

**Sustainable Forest Rehabilitation and Management for the Conservation of  
Trans-boundary Ecological Security in Montane Mainland Southeast Asia–  
Pilot Demonstration Project in Myanmar**

**Thematic report on best practices of forest  
rehabilitation practices in Myanmar**

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## 1. Background

Myanmar has more than one half of its land area covered by forests. Due to a wide range of topography, soil, rainfall and temperature, fauna and flora are also diverse. Although the forest department has been managing the forests systematically using Myanmar Selection System since 1856, forest depletion and degradation had taken place alarmingly especially over the last few decades. The Union of Myanmar has a population of 55.4 million (2005-2006 census), including over one hundred indigenous races with distinct dialects, and an annual population growth rate of 2.02% .

Majority of the rural population in Myanmar is commonly forest dweller and earns their incomes mainly through agriculture. So, they pay attention to the conservation of their natural resources. The small farmers are facing with more challenges as compared to the big farmers in their effort to conserve natural resources and rehabilitate it. Their constraints are due to poor infrastructure, lack of market opportunity, limited accessibility to credit, lack of pragmatically appropriate technological intervention, and so forth. Nonetheless, they do practice conservation of resources within their own capacity in various ways. Traditionally, resource management is a part of the social life among rural people and they inherit customary and traditional knowledge about resource management from elderly. Handing down of experiences of elderly people is invaluable for resource management.

### 1.1 Geographical Context

The Union of Myanmar has a total land area of 676,577 km<sup>2</sup> (or 67.6 million ha) which is topographically divided into four main regions:

- The **Western Mountain Ranges** comprise the Rakhine, Chin and Kachin hills in the west and the north of the country. The elevation in Rakhine State varies from 1,300 m to 1,500 m and in the Chin Hills from 1,500 m to 2,000 m. Mountains bordering China in the north reach an elevation of around 6,000 m. The hills and mountains contain extensive forests comprised of a wide range of types.

- The **Shan plateau** region includes the extensive Shan plateau and the mountain ranges in Kayah, Kayin and Mon States and Tanintharyi Region, rising to about 1,000 m in elevation. The forests range from tropical rain forests in the south to mixed deciduous forests, dipterocarps to pine forests in the north and northeast. Many upland areas are under long fallows *taungya* cultivation

- The **Central Region** includes the fertile agricultural valleys of the Ayeyawady, Chindwin and Sittaung Rivers. The topography is flat to undulating except the hills of the Bago Yoma which rise to about 1,000 m, and bear the finest teak forests of the country .

- The **Ayeyawady** delta and coastal region include coastal areas in Rakhine State, Mon State and Tanintharyi Region, which are alluvial plains. Some coastal areas are still covered by mangroves, although most areas suitable for rice cultivation have been cleared.

### 1.2 Climate

Myanmar's climate is greatly influenced by the monsoon, leading to three distinct seasons namely hot, rainy and cool. The hot season runs from mid-February to mid-May, the rainy season from mid-May to mid-October, and the cool season from mid-October to mid-February. The Rakhine mountains obstruct the southwest monsoon from coming to central Myanmar, leading to semi-arid conditions with summer temperatures rising to over 40°C, and minimum rainfall, gauging only about 500 mm annually. In

comparison, the coastal regions receive as much as 5,000 mm precipitation during the monsoon season. Temperatures over the whole country vary widely, from less than 0°C in the northern highlands to over 40°C in the central dry zone. Forest Department in 1856 to manage and regulate the orderly exploitation of Myanmar timber (see Bryant 1997), after which Forests were gradually reserved, including village forests.

### 1.3 Forests Status and Trends

Due to a wide range of topography, soil, rainfall and temperature, the vegetation types, fauna and flora are also diverse. Practically, all the forests in Myanmar are natural forests, which are commonly categorized by eight major forest types, namely: tidal forest, beach and dune forest, swamp forest, tropical evergreen forest, mixed deciduous forest, dry forest, dipterocarp forest, and hill and temperate evergreen forest.

Each forest type provides rich biodiversity, high value timbers, land for cultivation (both shifting and sedentary), ecosystem services like water supplies and a range of non-timber forest products. The mixed deciduous forest type comprises 40% of the country's remaining forests and is seen as economically most important, as these forests contain teak and other valued tree species such as pyinkado (*Xylia dolabriformis*), padauk (*Pterocarpus macrocarpus*), binga (*Mitragyna rotundifolia*) and hnaw (*Adina cordifolia*).

Myanmar's national forest cover is currently estimated at 47% (31.773 m ha according to FAO 2010), of which closed forests are estimated to be 19.9%. According to the National Forest Master Plan (NFMP) of the Forest Department, the forest cover has decreased from 65.8% of the total area of the country in 1925 to 52.3% in 1999. Myanmar's overall deforestation rate is estimated to be 1.2% per year (1989-2009) (FD 2009).

## 2. Policy and legislation

### 2.1 Forest policy

Myanmar forest policy adopted in 1995, has the following objectives:

- To encourage community forestry and peoples' participation for self sufficiency in domestic needs of forest produce, by planting fast growing multi-purpose tree species in degraded forest lands.
- To rehabilitate the forest resource base and adopt sound management planning and strategies to optimize production on a sustainable basis.
- To open up opportunities for private sector involvement in industrial plantations, with no environmentally adverse impacts or damage to the ecological balance.

### 2.2 Forest Legislation

Myanmar forest law promulgated in November 1992, has a clause empowering the Director-General to allow establishment of village-owned firewood plantations on degraded lands near villages. The plantations are to be established, maintained, and protected by the villagers, who have tenure rights to the trees and usage.

The legislation also allows the private sector and communities to establish and maintain plantations on state lands under usufruct basis, with the approval of the Government. These are the salient features of the new legislation and not found in previous legislation.

Community forestry instructions (CFI) has been issued ad interim, while awaiting the formulation of community forestry rules. The main features are usufruct right for 30 years extendable, and the right of ownership of the produce.

### **3. Deforestation and degradation**

Forest degradation is experienced in all developing countries and the main causes of forest degradation in Myanmar are as follows:

- (i) Population growth and poverty;
- (ii) Encroachment of agricultural land into Reserved Forest as well as plantation forests;
- (iii) Excessive production of wood ;
- (iv) Illegal logging; and
- (v) High demand for Fuel-wood and Charcoal.

The natural forests are depleted due to renowned explosion of population growth which inevitably followed by the encroachment of land for their livelihood needs. In Myanmar, about 70 percents of people are residing in the rural area and their main livelihood activity is agricultural food production and many others depend on forest resources especially on non timber forest products. Nowadays, due to the hunger of land for the rural people, the plantation forests are being challenged for agriculture lands. On the other hand, forestry sector is playing an important role on the development of national economy and the main production is relying on wood especially on high value timber. For this regard, the extraction of wood is increased to some extent over the annual increase of renewable resources. Illegal logging, which is readily followed by the timber production under annual allowable cut (AAC), is also an important cause of forest degradation because those forests are more accessible due to new road. Although timber production for the national economy is controlled by minimum girth limit, illegal logging regards without the girth limit. Since fuel-wood is the main energy source for daily cooking and other uses, the demand for this aspect is much higher in the rural area compared to the urban area. Even in the urban area of most cities, the charcoal and fuel-wood are still being used. The higher the demand on the fuel-wood is the more potential small sized trees are being cut, which causes the reduced number of regeneration of that area.

### **4. Forest Rehabilitation Practices in Myanmar**

Although the Forest Department has been managing the forests systematically using Myanmar Selection System since 1856, forest depletion and degradation had taken place alarmingly especially over the last few decades. For this reason, Government has taken several measures to address the problem of forest degradation and deforestation by developing National Forestry Master Plan and District Forest Management Plans.

## **4.1 Scientific Forest Rehabilitation Practices**

### **4.1.1 Silvicultural Interventions in Natural Forests**

To accelerate the natural restoration process, the degraded stands can be subjected to two basic types of silvicultural treatments, viz., improvement and enrichment. Choice of suitable silvicultural intervention depends primarily on the structural characteristics and regeneration potential of the degraded stand. If the number of economically valuable trees in the initial stand is not sufficient, or there is a complete lack of such trees, then enrichment may be a better option than improvement.

### **4.1.2 Afforestation and Reforestation Activities**

Plantation forestry has a complementary role to natural forest in order to control deforestation and forest degradation. The objectives of plantation establishment in Myanmar have been to rehabilitate degraded forest lands, restore deforested areas and supplement various timber yields from the natural forests. Re-afforestation in Myanmar got momentum in early 1960s and large-scale plantation forestry begun in the 1980s. Since then the annual plantation programme has been intensified gradually till it has reached the present target of over 40,000 ha. FD establishes four types of plantations, of which local supply plantations and watershed plantations especially aim at satisfying wood-fuel demand of local communities and rehabilitation of degraded watershed areas.

### **4.1.3 Protected Area System and Biodiversity Conservation**

Although rich in biodiversity in the region, loss of biodiversity due primarily to the socio-economic pressure is unavoidable in a developing country like Myanmar. The general trend of wild animal population is appeared to be decreasing compared with their relative abundance over the past 20 or 30 years. Due to habitat destruction, their population is not large enough to reproduce a viable population. The down-ward trend is apparent with large mammals such as tiger and elephant because of reduction of their sex ratio and home range by human activities. There can be decrease of wildlife where there is easy access to people and heavily populated areas. But, Myanmar is trying to conserve the habitats of wildlife species through establishment of protected areas. Therefore, there is an up-ward trend of wildlife in protected areas in general.

## **4.2 Traditional knowledge on forest rehabilitation practices**

The rural peoples depend on forests particularly for fuel wood, pastures and tree fodder, compost materials, timber, posts and poles for construction & sale, a wide range of non timber forest products including wild foods and medicines which can provide both seasonal incomes and a safety net function. There has been a long history of their local management as a common property resource. In Myanmar common property regimes began to be disrupted from the 19<sup>th</sup> century by the Colonial era. Village forest areas often became effectively open access leading to a tragedy of the commons. However, some informal commons management seems to have persisted. This includes protection of forests on private/ community land, grazing lands, sacred groves, woodlots in and around Buddhist monasteries and shrines, and private watershed forests in Shan State and so on.

Scared groves for instance remain fairly widespread (typically devoted to local Nats or spirit guardians). Communities enforce strict prohibition on any exploitation. These groves there from

community collective action is also prevalent. There are varieties of traditional management practices and community forestry adopted in Myanmar.

#### **4.2.1 Taungya system**

Taungya system which means hill (taung) cultivation (ya) and which have been established since 1869. Taungya proved very efficient as forestry plantations are established at a low cost and the villagers can also cultivate their food crops in the early stages of plantation establishment, in which, the species integrated are commercial tree species mostly with teak (*Tectona grandis*), Pyinkado (*Xylia dolarbiformis*), and Padauk (*Pterocarpus macrocarpus*). A variety of agricultural crops are commonly grown in taungya, such as rice, corn, maize, groundnut, sesame, etc. Simultaneous production of food, wood and fuel is provided by this system. The pruning of side branches and cutting of taungya felling also provides fuelwood. This system can be successfully introduced and adopted by shifting cultivators.

#### **4.2.2 Home garden**

Home garden is an important traditional agro-forestry system and which can be observed all over Myanmar. However, the magnitude of its economic and cultural importance and environmental significance varies from one place to another. In places where market opportunity is good, the produce from home gardens contributes a relatively large portion of the household's income.

#### **4.2.3 Forest garden**

Forest garden is a group of tree crops or fruit trees deliberately preserved or grown within the forest by the people from nearby villages. Some places in Kayin and Shan State have forest gardens generally with coffee and tea crops cultivated respectively. Gaps in the forest can be patched by forest garden. It provides for home consumption and increase income, and hence adds to socio-economic status of village households. However, this system is difficult to manage and subject to loss by theft, fire, or animals because they are located away from the village.

#### **4.2.4 Roadside planting**

Myanmar people always love to plant trees on roadsides as a provision of shade for pedestrians, passers-by, and animals and well-being for their own future life. Giant banyan trees (*Ficus religiosa* and *F. elastica*) can be seen along the various roads in Shan State, neem trees (*Azadirachta indica*) in dry zone, and rain tree (*Albizia lebbek*), star flower trees (*Mimusops clengi*), and ironwood trees (*Mesua ferrea*) in lower Myanmar. Trees are usually planted on the roadsides so that roots of the trees hold soil firmly whereby erosion of the roads is minimum. This type of planting provides travelers and wandering animals with shade and birds with nesting place. The pleasant micro-climate can be observed around roadside areas. It also meets fodder and fuelwood needs, to some extent.

#### **4.2.5 Shelterbelt or windbreak**

Shelterbelt or windbreak, in which farmers plant trees in a single line to protect their farm against erosive and desiccating wind and which can be found often in farms located on the windward or in the direction of the prevailing wind. It prevents soil loss by wind and also reduces soil desiccation and crop transpiration, and as a result increasing yield to some extent. However, the windbreak is not constructed systematically enough to maximize its effectiveness and also sometime is not aerodynamic, hence destroyed by violent winds.



#### 4.2.6 Water spring sources

Forest around water spring sources; with increased population, more forest are cut and transformed into slash and burn agriculture but they never touch the forests around the water springs used for fetching water. This is irrespective of need the land or forest products. And it is also believe that any damage to trees around spring will cause cessation of spring. Fuelwood gathering, burning and grazing are strictly prohibited and in some places, the forest is fenced with wooden posts and bamboo. This practice is quite effective in forest and water conservation and also forest ecology is maintained since the villagers exercise this practice voluntarily for their own welfare.

#### 4.2.7 Spiritual Forests

Forests safeguarded by spiritual belief; forests owned by monks, forests presumably guarded by super natural beings, and the people regard forests around cemetery as untouchable forests. Because majority of the Buddhist people, who account for approximately 80% of the country's population, believe in super natural beings and follow this practice very strictly. For instance, at Mount Poppa in the dry area where the Poppa National Park is located where there is the only green area in the dry zone of central Myanmar. An influential monk protects some parts of this park successfully. Believe can play a fundamental role in maintaining the environment. Many people believe that super natural beings can either harm or benefit them, so the destruction of trees and forested areas where super natural beings presumably dwell is regarded as wrong doing for their spiritual will being. Thus, this belief safeguards forests to a great extent. A small shrine is usually built in such forest and so local people already know what it means and what should not be done in these area. Likewise, the graveyard is regarded as the place where all ominous are present. Consequently, tree groves in the cemetery sites are secluded from the access by people out of fear.

#### 4.2.8 Self-Reliance Woodlots

Self-Reliance Woodlots; most villages in Myanmar do not have electricity. They entirely rely on fuelwood for cooking and heating purposes. Some ethnic group, such as Lesu, Akha and etc have established, protected and utilized woodlots for decades. Some woodlots are inherited but some people established their own when they married and in some places which owned communally. Woodlots provide from fuelwood to construction materials such as post and pole, and make local people self-sufficient and economically feasible. In addition, they act as windbreaks protecting soil and also make favorable climate to live for both man and animals in dry zone area.

#### 4.2.9 Traditional Pest Control Practices

One of the methods used is tobacco spraying. The farmers put tobacco (*Nicotiana tabacum*) leaves, which is cheaply available in the area, in the containers filled with water for a night, and spray that liquid on vegetables such as rose, mustard and cabbage to protect them from pests.

Another method used is fumigation. The farmers prevent air-borne insects from attacking tree crops and seasonal crops by means of fumigation using locally available materials. Leftover of tobacco leaves (mainly primary veins), vegetative parts of *Artemesia* sp., needles of *Pinus merkusii*, *P. kesiya*, and turmeric are burned from the windward side of the farms during the late evening.

Farmer broadcast ash on the plants of gourd, marrow, pumpkin, grinjaki, okra and cucumber when insect attack is detected. Ash supposedly has insecticidal or insect-repellent properties. Some

nutrients from ash may be available from plants. There is however, no systematic study on effectiveness of the use of ash.

### **4.3 Trends of Forest Governance in Myanmar**

Scientific Forest Management in Myanmar dated back to 1856 with the initiation of the Myanmar Selection System by Dr. Dietrich Brandis. Although intensive and various efforts of the Forest Department to protect the forests and ensure sustainability, deforestation and forest degradation occurs at an alarmingly rate. Therefore, it has become increasingly apparent that unless the basic needs of the local forest dependent poor especially the need for wood fuel can be met, sustainable forest management will remain a far cry.

As a matter of fact, this issue was conceived even at the very initial stages of the scientific forestry in the country. Forest district working plans used to include Local Supply Working Circles (LSWCs) which were managed to provide the community in the locality with fuel wood, poles, posts, small timber and a variety of NTFPs. The LSWCs had been constructed with the forests in the vicinity of the villages for their easy access. This had ultimately and unfortunately resulted in their disappearance. The encroachments for agriculture, settlements and infrastructural developments and overexploitations had been uncontrollable.

Sustainable forest management demands sustainable management of the forest's entire ecosystem which will include forest dependent community also. To make it sustainable and effective, the forest development and management system must of necessity involve the target community's participation, give the community the sense of ownership and address its needs.

In this perspective, community forestry had been considered the right choice. Consequently, the Community Forestry Instructions were formulated in 1995, approved by the Minister of Forestry and instructed by the Director-General of the Forest Department for implementation throughout the country starting from 1996.

## **5. Review of best practices of project site in Myanmar**

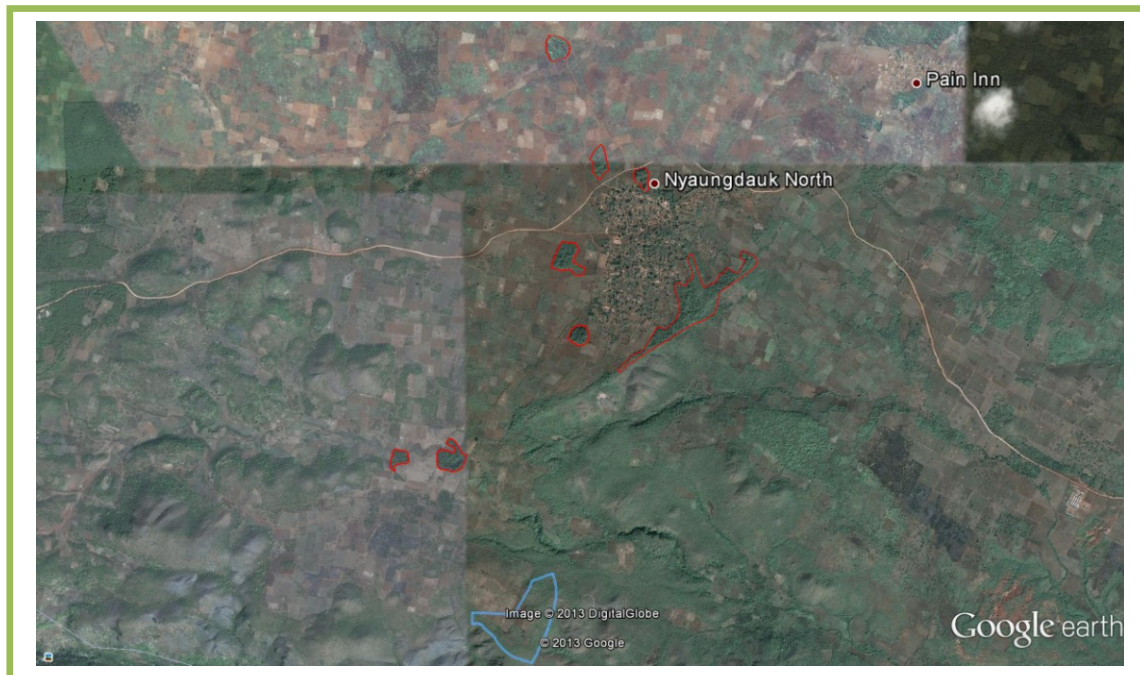
### **5.1 Description of Project site**

The demonstration plot site area is 25 ha which is located at the Nyaung Htauk Reserved Forest Compartment no. 2, located at 22° 45' and 23° 15' North latitude and 96° 00' and 97° 00' East longitude. From 2003 to 2012 the average minimum and maximum temperature is 7.8° C and 32.3°C respectively. The average annual rainfall is 51.17 inches. Near the demonstration plot, there are three water spring sources about 24.82 ha of natural forest conserved by local community traditionally. There are also 3.58 ha of natural forest safe guarded by spiritual belief since the village was established (200 years ago). There are altogether about 140 ha of private Teak plantation and departmental pine plantation which is established in 2013 near the project area.

The demonstration project site area and the surrounding reserved forest area is mainly fallow land and seriously degraded secondary forest. About one third (8.41 ha) of demonstration site is highly productive flat area while other 15.89 ha is degraded secondary forest area covered with Teak (*Tectona grandis*) and some hardwoods species such as Thit-ya (*Shorea obtusa*), In-gyin (*Shorea siamensis*),

Thingyan (*Hopea odorata*). Some species are rare and endangered like Tamalan and Thin-win. Its altitude is 2213 feet above sea level.

The soil type is Acrisol (according to FAO classification). According to the old records (District Forest Management Plan), this area was originally endowed with natural forest of Moist Upper Mixed Deciduous type.



Project site and



Reserved water source forests



## 5.2 Socioeconomic conditions

Nyaung Htauk village is located beside the Nyaung Htauk Reserved Forest. The village is divided into southern and northern part. The village is composed of 219 households with a population of about 800. Number of household increases from 80 to 220 within 30 years. Majority is Danu (an ethnic of Shan tribes) and the religion is Buddhism. The village has good access to highway road, Monastery, Middle School and ground water resource. Last 30 years ago, there was no clinic and only a primary school and Monastery Education in the village.



Clinic of village



Middle School of Village

Main livelihood is growing agricultural crops in farms and shifting cultivation. Some landless people works as labors for farms as well as carpenters. The main agricultural crop is corn which is grown in and around the reserved forest areas by means of shifting cultivation practice. Rice and groundnut are also grown but in small scale. Subsistence income sources come from charcoal making, fuelwood and collecting and selling non timber forest products (NTFPs) such as bamboo shoot, mushroom, na nwin, in u, honey, medical plants and so on. However, forest condition is decreasing year by year and wild animals found in the last 30years such as bear and tiger disappeared.

According to the wealth ranking, it can be said that 57% of total households are poor; 32% are middle and the remaining 11% are rich. UNDP microfinance association in the village seeks to increase income for the villagers.

## 5.3 Appropriate Practices for the demonstration site

Preliminary survey assessment indicated that local community relies on the forest products for their livelihoods. In order to secure the sustainable forest management, it is needed to fulfill basic needs of the forest dependent local people. On the other hand, some traditional forest conservation practices such as spiritual belief forest, home garden and water spring sources are found in the project site. Therefore, the project intends to design the rehabilitation model by combining scientific forest management into the local traditional forest management practices to rehabilitate forest ecosystem and to develop the local livelihood options. The proposed rehabilitation practices in the project area are as follow:



### 5.3.1 Community Forestry

Community Forestry will be established in degraded forest areas where local community has long been encroached and practiced shifting cultivation. A user group consisting of nine households' members will be organized. In the shifting cultivation area, Agro-forestry practices will be introduced whereas in the remaining natural forest areas, silvicultural practices such as improvement felling, enrichment planting, and coppicing will be conducted. According to the village consultation, the local peoples prefer to plant Shaw Phyu (*Sterculia versicolor*), Yamanae (*Gmelina arborea*) and Mezali (*Cassia Siamea*) together with corn, rice and groundnut in the farms as agro-forestry.

### 5.3.2 Home garden



Home Garden with banana, bean and danyin

In this project village, most of the households used to plant fruit trees and seasonal crops as home garden. This practice consists of a house surrounded by cultivation of annuals and perennials. While mustard, beans, pumpkin, ladies' finger and na nwin are widely grown as annuals crops, fruit trees such as avocado, banana, danyin, coconut and mango are also planted around the yards.

Aside from edible crops, ornamental plants such as *Plumeria acutifolia* (Chinese sager), *Musaenda luteola* (ywet hla) are also grown. Because of their traditional belief, some people don't want to plant pine trees and bamboo inside the yards. This practice should be enhanced and encouraged to be systematic and sustainable. The project will provide seedlings of *Artocarpus heterophyllus* and *Mangifera indica* for growing in home garden.

### 5.3.3 Buddhist monasteries and shrines Garden



Buddhist monasteries and shrines Garden with mango, jackfruit and sesame

There are two monasteries in this village, North village monasteries and South village monasteries. The trees inside the compound of monasteries were also conserved by the monks and villagers. They also plant some crops, sesame and corn as the agroforestry system.

### 5.3.4 Live fence

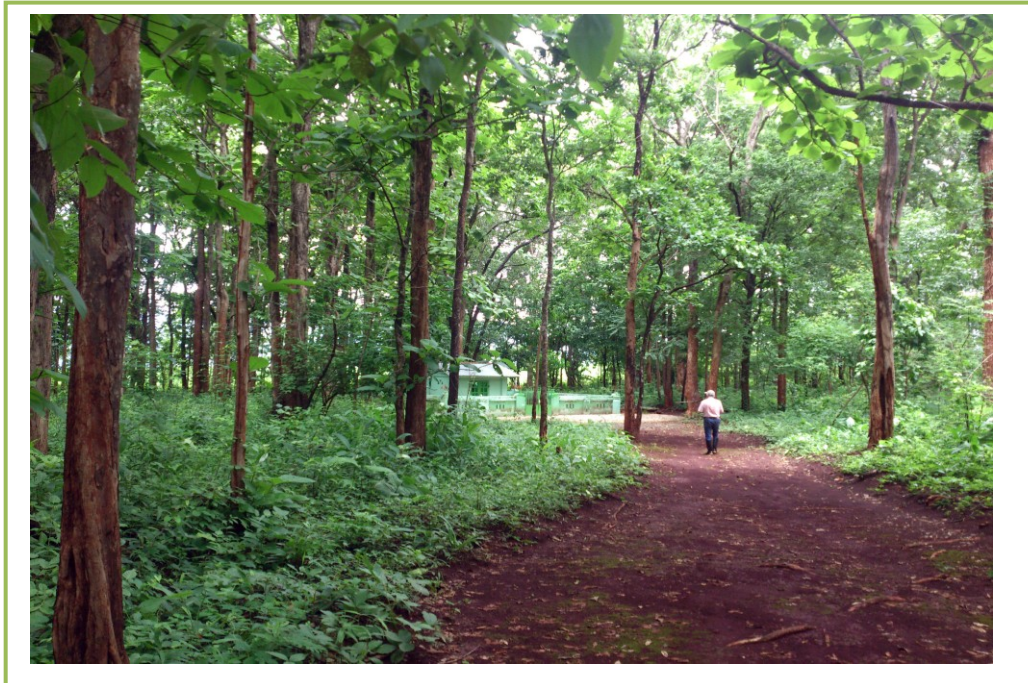
Some ethnic group who lived in upland area such as Shan, Danu, Pa-O, and Palaung are used to plant *Jatropha curcus* as live fence in their field and homestead. In this village, *Jatropha curcus* and coffee were planted as live fence in the middle or poor households while rich house use brick for fencing. This practice will be encouraged to plant not only *Jatropha curcus* and coffee but also other cash crop like na-ga-mout.

### 5.3.5 Farm Forestry

In the project site, local people maintain trees in and around the farms as windbreak and erosion control. The project will introduce trees which bear edible fruits to provide intermittent income and fuel-wood and fodder. *Jatropha curcus*, coffee, and *Mangifera indica* will be introduced by the project into the traditionally managed farm forestry.

### 5.3.6 Forest safeguarded by spiritual belief

In Myanmar, belief can play an important role in maintaining the environment. The forest is completely protected by collaboration with village administrative organization and executive person. Traditionally, the executive person is called “Nat Htein”. A small shrine was built by the villagers at the middle of the spiritual forest. Villagers believe that “a shin gyi” takes care of their farming, health and economic. That is why, the forest where there is home of “a shin gyi” have to be safeguarded. All people are aware that they should not cut the trees since they were young. Generally it can be concluded that this belief is very efficient to conserve the natural forest. It is also a kind of participatory forest management.



Spiritual Forest around the village

### 5.3.7 Forest around water spring



As mentioned earlier, there are three water spring sources about 24.82 ha of the natural forest. Aside from fuelwood gathering from dry trees, forests around the water springs are conserved by the villagers. Water is used not only for the people but also for the buffaloes. Everybody who saw the cutter inform the village head and then village head requested the ten households' representative to take action on that matter.

They use green punishments such as collecting the timber they cut and sharing labor for road construction and donating lime for the Monastery. Sometimes, the offenders will be liable to a fine. Although this practice is seemed to be a good local forest management system, underground new regeneration cannot be grown under the dense canopy of the natural forest. Systematic silvicultural practices should be conducted in such area.



Natural Forests around water spring conserved by the local people

## 5.4 Enhancing livelihoods through income generation activities

As mentioned earlier, poverty and heavily dependent on natural forest are one of the causes of deforestation. Therefore, socioeconomic development of local community is important in sustainable forest management. To reduce the dependence on forest products, alternative livelihoods options should be enhanced. Income generation programs also should be introduced. Collecting the non wood forest products in natural forest by local community may lead to deforestation due to unsystematic and unsustainable ways. Trainings for income generation, sustainable livelihoods, and systematic collection of NTFPs should be provided.

## 5.5 Soil improvement

Community used to use chemical fertilizers for faster and higher yields especially by using imported hybrid seeds in their cultivation areas including shifting cultivation. Shifting cultivation leads to nutrient and soil erosion. Therefore, training for making organic manual by using agricultural residues,

animal waste, green leaves should be provided. Planting nitrogen fixing species should be introduced. Agroforestry techniques training should be given.



Soil pH testing



Soil collection

## 5.6 Alternative energy

To reduce over exploitation of fuelwood, promotion of energy efficient cook stoves will be effective strategy. Technical and financial services to promote agriculture waste for energy should be supported because they have been using agricultural waste for energy traditionally e.g. waste of the corn after removing its seeds.

## 6. Challenges

In Myanmar, about 70% of the population live in rural areas and has to depend on forests for their living. Although the scientific forest management has been introduced since the colonial time, the needs of the local forest dependent are not fully satisfied and their roles in conventional forest management are quite dim. Having such a background, the rehabilitation of forest in Myanmar needs to achieve the active participation of the local people. However, many of the local people are hand-to-mouth people and could not afford much time for the long term programs. Moreover in establishing Community Forestry as a means to gain participation of local people in forest management and development of the rural livelihoods, it will be difficult for them to wait for 5 or 6 years to benefit from the forest. In introducing Agroforestry, most of the local people do not have enough knowledge and technology for the Agroforestry system and initial investment for change.

## 7. Conclusion

Sustainable forest management cannot be achieved without satisfying the basic needs of the local forest dependent. Sustainable forest management means not only the management of the timber tree species but also the entire forest ecosystem. Active participation of the local people is the key in practicing sustainable forest management.



With recent policy reform in Myanmar, Forest Department intends to regularize the settlements which have encroached in the reserved forests for a long time by establishing Agroforestry under Community Forestry scheme. A total of 1,213 villages (140,036 ha) were excluded from reserved forest and demarcated as permanent village land use as first stage. Therefore, this project design can act as a good model to demonstrate community forestry with agroforestry.

(SFR-MMSEA)项目:

## 热区现行造林措施合理性评估

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云南热区具有优越的水热条件,是我国发展热带林业的极佳区域,其热区人工林的培育与研究工作起步较早,自1974年开始人工造林至今,热区人工林的发展取得了长足的发展,但同其它人工林一样,其经营过程的科学合理性有待进一步论证和改进。以下将主要从造林过程的各个环节对热区造林措施进行回顾和评估。

(1) 种苗。种苗是造林的基础,苗木的好坏直接影响着造林质量,“良种”只有与“良法”结合才能使林地产生最大的效益。通常情况下,良种的增益率在10%以上,使用良种是提高单位面积林地生产力重要措施。目前,热区造林良种使用率不到10%,多数新造人工林仍然处于低水平低效益的重复建。良种使用率低主要由三方面的因素决定,一是良种选育严重滞后,而研究起步晚和科研经费投入不足造成了良种选育的滞后;二是现有良种推广示范力度不够,而良种种苗价格偏高是制约的主要因素;三是林农对良种的增益率缺乏造成对良种的积极性不高。

(2) 育苗。主要造林树种的育苗采取建立临时苗圃的方式进行,为了降低育苗成本育苗基质通常采用就地取材的方式,育苗环节不注重基质配方的研究,较之轻基质配方育苗,苗木基质容易板结,苗木根系不易生长,进而影响苗木植株生长,造成苗木质量参差不齐,弱苗差苗比例高,造林成活率低。另外,缺乏主要造林树种苗木的培育标准指导苗木生产,也缺乏工厂化的育苗企业统一提供高质量苗木,苗木培育以分散经营和个体经营为主,没有统一的苗木出圃标准约束生产,造成市场上的造林苗木质量难以控制,高质量合格苗木缺乏。

(3) 林地清理。采伐剩余物处理是林地清理的重要环节,烧除法(炼山)为采伐迹地清理采伐剩余物最常用也是最主要的方法。全面炼山的林地清理方式,炼山造林烧掉砍伐后留下的树枝、杂灌、杂草等,方便了造林操作,也增加土壤的速效养分,同时烧垦能去除大部分植物,尤其是草本植物的地下宿根(宿

根指个体寿命超过两年，可持续生长，多次开花、结果，且地下根系或地下茎形态正常，不发生变态的一类多年生草本花卉）或降低其萌发力，消灭附着在采伐剩余物或林地上的部分有害真菌、细菌和害虫(卵、蛹、幼虫和成虫)，提高造林成活率和造林第一、二年的林木生长量。但经炼山后，原林地上的有机物质被完全分解，地表上腐殖质及枯落物均被烧掉，土壤变得疏松，并完全裸露，雨季造林时造成严重的水土流失，土壤的有效养分也随之流失，坡度较陡的山地水土流失更为严重，急需寻找科学高效的林地清理方式减少对环境的影响。

(4) 整地。目前最为常用的整地方式有带状整地，穴状整地两种方式。带状整地主要是在山坡上沿等高线开带，带宽 0.8-2cm 不等，带面平整，内低外高，然后在带中按设计好的株距挖塘。带状整地一方面可以增加土壤的温度，增强土壤的通透性，在操作上，方便后续的造林活动，便以林地的抚育与管理，但另一方面带状整地使富含养分的土壤表层大量流失，极易造成大面积的水土流失。穴状整地即在造林地上按规划设计好的株行距挖塘，塘规格一般为 40×40×40cm。穴状整地可最大程度的减低土壤流失，同时又满足造林需要。通常认为塘的规格越大越有利于苗木的生长，但随着塘大小的增加，其成本也必然的增加。不同树种其生物学属性不同，生长速度不同，根系生长对土壤的要求也不同，对定植穴大小的需求也不尽相同，目前未对定植穴规格对定植植株生长影响开展深入研究，按经验值 40×40×40cm 开挖定植穴缺乏科学合理的评估。

(5) 施肥。云南热区传统造林，尤其是乡土树种造林一般不施用肥料，极少部分的示范林在定植的时候施用少量的底肥，但也存在施用方法合理性的问题，通常施放于塘底，其幼苗根系对施用肥料的吸收效率不高，多数肥料在雨水的淋冲下流失。而近年来，随着桉树及其栽培方法的引入，化肥在桉树工业人工林中的大量应用，桉树人工林在定植前三年每年每株的施肥量达 300g 以上，有的高达 600g，大量化肥的施用，在增加土壤肥力提高林地生产力的同时，也给环境带诸多负面效应，对土壤的影响（污染）最为明显：一方面导致土壤物理性退化，表现为土壤结构变差、容重增加、孔隙度减少，土壤板结；另一方面是破坏土壤肥力平衡。施用化肥可能使土壤有机质上升速度减缓甚至下降，部分养分含量相对较低或养分间不平衡，不利于土壤肥力的发展；其次是导致土壤微生物活性下降，有益微生物数量甚至微生物总量减少。因此，热区造林树种如何科学

合理施肥有待深入研究。

(6) 抚育。林地抚育可改良目的树种的生长环境，减少对光、热、水、肥等资源的竞争，促进目的树种生长。传统热区造林缺乏抚育管理，个体林农通常不对林地进行抚育管理。而热区由于水热条件优越，杂草生长迅速，草害成为是热区人工林培育的大害，热区人工林幼林期树高生长难以超过高草、杂木而受压，容易由于光照不足而死亡或生长势弱，极大地降低生长量，影响造林保存率，造成林分生长不整齐和推迟林分郁闭，从而影响人工林的质量和产量。另一方面，疏伐也是林地抚育的重要措施，目前的经营水平，疏伐基本上都是赔本的经营，加之幼林疏伐材难以利用，无形中增加了人工林经营的成本，成本的增加进而影响林农对抚育的积极性。因此，林地科学管理，有效管理有待提高。

(7) 混交造林。选择生态位不重叠的树种营造混交林，可充分利用空间和光资源，既可获得最大的生物量，又有利于森林的健康发展，集中表现在生物多样性高、林分结构复杂、病虫害少、土壤不易衰退、生态系统稳定等。热区人工林的实践过程中开展了一系列的混交试验，主要集中在推广潜力较大的两个树种上，混交树种的选择也主要以主栽树种在天然林中出现的伴生树种为主，混交方式主要有行状混交、块状混交和带状混交 3 种。初步的实践表明，混交造林只要树种及混交比例选择得当，既可以增加物种多样性，又可以增加目的树种的生长量。混交林具有显著的生态效益，但是造林成本和管理成本较高，阻碍了混交造林的推广，目前混交造林仅仅在试验林和示范林中开展，面积较小，绝大多数的人工林仍然以纯林为主，人工林的营建和管理更加注重经济效益。

(8) 造林对环境的影响。热区现行的造林活动，仍然以追求经济利益为目的，较之经济利益，造林活动对环境的影响考虑较少。目前为止，没有系统的建立起造林活动对环境的影响的评价体系和机制，受制于经济发展水平低和认识的不到位，造林活动从规划设计开始就只注重经济效益的低投入和高产出，造林实践活动可能带来的负面效应，如生物多样性降低、景观破坏、地理衰退等影响不被重视甚至不考虑，现行的造林活动与可持续经营的理念还有较大的差距。环境友好型的造林活动应该成为今后发展的重点方向。

(9) 造林技术储备与研究。从森林培育的合理性探索方面看，云南热区造林经过近 40 年的发展，也探索出了许多成功的模式，积累了大量有益的经验，

如优先使用乡土树种造林、利用良种提高生产力、破坏迹地人工营造乡土树种林加速植被恢复、混交种植及非均匀密度配置提高生产力与林地稳定性、自然腐烂法及喷施菌剂腐烂法代替烧除法清理采伐剩余物、栽松留阔抚育法提高林地抗虫害等等，有的模式在局部地区得到良好的推广，如利用思茅松种子园种子提高生产力，利用速生丰产林高效密度模式造林营建思茅松短周期工业人工林，但规模都不大，只能起到示范的作用，更多优良的人工林经营模式，由于涉及到成本较高的问题，在许多地区难以推广。

回顾云南热区的造林实践，人工林经营水平仍然较低，与可持续经营要求还有较大的距离，这一方面需要科研人员积极探索更为经济可行的科学经营模式，更重要的是需要政府部门积极引导，建议加大对热区人工林可持续经营的宣传，在政策上给予科学经营模式更多的支持，加大推广示范资金的投入力度。

**Sustainable Forest Rehabilitation and Management for the Conservation of Trans-boundary Ecological Security in Montane Mainland Southeast Asia in Lao PDR**

**Thematic report on best practices of forest rehabilitation practices in Lao PDR**



## 1.1 Geographical Context

Lao PDR is distinguished topographically by a mountainous area extending throughout most of the country. Some small areas of lowland are available along the southern and southwestern borders. It has a land area of 236,800 square kilometers, stretching more than 1,700 km from north to south and between 100 and 400 km from east to west. The nation shares borders with Cambodia, China, Myanmar, Thailand and Vietnam.

The mountainous area covers about 80 percent of the country. The country is divided into northern section of heavily forested mountain ranges and plateaus cut deep, narrow valleys and gorges and a southern section containing more sparsely forested limestone terraces. The maximum elevation is Phou Bia in the north (2,820 meters). In the south, the maximum height reaches about 1,980 meters above the sea level.

## 1.2 Climate

The climate is monsoon tropical, but wide variations in temperatures occur in different areas because of variations in elevation. The wet summer season prevails from May to October, with rainfall averaging about 1,700 millimeters (about 70 inches). A dry, cool season extends from about November to February. The remainder of the year is hot and humid.

The sub-tropical climate is dominated by the southwest monsoon which brings high rainfall, high humidity and high temperatures between mid April to mid October. Average temperature ranges from around 20°C in mountainous areas and 25-27°C in the plains. There are three main agro-climatic zones:

- The mountainous north: with elevations over 1000 m and steep slopes is dominated by moist to dry subtropical climate with annual rainfall between 1500-2000mm.
- The mountainous parts of center and south: with elevations between 500-1000 m generally moderate slopes is dominated by a tropical monsoon climate with annual rainfall from 2000-2500 mm on the Bolovens plateau.
- The plains: they are located along the Mekong river and its tributaries including the Vientiane plain, the narrow plain Bolikhamxay province and the larger plain from northern Khammouane province to the southern Savannakhet province and a series of smaller plains in the southern provinces (Champasack, Saravane, Attapeu) these areas are inhabited by more than 50 percent of population and are dominated by a moist to dry tropical climate with annual rainfall from 1200-2000 mm.

## 1.2 Forests Status and Trends

As an initial result of the study, which is currently under MAF review, of the country's total land area of 23,680 million hectares, current forest which has more than 20% of canopy density now cover some 41.5 percent. It is implied that forest has been declined at an alarming rate as compared to an estimated 70 percent in the mid-sixties. Forest change, which encompasses decreases in stocking, changes in species composition and size structure, loss of wildlife and plant habitats, and declines in wildlife and plant population is, in many areas, as important as deforestation itself.

## 2. Policy and legislation

### 2.1 Forest policy

The National Forestry Conference was convened in May 1989 under growing concern over deforestation, and charted the overall direction of forest policy. Three main **policy directions** were defined:

- to preserve, improve and increase the biological capacity of the present forest, especially by improving existing systems of management and protection;

- to rationally use forests and its associated benefits, especially to improve economic benefits from forest resources; and
- to link rehabilitation, preservation and expansion of forests with requirements for food, commodities and creation of permanent economic activities for upland populations.

The Conference agreed on steps to be taken to reverse deforestation and resolved that forests cover should be returned to 70 percent by the year 2020.

## **2.2 Forest legislation**

After 1996, several forest related laws were approved and promulgated by the National Assembly. They included the Forestry Law in 1996, the Land Law in 1997 and the Environment Protection Law in 1999 and Processing Industry Law. The Forestry Law is comprehensive and gives relatively clear directions in many aspects of forestry. Although the associated implementing PM Decree was only issued in late 1999, MAF has issued several sets of regulations for field implementation of the Law.

The Socio-economic Development Strategic Plan to the year 2020, 2010 and 5 year plan set development targets for 2005, 2010 and 2020 have been endorsed by the National Assembly in the year 2001. In accordance with these targets, shifting cultivation is to be basically stabilized by 2005 and completely stabilized by 2010. Secondly, tree plantation for commodity production is to be strongly promoted, with a target area of 134,000 ha for the 5-year period to 2005. The third priority action is to accelerate classification and delineation of forest for protection, conservation and production purposes

## **3. Deforestation and degradation**

A recent comparative study on land use and current forest area changes in Lao P.D.R. was carried out in late 2002 and early 2003 by plot sampling of SPOT Satellite Image Maps from 1982, 1992 and 2002. The main result of the study, currently under MAF review, is that the current forest which has more than 20% of canopy density has declined from around 70 percent in 1940 to 64 percent in the mid-sixties and then from 47 percent in 1992 to a current level of 41.5 percent. At the same time, the potential forest area (including bamboo brake, unstocked areas and areas used for shifting cultivation) has increased from 36% of the national area in 1982 to 47.1% today. Within the potential forest area, unstocked areas have increased from 27% in 1982 to 42.6% (10.1 million ha) today, an area larger than that currently covered by forest.

Causes of Forest Decline

### ***External factors***

- High demand for wood and NTFPs in the markets of wood deficient neighbouring countries and countries in the region as well as the imposition of logging bans in some neighbouring countries brought about high pressure on forest resources in Lao PDR.

### ***Internal Factors***

- Shifting cultivation practices and forest fires are still the main causes of forest degradation particularly in the north.
- Unsustainable harvesting of production forest which occurs mainly in central and southern regions, and unsustainable management and use of allocated village used forests.

## **4. Forest Rehabilitation approaches in Lao PDR**



#### **4.1                    *Bio-diversity Conservation***

##### *Improving the legal and regulatory framework*

- Consider participation in other international conventions (besides the Convention on Biodiversity (CBD) and (CITES)
- Review and improve existing NBCA rules and regulations to improve appropriateness for biodiversity protection (e.g. including a biodiversity conservation law)
- Establish a unit responsible for assessing the environmental impacts of large development projects and developing approaches enabling their mitigation

##### *Improving NBCA development and management*

- Review the existing NBCA system to include important wildlife and aquatic habitats and exclude more developed areas
- Prepare long-term NBCA development and management plans with participation of stakeholders including local villagers
- Improve NBCA financing through government funding and income generating activities and fines
- Develop ecotourism through investment programs and projects
- Provide NBCA managers with the required materials and facilities (transport, computers, uniforms, etc.)
- Increase NBCA staff numbers and skill levels through short and long-term programs and establish an NBCA staff management and reward system to compensate for duties performed under difficult living and working conditions
- Consider the development of codes of practice or guideline for tourism operators to provide a basis for development of responsible/ecotourism that benefits rural communities and the environment while generating revenue for the nation

#### **4.2                    *Protection Forest and Watershed Management***

- Set up an inter-sectoral coordination mechanism for effective watershed management
- Support implementation of Integrated Watershed Management in the field
- Develop innovative funding schemes to finance watershed management activities
- Initiate schemes for rehabilitation of degraded watershed areas with villagers' participation

#### **4.3                    *Improving Tree Plantation Profitability***

##### *Improving Tree Growing Technology*

- Conduct applied, adaptive research on species (including seed and nursery requirements and the use of indigenous species), species/site matching, harvesting, thinning and coppicing methods, site and soil preparation, fertilization programs and post-plantation management
- Make research results available to PAFO and DAFO and thence to potential growers. This would entail assisting DAFO in developing adequate capacity for the task
- Provide tree plantation owners, especially those owning teak plantation in the north, with skills to select seed, plant at the correct density, thin and prune stands for quality improvement and increased sale price.

### **5. Review of best practices in northern part of Lao PDR**

## **Traditional Agroforestry in mountainous villages in Phonxay district Luangprabang province**

### **Home gardens**

In Ponxai district it seems like home gardens, fruit gardens and orchards etc is quite well known and wide spread. There are many examples of these kinds of gardens and they are found in almost all villages visited. In villages which are newly relocated and with many newcomers the amount of home gardens are fewer. Especially gardens where fruit trees plays an important role is difficult to find.

In general a home garden in Ponxai district is between 0.25 – 1 ha big and you can usually find fruit trees, like papaya, banana, **citruses and jackfruit**. Other crops which are common are different kind of vegetables and fruits like eggplants, chili, cabbage, beans and pineapples. In one home garden in Huay doy, a hmong/khamu village high up in the mountains more than 50 different plants were grown (see picture 2). Often these plants are mixed with each other or in one way rotated within the garden. Most of the home gardens have a living fence of various species (see picture 1). Some gardens have fences made of cut bamboo or a mix between living and bamboo fences. Common is that you see chicken and sometimes even pigs inside the fence. This is not preferred by the farmers since they claim that the animals destroy their crops and eat their fruits. Common are also various kind of medicine plants, especially in the older gardens. The home gardens observed were situated in all kind of environments from on top of the mountains down to close to the rivers. Mainly the gardens were relatively flat located and close to the village houses.

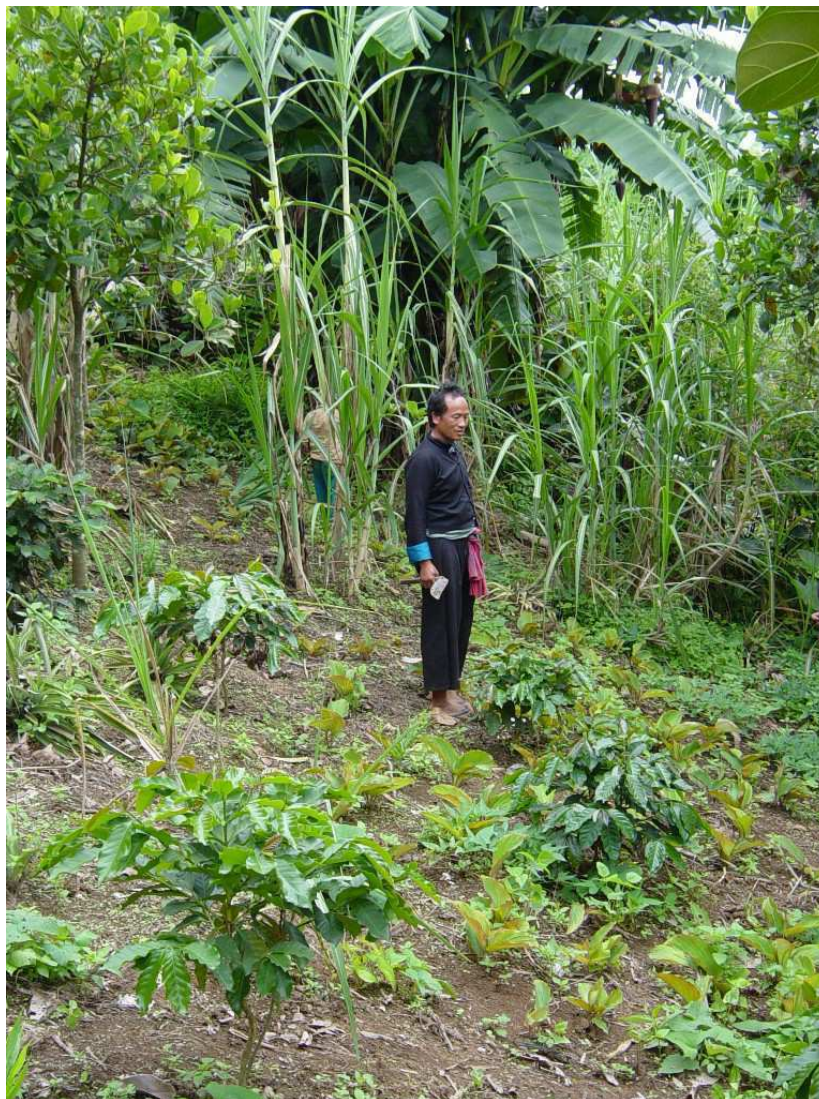


*Picture 1; a home garden with living fence, chili, eggplants and beans, Ban Huay man  
Ponxai district*

Some home gardens are also mixed or intercropped with e.g. rice or corn. These gardens are often a little bit bigger than the “traditional” (>0.5 ha) home garden and you can’t really find the great variety of plants used as well. In this kind of gardens fruit trees as the one mentioned are common and planted often as contour along the borders or scattered within the plot. Fences haven’t been observed in these gardens. Vegetables like cabbage,



chili, tarot etc are common and grown mixed with the rice or corn.



*Picture 2; a home garden containing more than 50 different species. In the picture are banana, jackfruit and sugarcane, coffee and black ginger. Ban Huay doy, Ponxai district*

### **Intercropping and rotational practices**

Closely related to the relatively large home gardens are rotational systems or intercropping permanent systems, usually around one hectare big. Here the main focus is on some kind of grain crop like e.g. rice, **Job's tears** or corn. In the rotational systems it is common to rotate crops during the year or between the years. Often organic fertilizers like peanuts are grown between the different periods of crops or mixed with e.g. corn. Some other vegetables like banana, sesame, tarot and chili could also be found within the area. Fences haven't been observed around these kinds of fields. Trees observed in these systems are fruit trees like jackfruit and papaya and quite common is that teak trees are grown in the boarder or scattered around in the field. The teak is mainly used for home consumptions and the quality is rather bad with many branches and tops. These kinds of practices could mostly be found in the valleys quite close to rivers or in moist places with good soils.

Intercropped field could also be found. Here that means some kind of grain crop mixed with trees or other plants. One example is Job's tear intercropped with **paper mulberry** (See picture 3), here the paper mulberry is probably naturally growing and spreads and regenerates by roots. It is cut down and harvested every second year. After that paper mulberry is harvested Job's tear is planted and harvested during the year. In between the



paper mulberry can continue re-growing and is when the Job's tear is harvested already around one year old. This system gives crops every year with no fallow periods and as it's seems sustainable yields. The paper mulberry practice was found in rather steep areas far away from the valley river. Other intercropped areas were though mainly situated more closely to rivers and streams.



*Picture 3; intercropping practice with Job's tears and paper mulberry*

### **Livestock practices**

Practices with animals are common in Ponxai district, maybe the most common agroforestry practice. The most widespread and common livestock practice is free grazing livestock. Chickens and pigs are mainly grazing closely around the houses, in the home gardens and other nearby areas. Cows and buffalos are also free grazing around the villages but in a more extensive way. The animals feed themselves of what they can found in the fallows and forests. The management and organization of the animals with this system is very unclear and it seems like they are just let out free and then only sometimes gathered for reasons like slaughter or going to the market. Problems with this system are, according to our interviewed farmers, that the animals eat planted un-fenced crops, difficulties with observing the cattle, difficulties to know who owns the animals and finally that the animals grow quite slow and are very thin. The advantage is a very low labor intensive system, no ones needs to herd or take care of them. It seems quite common that farmers use the animals like investments. Instead of putting the money in the bank they buy cattle and raise them using this free grazing system.

Some villages also keep cattle fenced or herded. These systems vary but in general some farmers go together and build fences in fallow land where the cattle are set free inside. The reason for keeping them fenced is to protect cultivated crops from being eaten by the livestock. Therefore the livestock are only fenced during cropping seasons around 6 months a year, the rest of the time they are free grazing. A village can have several fenced areas within the village area it depends on how many cattle and farmers that are participating in this often cooperative practice. A fenced area is in the range of around 200 ha and holds about 40 animals. It should also contain preferred grasses, e.g. Imperata-grass, and a stream for fresh water, see figure 3. This way of keeping cattle could be classified like a fallow improvement practice, since the farmers said that after

some years the fallow area will be a really good rice production site. Old fenced livestock areas were much preferred for growing rice if they were located close to the village. But relatively often these systems were practiced far away from the villages (probably close to their old villages), further up on the mountains. In the cases where no rice was planted the forest now are growing back according to the interviewed farmers. It seems like this cooperative way of fencing cattle mainly is done by Hmong-farmers and that the idea came with them when they moved down to the new villages along the roads. But, also Khamu-farmers now copied and organized own groups or even joined Hmong-farmers groups with this management system. This system is also used for raising goats. The main problem with goats is that they eat everything so it is very important that they are fenced during cropping season. But, the farmers said that at the same time this is a problem it is also an advantage since the fenced area can be relatively poor and bad and anyway the goat can graze.

Livestock is also raised in fenced areas directly in the “primary” forest. This system was found high up in the mountains in an old village where the pressure on land was less than close to the roads. Here Hmong-farmers organized in big groups around 40 persons and build a fence around an area of 1000 ha. Within that area around 200 animals could graze permanently. All families have a special ear mark for the cattle to keep them separated from other families’ cattle. There are some problems with wildlife mainly wild dogs (probably *Cuon alpinus*) attacking the animals so they have to be guarded or herded within the fenced area. Advantages with this system are protecting other crops from being grazed and that animals get fatter the farmers claimed. It was also much easier to keep them protected from wild dogs, tigers and other threats. Since the area was so big the farmers said that vaccinations etc weren’t necessary, as it is if you keep them in smaller areas. This system was very sustainable according to the farmers and they have now used this area and practice without any declines for ages.

## **Indigenous Agroforestry in Upland sloping land villages in Namor district Oudomxay provinces**

### **Home gardens**

The tradition of having home gardens in Namo district is well known and spread. In almost every village there is some kind of home garden. They are often based on fruit trees, like citruses, jack fruit, mango and papaya. Within the garden crops like tarot, peanuts, ginger and medicinal plants are grown. Some gardens contained up to 20 different species. In one village, Ban Kuang, home gardens were based on planted bitter bamboo, see picture 5. Bitter bamboo stems were collected from the surrounding forests and planted in the home gardens close to the houses. Between the bamboo stems several species then were planted like e.g. pineapple and fruit trees. Within these bamboo home gardens also vegetables, medicinal plants and other crops were grown.



*Picture 5; bitter bamboo home garden, Ban Kuang Namo district*

### **Advanced farming systems**

For some farmers the home gardens seems to have developed to larger gardens containing several important production factors, we here call these gardens advanced farming systems. These relatively advanced farming systems contain firstly different plants like teak, fruit trees, several vegetables and crops like rice, corn and cassava. Secondly the systems also contain protein sources like fish ponds, pigs and poultry. All factors depend and make use of each other to be able to functioning. In one example from Ban Nathong a fishpond is the base for the system and other production units supply the fish with food, like e.g. pigs, banana, rice husk, corn and cassava. These systems seem very productive and efficient but they are complicated to run and you need a lot of investments and available land to start it up, especially if it should contain a fishpond.

### **Improved fallow**

In Namo district farmers never really plan for fallow improvement but the way they manage their land and fallow gives some preferred species in the fallow anyway. Most common is the growth of different cardamoms during the fallow period. Green cardamom for example grows best in a fallow area, it needs light. Three years after rice harvest the green cardamom could be harvested in the fallow. Harvesting can go on for two years before the land had to be clear again. If the fallow would grow older also the green cardamom would disappear as the woody vegetation would take over. For red cardamom



it is the opposite since it seems to prefer shaded environments. Since red cardamom is very valuable farmers now let fallows grow into forests to create environments for the specie. After ten years fallow often red cardamom can be harvested and the area is in one way transformed to a NTFP-plantation. To keep the area as a cardamom production area thinning of big trees occur. Where this now have take place and the areas are ten years or more the actual production generates more than it would have done if it still would have been a traditional upland rice field.

### **NTFP-plantations**

Red cardamom fallow production is one example of a NTFP-plantation. Another interesting NTFP which successfully have been transformed to a plantation crop is bitter bamboo. The knowledge of planting bitter bamboo was mainly found in only one village, Ban kuang where they also plant it in their home gardens. The planting started for around 30 years ago and at that time it was planted directly in the secondary forest. These plantations are still ongoing and during the years several new ones have been established. When establishing them they are often intercropped with pineapple the first years. Today plantations up to one ha big can be found. Also other bamboo species are planted in plantations, often like boarder plantations between rice fields (picture 6). These bamboos are used for several things like shoot production, handicraft and construction purposes.

### **Advanced practices in forest restoration in Northern provinces of Lao PDR**

#### **ANR What is Assisted Natural Regeneration (ANR)?**

If you observe grassland areas over a span of several years, you will note that trees and other woody plants (e.g. bushes) gradually replace the grass if the area is not burned or otherwise disturbed. These trees (etc.) grow from seeds spread by birds, animals, wind and other means. In other words, the seeds are dispersed by Mother Nature. The process of dispersal and growth is “natural regeneration”, sometimes called “plant succession”. Most areas that are currently grasslands were formerly forests. The change from forest to grassland happens over many years. Similarly, restoring the forest through natural regeneration can also take many years. For instance, after 15-20 years of fire prevention, grasslands evolve into secondary forests as a result of natural regeneration. ANR “speeds up” this process, usually resulting in re-establishment of tree-cover in around 5 to 8 years, sometimes even faster than that.

The word “*assisted*” in ANR simply means helping the naturally-growing young trees and other woody species grow faster. This is done by reducing or removing competing grasses, bushes and vines and protecting these trees against damage from fire, stray domestic animals and human vandals. In ANR, the same “tender loving care” that we apply to trees we plant is applied to trees planted by Mother Nature.



Figure 1. Grassland with emerging trees



Figure 2. Young Secondary forest in former grassland

### **Why use ANR and where is it applicable?**

There are three principal reasons for applying ANR.

One reason is to reduce forest restoration costs. Traditional reforestation practice involves: seedling production, site preparation, planting, maintenance and protection. As a general rule, no costs are incurred in ANR for seedling production, site preparation and planting. Thus costs are much lower than in traditional reforestation. However, there may be some instances wherein planting with seedlings or seeds can be included in ANR, as discussed in this Manual

Another important reason for applying ANR is to **expedite** (“speed up”) forest restoration. ANR takes advantage of wild seedlings already growing in an area. Root systems of these seedlings are already in place. Therefore, the trees can grow rapidly when competition is removed or reduced.

A third important reason for applying ANR is to enhance plant diversity. Naturally-regenerated vegetation will almost always comprise a mixture of species. Therefore, ANR produces a more diverse and multi-layered vegetative cover than traditional reforestation. This diversity helps ensure environmental stability and is very desirable in areas intended for watersheds.

Some important factors to consider in selecting sites for application of ANR include the following:

- Level of community and local government interest and potential participation
- Capability and interest of the implementing agency to provide personnel for supervision and funds to support the transportation required for effective supervision
- Existing vegetative cover (e.g. if dominated by *Imperata cylindrica*, are there suppressed regenerants under the *Imperata*?)
- Project objectives (i.e. Protection forest or production forest? If production forest, ANR can be used to establish nurse crops for the commercial species)





Figure 3. Normal cross-section of an area reforested through conventional practice (upper right portion of the picture)

ANR can be applied in all areas where forest restoration is required or desired: grasslands, areas dominated by brush or small trees and young secondary forests or gulley forests. The following sections describe how to do ANR under these different conditions.

1. “Forest under the Grass”



Figure 4. Grass dominated area. Note the presence of woody species.

The most impressive results of ANR can be observed when applied in areas dominated by grass, such as *Imperata cylindrica*.

You may wonder how grasslands can be reforested without any planting. Actually, because of the natural process of “plant succession”, many sprouts and seedlings of woody species and other non-grass plants can be found growing within and among the grass.



Figure 5. Woody species growing under and among the grass

When existing seedlings are freed from competition and protected against destruction and damage, they grow much faster and, within a short time, begin to dominate and suppress the grass. Under favorable soil and climatic conditions, the trees and brush will begin to dominate the grass in one to two years.

The following are simple steps to follow in doing ANR in grasslands:

**Step 1. Marking of “Wildlings”**

After the target area is identified and its boundaries demarcated, walk through it and look for woody plants among the grass. You can immediately see the larger ones. Mark them with stakes. As you do this in each spot, look within and under the grass nearby to locate and mark more individuals that are growing below the top of the grass. Do not take the stakes you are going to use for marking from tree saplings in the area. Preferably use bamboo stakes if these are available. You can also use stalks of *Saccharum spontaneum* and similar cane-type grasses. Stakes are only temporary. They do not have to be from durable wood or other strong materials. If the target area has not been burned or disturbed for more than a year, there will usually be hundreds (sometimes thousands) of emerging woody plants (“wildlings”) in every hectare of grassland. So your decision on what and how many to mark depends on the following:

**I. Intended purpose.** If the area is being rehabilitated for timber production, mark the species of the proposed final crop that are clearly emerging above the grass. Additionally, consider their spacing, particularly if there is an intention or a need to intercrop with other commercial trees. If the intention is for protection, then likewise mark even those seedlings that are growing below the tops of the grass. There is no ideal number in this case as the purpose would be to provide as dense a tree cover as possible over the area.

**II. Budgetary and time constraints.** Locating and marking wildlings can be tedious and timeconsuming.

So it is best to plan how long it will take to complete this work. Therefore, if you are a project manager, you should have a good idea on the capacity of your field workers. Normally, in moderately sloping terrain, one worker can usually complete locating and marking 400-500 spots in one hectare within eight hours. Remember to include the time you need to collect stakes for marking.



Figure 6. Marking of Wildlings

### **Step 2. Liberating “Wildlings”**

The next step is **ring weeding** to remove competing non-woody species from around the marked “wildlings”. To save time, ring weeding of the wildlings can even precede marking (i.e. Step 1.). But if this done, be aware of species density. Otherwise, you might ringweed more wildlings than necessary, thus increasing costs. **As a general rule, 800 well-distributed wildlings per hectare will be enough to restore forest cover.**

Remove all competing vegetation, such as grass and vines, within at least one-half meter radius around the marked woody species remove. Do this manually, digging out the competing vegetation and exposing their roots to air and sunshine. It is preferable to cultivate the soil around the “wildlings”. This will (1) expose seeds and roots of other undesired species and (2) make it easier for fertilizer (if used) to penetrate towards the roots of the marked plant.

### **Step 3. Suppressing the Grass**

Once the desired “wildlings” have been marked and ring weeded, suppress the surrounding grass, particularly (*Imperata cylindrica*) and *Saccharum spontaneum*, by the method called “pressing” or “lodging”. Do this using a wooden board approximately one inch thick, 6-12 inches wide and 3-4 feet long. Tie an adequately long rope to each end of the board.

The correct time to press is when grass leaves, or stems, are soft, usually a few weeks after the start of the rainy season and before the end of the rainy season. If done properly, the beneficial effects of pressing can last up to three or four months. A steady worker can usually complete one hectare in six days or 48 working hours. Cutting grasses with a bladed tool can take up to 12 person-days to fully cover one hectare. Pressing is, therefore, a much cheaper way of controlling the grass. Furthermore, the nature of dominant grasses makes them more competitive when they are cut instead of being pressed (lodged). Additionally, vines can easily crawl over and smother the flattened grass. The flattened grass also acts as mulch, thereby reducing evaporation of moisture from the soil.





Figure 7. A pressboard and its user

When pressing, loop the rope over your shoulders as you lift the board from one location to the next. See to it that the rope is long enough to ensure that the board lays flat on the ground when you are standing upright. Logically, adjust the length according to your height by knotting the rope. Pull the board up with the use of the ropes when moving forward. Lay the board on top of the grass and press down by stepping on it. It is similar to ironing clothes and has almost the same effect on the grass (Figure 8).



Figure 8. Grass flattened with a pressboard

#### **Step 4. Protection**

Protecting against fire and other forms of damage is the most important ANR activity. All other work done in an area is useless if the liberated wildlings are destroyed by fire or damaged by animals or negative human activity. In this case, it should be mentioned that an additional advantage of pressing (Step 3) is that the flattened grass produces less intense fires than large piles of cut grass or dried standing grass. Thus, flattened grass makes it easier to control fires if they accidentally occur.



Figure 9 Fireline (Area cleared of vegetation)



Figure 10 Fireline planted with Bananas and pineapples

It is essential to establish firebreaks around blocks of ANR-treated areas. Determine the size of each block, depending on the terrain and amount of volatile material. Fires in flatter areas tend to spread less quickly than on slopes so blocks can be larger. Logically, make the blocks smaller where there is more flammable material.

Firebreak widths are also dependent on the cost of establishment. Experience has shown that firebreaks should be at least six meters wide. However, wider is always better. What is most important is to remove all volatile material (particularly grass) from within the firebreak.

#### **Step 5. Regular Maintenance and Enrichment Planting**

Maintenance in an ANR area usually consists of ring weeding and pressing of grass. You may apply fertilizer to further speed the growth of desired species, especially if the area is intended for development of a production forest.

Also carry out enrichment planting if density of the desired naturally-growing species is low. You can do enrichment planting with seeds and/or seedlings, depending on costs and availability.

#### **2. ANR in Areas Dominated by Brush and/or Small Trees**

In some areas, woody species in the form of bushes and small trees (rather than grass) already comprise the dominant vegetation.





Figure 11. An area dominated by brush, vines and young pioneer trees

In these types of areas, and if the objective is establishment of a protection forest (e.g. as in watershed), the only ANR interventions required will be firebreak establishment and other sustained protection against fire, stray animals, etc.

It is also worth noting that some areas already dominated by young trees and brush may be suitable for establishing a production forest of naturally-growing species. This is especially so if there are many seedlings and saplings of commercially valuable trees. To convert such an area into a production forest, undertake these activities: a) locate desired future nurse and climax trees, b) remove competing vegetation from seedlings and younger individuals to enable them to grow faster and, c) protect the area against damage by fire, stray animals, etc. Since there is not much grass in these types of areas, there usually is no need for you to do pressing/lodging. However, you may need to do some ring weeding around “wildlings” of preferred species.

You may fertilize preferred commercial species if the area is intended as a production forest.

### 3. ANR in Young Secondary Forest or in “Gulley Forests”.

Because of good water supply and safety from fire, young secondary forests can often be found growing along creeks or in gulleys in large denuded areas. These are sometimes called “gulley forests” (Figure 12).



Figure 12 A Gulley Forest and Ecotone

There are usually many different mature tree species in “gulley forests” from which seeds are dispersed to nearby grasslands by wind and animals. A strip of brush usually lies between the gulley forests and adjacent grasslands. This is the transition area or technically termed as the “ecotone”. If left undisturbed by fire, vegetation in this ecotone will steadily expand into the

grassland over the years and areas behind evolve into secondary forest. This process is called “invasion” and the objective of applying ANR is to speed up the process.



Figure 13. Trainees cleaning an **ecotone** area

Undertake ANR activities in the ecotone by removing all the grass along a strip that starts at the edge of the transition zone (ecotone). This is similar to making a firebreak, except that all woody plants must remain. If funds are available, it may be advantageous to fertilize these woody plants.

Release the bigger trees within the gully forest from vines that would otherwise suffocate these trees. Remove the vines to promote growth and better seeding of these trees. The vines also might hazards during the dry season because they may be prone to fires.

#### Conclusion

Viewed broadly now, you can apply ANR under a variety of conditions and for a variety of purposes. To be successful, abide by and respect the following principles:

- Prevent damage by fire, stray animals and vandals
- Take care of the “wildlings” that Mother Nature has planted.