisit, 2000; Sist and Nguyen-Thé, 2002; Pearce *et al.,* 2003; Van Gardingen *et al.,* 2003; Sist *et al.,* 2003a; b; c; Sist and Brown, 2004; Dauber *et al.,* 2005; Van Gardingen *et al.,* 2006; Kao and Ida, 2006; Sist and Ferreira, 2007).

In Cambodia, the Selective Management System for production of timber is applied mainly to dense evergreen and semi-evergreen forests. These forests are dominated mainly by dipterocarp species. The average growing stock of all trees with diameters greater than 10 cm at dbh in Cambodia's evergreen forest is about 230 m^3/ha with a mean growth rate of 0.33 m^3/ha/year. Several growth rates of the

regenerated forests in Cambodia based on growth and yield plots, however, recorded higher growth rates (Kao *et al.*, 2010).

The present status of the forest resources of Cambodia indicates that many of the remaining forest areas are significantly degraded (McKenney and Prom, 2002). The problem of forest management is always linked to the rural poverty and over exploitation of the forest resource. Causes for deforestation could be summarised as follows:

(a) Many forests are cleared for agriculture, fuel-wood, food, pole, construction timber, and development of infrastructure.

(b) Most of the poor people resort to farming by clearing or converting forest lands to agriculture through slash and burn cultivation.

(c) Forests are often targets for migrants because they often provide fertile agricultural lands or pasture that can be converted by colonists (Sunderlin, 2007). Even if natural forests are formally the property of the state, the state is often unable to enforce exclusionary laws, in part because of the remoteness of some forests (Sunderlin, 2007)

The extend of land-use change is shown in Table 1.3 and Figure 1.2. The total areas changed (decline) from 2002 to 2010 are about -740,502 ha or 4.1% of the total forest land area. The biggest forest change or decline happened in deciduous forests, of which about -352,673 ha or 1.9% were deforested, followed by evergreen forests of about -221,308 ha or1.2%. This is mainly due to the encroachment of people to the forest areas for their agriculture activities. Most of the statistics on forests change are concerned on the change of the forest areas. For the production of timber, the concerns could be extended to the ability to manage it to a sustainable basis. In this case, it will focus on the quality of forest and the ability of the forest to be continuously productive in producing timber for wood-based industries.

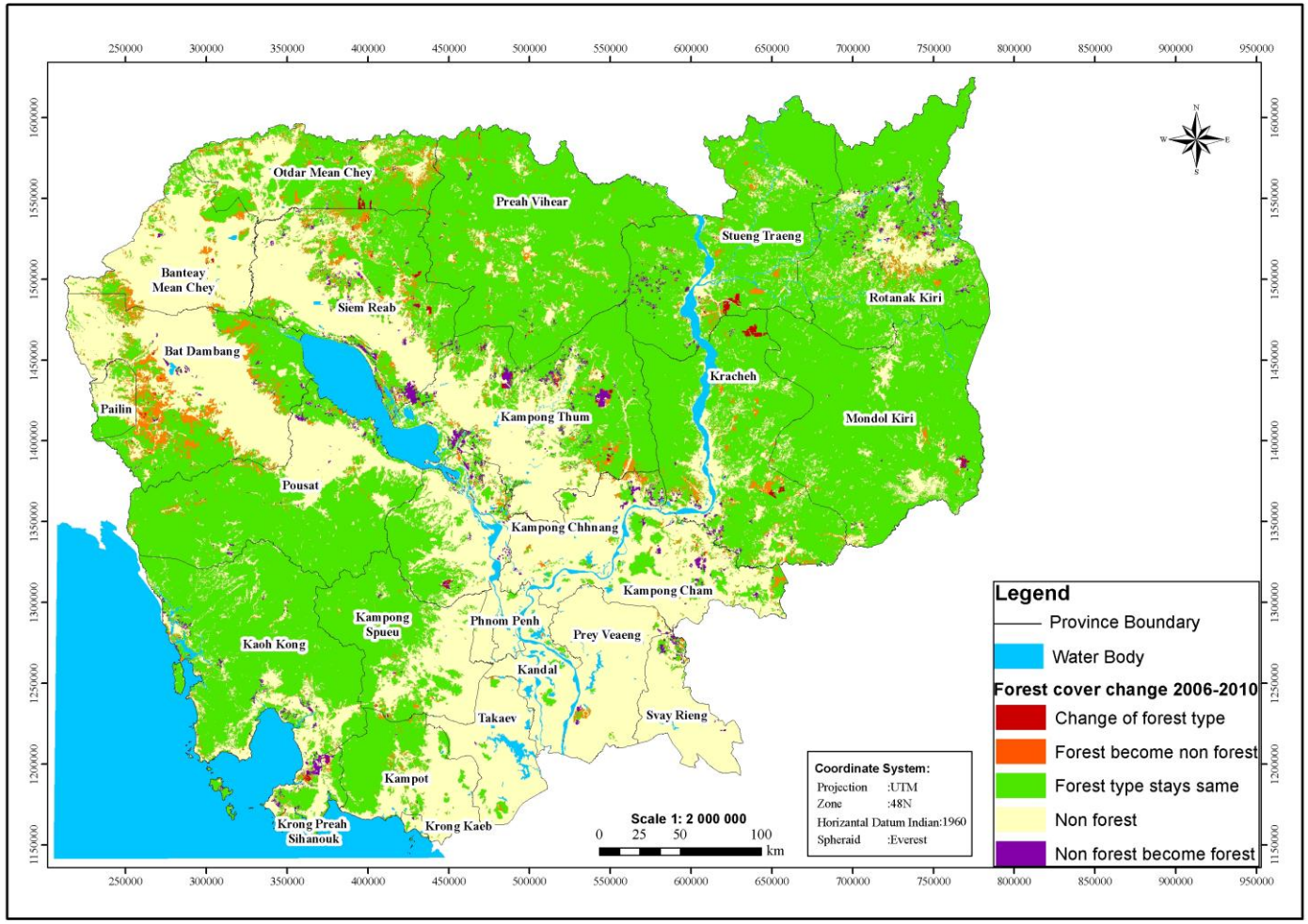

Figure1.2. Forest cover map change (Source: Forestry Administration, 2010)

Table 1.3 Forest area change from 2002 - 2010

No	Forest types	Change					
		2002 - 2006		2006 - 2010		2002 - 2010	
		Ha	%	Ha	%	Ha	%
1	Evergreen forest	-51,591	-0.28	-169,717	-0.93	-221,308	-1.22
2	Semi evergreen forest	-92,545	-0.51	-87,849	-0.48	-180,394	-0.99
3	Deciduous forest	-141,789	-0.78	-210,884	-1.16	-352,673	-1.94
4	Other forest	-87,585	-0.48	101,457	0.56	13,872	0.08
5	Non forest	373,510	2.06	366,992	2.02	740,502	4.08
Total forest land		**-373,510**	**-2.06**	**-366,993**	**-2.02**	**-740,502**	**-4.08**

(Source: Forestry Administration, 2010)

The issues related to timber productivity could be summarized as follows:

(a) Over exploitation of timber production. Most of forests are degraded. In one of the felling inventories in a concession area, the volume of all trees with diameters greater than 10 cm is 82 m^3/ha on average – approximately one-third that of virgin evergreen forests which averages 230 m^3/ha, with a density of 298 trees/ha. Thus as in many other forest areas, had been due to over logging, particularly that of commercial species. This had resulted in the remaining trees being smaller in diameter and volume. The continued of logging in already degraded natural forests made the forests to be more degraded, and are not able to produce timber in a sustainable way (Kao and Ida, 2006).

(b) Encroachment by people**.** The rates of forest destroyed by populations living around forests are considered very alarming. People used forest lands for their agriculture activities, timbers for housing, and non-forest produces for

consumption. The rates for natural mortality and intervention for different forest types are based on the number of trees which died or were destroyed. The work by the Department of Forestry shows that trees destroyed by people who are living near to forests are higher than the number of trees dying under natural processes (Forestry Administration, 2004b). In this case, as well as in many other cases in Cambodia, people living in the surrounding areas will continue to destroy the forests, and this will form a major threat to the sustainable management of forests in producing timber in future.

(d) Plantation forests have not been productive. Plantation forests have been established to complement the supply of timber from natural forests (Lamb *et al.,* 2005). A few fast growing species have been identified for timber plantations in many tropical countries. Until 2010, about 99,000 ha of plantation areas have been established, and these areas have been planted with local and fast growing species. The development of timber plantations had not been sufficient to compensate the reduction of timber from natural forests. In addition, many of these plantation areas have not been properly managed or have been destroyed by people living in the surrounding areas.

(e) Loss of biodiversity and conservation of timber species**.** As timber production is critical for the development of timber industries, the depleting of forests due to excessive logging and land clearing gives rise to the need to sustain the conservation of commercial timber species (Gardner *et al.,* 2009; Gibson *et al.,* 2011). Many of these timber species are heavily exploited due to its popular demands by timber industries.

The deforestation makes more difficult to collect seeds of commercial timber species for plantation and conservation activities (Hamilton, 1999). As these species are now located in deep forests due to deforestation and excessive logging, more efforts are needed to locate trees of these timber species for seed collection and other related conservation activities. In addition, most of the current conservation initiatives are government driven either *in-situ* or *ex-situ* activities. Germinating seedlings for planting activities are also limited to government established nurseries. As the number of forest plantation is relatively small, hence the number of nurseries established is therefore limited. This limitation of established nurseries gives rise to the risk that many of these timber species will not be available for commercial activities or may be extinct in future.

As the result of the current status of deforestation and its impact to its conservation, options to conserve the valuable timber species in the current agriculture areas, should be seen as critical and in order to protect the timber industries (Anyonge and Roshetko, 2003; Kettle, 2010). Encouraging people to plant trees of important timber species could be the most effective initiative to complement the current conservation activities (Thacher *et al.,* 1996). This could also be due to the need to create situations of forest friendly communities to people living around the forests as follows:

(i) Bring people to participate in the *ex-situ* conservation of forests. Thus the forest initiative is not distancing from people to conserve forest timber species, rather to bring people together to conserve the species as part of their economic livelihood activities.

(ii) As timber plantations require big investments and capital, it is a better way to initiate people participation in the conservation of timber species as well as in supplying the timber from outside forests. In this aspect, integrating of agriculture practices with planting of timber species could contribute to the conservation as well as to complement timber supply from natural forests.

1.3 Non-timber forest products

Forests in the tropics provide a lot of goods and services. In addition to timber, forest produces a lot of other non-wood produces (Belcher and Schreckenberg, 2007; Shackleton *et al.*, 2004; Ticktin, 2004). These products are being used by forest-dependant people for their own consumption as well as to sell it for income generation. Among other the main produces of forests are as follows:

(a) *Rattan* - is the main non-timber forest product that is being used in domestic industries, particularly furniture and others for sale locally or for export (Khou, 2008). Cambodian rattan researches to date have documented 18 species across the country. Major rattan species found in Cambodia used by domestic industries are *Calamus rudentum*, *Calamus siamensia, Calamus tetradactilus, Calamus viminalis, Daemonorops jenkinsiana, Daemonorops, Rattan Manaus*, *Calamus palustris* Griff, *Rattani irit* (Khou, 2008). Rattans have been used for centuries by local communities for construction materials, traditional medicine, and furniture. Rattan shoots of many species of *Calamus, Korthalsia laciniosa, C. rudentum* and *Myrialepis paradoxa, Daemonorop jenkinsiana* are edible and are preferred food by forest dwellers.

(b) *Bamboo* - Bamboo is another non-timber forest product that has high commercial values. Local people use bamboo for house building. In housing bamboo is used for truss, fencing, walls, and temporary structures such as stalls in roadside. Bamboo is also used to make musical instruments, while bamboo shoots are used for food. Major Bamboo species found in Cambodia used by domestic industries are - *Bambusa bambos, Bambusa pallida, Dendrocalamus nudus,* and *Thyrsostachys siamensis.*

(c) *Wild Fruits* - are the main wild fruit that are being used for in-house consumption as well as to increase income by selling them at local markets. These fruits in Cambodia are as follows: *Melastoma* sp, *Mangifera duperreana* (Svay Prey), *Spondias* sp (Deum Pon), *Flacourtia indica (*Krokhop prey)*, Eugenia* sp (Pring) and *Schleicheraoleosa* (Pongro). Semi-over green forest and riparian forest contain a number of edible wild fruit producing trees. These trees include *Antidesma* sp (Dangkeab Kdam), *Baccaurea rami flora* (Preal, Phnheav), *Willughbeiaedulis* (Kuy), *Dimocarpus* sp (Mien), *Melodorum fruticosum* (Phle Romduol), *Nephelium* sp (Semoan), *Bouea* sp (Makpreng Makprang). Wild fruits especially sour fruits like *Dialium cochinchinense* and *Schleicheraoleosa* are added to soups to make it sour.

(d) *Herbs* - Recent study has found that Cambodia accounts for 824 medicinal and aromatic plant species, in equivalent to 30-40% of total recorded plants. These medicinal and aromatic plan species, about 200 species are commercially traded in Phnom Penh. It has been experienced that plants of high demand and high market price are under threat from over harvest and unsustainable collection practice. At

present, a number of medicinal and aromatic plants such as *Aquilaria crassna* (agar wood), *Coscinium fenestratum* (yellowvine), *Scaphiumma cropodium* (malva nut), *Strychnoxnux-vomica*, *Cinnamomum Cambodianum* and *Cinnamomum parthenoxylum* are facing threats because of high market demand and improved standard price (Sukhdev *et al.* 2006).

(e) *Fish* - many types of fishes are found in many rivers of Cambodia. For farmers and forest-dependant people in Cambodia, fish is the major source of protein and it can be found in abundance in the river systems of Cambodia. There are three main important rivers in Cambodia, Sesan, Sekong, and Srepok River. Together these rivers contribute 20% of the Mekong's total volume of water. They are therefore extremely significant in terms of the lower Mekong River basin as a whole. The fish biodiversity of the three rivers appears to be very high, although the fish species found in each of the rivers appear to be quite similar. Artisanal fisheries dominate these three rivers and their tributaries in Rattanakiri and virtually every family along those rivers are engaged in subsistence fishing. The people who are living along or near the river are heavily involved in fishing, and fish contributes about 70-80% of the protein. Apart from relying on fish as a major source of protein, many people also sell fresh fish to generate cash income. The Srepok River has high fish species diversity: there were at least 193 fish species belonging to 32 families and 84 genera detected in the Srepok River in February 2008. The most dominant family is Cyprinidae or carps (38%), followed by catfish species (23%), and the family Cobitidae (7%).

1.4 Forest strategies to address the problem of deforestation

1.4.1 Forestry initiatives: Community and Social forestry

Professional foresters still hold the view that timber production can only be attained through exclusion of humans from the forests. However, as the deforestation is derived from many external factors particularly human, then the participant of these people should be given higher priority. Community Forestry was designed as a strategy in addressing rural poverty and sustainable forest management (Bowler *et al.,* 2012). Two types of activities to be carried out under community forestry: Managing the existing forest areas through the sustainable utilisation of forest goods and services, and sharing the resources by planting trees for their own consumption.

Although community-based natural resource management (CBNRM) is considered the most appropriate strategy for reducing poverty, limited benefits remain a major threat to its continued practices (Brosius *et al.,* 1998; Agrawal Gibson, 1999; Leach *et al.,* 1999; Hackel, 1999; Scheberle, 2000; Bradshaw, 2003; Thompson *et al.,* 2003; Olsson *et al.,* 2004; Zanetell and Knuth, 2004; Armitage, 2005; Barker, 2005; Butler and Koontz, 2005; Gruber, 2010;). To date, there are limited assessments on the progress in promoting natural resource management by local communities including its impacts (Bowler *et al.,* 2012). Also, there is still a poor understanding and lack of documentations of the relationships between the type and condition of a forest, its corresponding benefits to the local communities, and the experiences in community-based timber production within the tropics in particular (Edmonds, 2002; Gautam *et al.*, 2002; Bandyopadhyay and Shyamsunda, 2004; Gautam *et al.,* 2004; Gupta *et al.,* 2004; Duran-Medina *et al.,* 2005; Sreedharan *at al.*, 2005 Adhikari *et al.,* 2007; Bray *et al*., 2008; Ellis and Porter-Bolland, 2008; Nagendra *et al*., 2008).

1.4.2 Family initiatives-integration of house farming with the conservation of several timber species

One of the targeted forest changes is to convert forest lands to non-forests, particularly agriculture. Farmers cleared forest lands and planted them with various cash crops for them to generate income to their family (Anyonge *et al.*, 2003). The most popular crops are cashew nuts, soya beans, ground nuts, cassava, rice and vegetables. If the farmers are fully committed, then the tendency for them to clear more forest will be lower. Intensive agriculture will encourage them to focus on their land's productivity rather than the expansion of unproductive lands.

The focus on individual farmers rather than community is to reduce the complexity in terms of decision making process. The farmers are the only actors responsible on their lands and could decide on the utilisation of their lands. In this aspect, the initiative on the long term plan such as high quality timber for conservation purpose could have a better chance to be successful.

1.5 Objectives and purposes of the study

The main focus of this study is to find out whether local family-base social forestry can play an active role in addressing the issues of deforestation through their participations in replanting of threatened timber species in their farms. The experiment is critical to find out whether the people who are involved in the opening of lands (legal or illegal) used as the driving force for the rehabilitation activities, and to ensure the deforestation can be controlled at the manageable level.

The main objectives of this study are therefore to assess and find out whether:

(a) The farmers can be the main actors to promote the conservation of valuable timber species to minimise species extinction;

(b) The planting of timber species can be integrated in the farms, and at the same time will not jeopardise the farmers' activities of planting cash crops in their lands; and,

(c) The timber planted trees, can also be used as sources of important timber species for future timber industries.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Like any other global environmental problems, the root causes of deforestation in Cambodia are due to social, demographic and economic factors (Kim Phat *et al.,* 1999; Kim Phat *et al.*, 2000; Kim Phat *et al.,* 2001; Geist and Lambin, 2002; Top *et al.,* 2003; Kim Phat *et al*., 2004; Top *et al.,* 2004 a, b, c; Kim *et al.,* 2005; Kim *et al.,* 2006; Sasaki 2006; Top *et al.,* 2009; Sasaki and Yoshimoto, 2010). The success of the forest strategy in addressing issues of deforestation depends on the social forces that could be used to accomplish the task. These strategies are not confined to simply conservation of the remaining forests, but also to include tree planting, both inside and outside forests for reforestation activities (Chazdon, 2008; Lamb *et al.,* 2005).

Reforestation provides convincing illustration of the proposition that the solution of forestry problems of development is to be searched through social aspects of the people living around or outside the forests (Djamhuri 2008). These aspects can be viewed as two pronged, i.e. to reduce the deforestation through conservation of the remaining forest (this strategy includes community forestry; group based social forestry, etc (Bowler *et al.,* 2012) and, to increase reforestation outside forest areas, particularly converted agriculture areas (Pasicolan *et al.,* 1997; Hoch *et al.,* 2009; Bertomeu 2012; Hall *et al.,* 2011; Lamb *et al.,* 2005).

2.2 People participation in reforestation

2.2.1 The need for planting trees

Forests have always been associated with people with regard to providing goods and services (Jack *et al.,* 2008; Tallis *et al.,* 2008). The main priority is therefore to ensure that the supply of these goods is sustainable.

People in the initial stage of civilization were known as food gatherers. Later, they learned to cultivate plants and to domesticate animals. This shift in lifestyle has resulted in an increase for more lands for cultivation to meet their basic needs, particularly for fuel, housing and food. In India, about 10 % of its farmers cultivate trees for fuel wood and also increasingly intense gathering of trees for fuel and construction, combined with other causes of forest depletion-clearing of forests for agriculture, had reduced the wood volume produced by natural regeneration (Goodland 1991; Guggenheim and Spears, 1991).

2.2.2 The Concept of social forestry

Social forestry programs aim primarily at helping small farmers and the landless to meet their consumption and income needs (Hyde, 1991). The strategic objectives embedded in the very concept of social-forestry are to encourage large numbers of people to plant trees, for either timber, forest products, or to improve environmental protection (Dove, 1995).

In contrast to industrial forestry, social forestry programs made attempts to influence people's behaviour toward trees (Dove, 1995). Under conventional industrial forestry programs, business corporations or government agencies hire labourers to

establish plantations on large tracts of land controlled by private businesses or agencies; the wood harvested for use in industries or constructions. Social forestry, in contrast, aims to induce a large number of small farmers to plant trees systematically for their own needs and on their own (and other available) lands (Agrawal *et al.,* 2008).

By definition therefore, social forestry programs require intensive farmer participation in tree planting activities. Its success or failure depends on whether the farmers are fully engaged in the program (Acharya, 2002; Pagdee *et al.,* 2006). These programs are most likely to be effective when people belong to organized groups, and they are informed and become conscious that it is in their best interests to act in a coordinated manner, when the group has developed leadership structures and internal norms and procedures likely to mobilize and manage its members to overcome conflicts and deviant behaviour (Somlai, 2008). Effective and successful social forestry programs would have the following steps:

(a) Identifying or establishing viable groups,

(b) Engaging farmers to produce wood they need in an organized manner,

(c) Promoting technologies that are suitable according to the level of competence of the group, and

(d) Dealing with issues of social engineering (group formation, leadership, participation in decision making, intra-group structures, incentives, penalties, communication, and benefit distribution) in line with the available technical or financial elements of the program.

When social forestry programs are designed, the capacity of the members to carry out various tasks should be studied first. The technical tasks for this program

may include site selection, nursery development, species selection, planting technology and configurations, fertilization, plantation management, enclosure or other protection, and marketing. Various technical aspects of planting such as selection of types of tree arrangements (block planting, linear planting or alley cropping) and the selection of tree species, should be in line with the needs of farmers, local land-tenure systems and land availability.

Trees have socio-economic attributes and the same tree may have different uses and meanings to different people in different cultures (Raintree, 1991). In this aspect, farmers may be interested in planting multipurpose tree species, rather than planting trees just for fuel wood alone. In social forestry, tenure rights, incentives, and awareness of the designing strategies around farmers and groups, requires at least two more key elements: first, tangible economic incentives and benefits to the farmers and groups; and, second, awareness of the need for reforestation. An important incentive is clarifying the land-tenure systems on forested lands, and protecting the land rights of the tree producers (Pasicolan *et al.,* 1997).

Similarly, tenure on trees must be clarified and secured legally. Customary land-tenure rules often discourage tree planting by tenants, because planting and owning trees traditionally entail title to land. Conversely, modern regulations in some developing countries have introduced disincentives in other ways. For instance, by limiting farmers' rights to cutting and harvesting trees that they planted on their own land. Recognizing farmers' tenure on trees and their decision-making rights to harvest, use, or sell their trees according to their wishes would increase the incentives to tree planting (Martín *et al.*, 2012).