CHAPTER V
ASSESSMENT OF UPLAND RICE PRODUCTION SYSTEMS AND FALLOW REGENERATION

5.1 Introduction

Much attempts and efforts have been made to develop alternative production systems to replace traditional shifting cultivation. Over the past 5 years, many successes are evident in the Theun-Hinboun Hydropower Project where are of shifting cultivation has been reduced by at least 2/3 of total area (Chapter 4). Paddy fields were constructed to sustain production to meet the requirement of farming households in the villages. Many new income generation activities were developed and offer the small holding households with variety of options to meet their living, e.g. selling of cash crops to external markets, opening up new market for NTFPs, plenty of fruit trees and agar wood for income and many others.

Despite the above, production of upland rice continues to serve as one of the major sources for consumption. Total eradication of shifting cultivation could upset upland rice production on one hand but land degradation in the project site will have to be stopped and degraded landscapes will have to be restored.

The above conflict of interests between Local agenda (food security) and Project agenda (conservation and natural resources and watershed) will have to be resolved in complementary way for sustainable results on a long run. Recently, many development projects have now incorporated a livelihood approach, originally developed by Chambers and Conway (1987) into conservation projects. Examples are a project on People, Land Management and Environmental Change (Stocking, 2000 and Brookfield, et al. 2003) and Global Environment Facilities supported projects on Land Degradation in many parts of the world (UNEP/GEF, 2005).

A field study was conducted during the rice growing season in 2005 in order to assess the production systems where rice is dominated and/or incorporated into a newly emerging production systems and their productivity in terms of production as well as nutrient uptake.

In general, fallow regeneration is believed to proceed to a stable climax forests if shifting cultivation can be prevented. However, natural regeneration of fallows depended upon the intensity of cropping periods and the amount of nutrients removed from the soil during the cropping phase or soil fertility level. As long as the systems are operating on the stable equilibrium domain of the determinants, biomass accumulation of fallows could be managed in rotation with forest fallows (Trenbeth, et al. 1990). Stopping shifting cultivation may allow the limited fallow cycle to proceed to climax forests. On the other hand, if soil fertility was depleted beyond the level limit of rotation, the system may move toward grassland or annual weed climax, forest regeneration is almost impossible and/or highly costly.

Against the above fallow regeneration and degradation hypothesis, this component of present study was undertaken with systematic field assessments in different fallow regrowth to assess patterns of fallow regeneration and structural organization of the bush fallow species, including an undisturbed forest nearby.

5.2 Data collection and field assessment methods

As village land use was established in Chapter 4, transect walks were conducted with key farmers to identify and assess the rice systems in the villages. Observations were also made of different signs of soil erosion on the sloping area and different fallow. Field assessment of soil erosion suggested by Stocking, and Murnaghan, (2000) was adopted for erosion observation. With unobvious sign of soil erosion between different land use types, no measurements were made in this study.

In the course of field surveys, records of the past and present management technological changes and inputs used were made from discussion with farmers. These data and information were verified with other key informants including relevant project personnel and local government authorities. Production data were collected from all household in the village. Available data from the Environment Management Division of Theun-Hinboun Hydropower Project were also included in the analysis of rice production in the farming households.

5.2.1 Rice systems

A total of 23 families plots were selected as the representative of the whole range of rice production systems in the village.

Table 5.1 Design of selected fields and sample size of crop cutting survey.

Rice Production Systems	Key Management Practices	Number of farmers' plots
1. Bush fallow rotational	Fallowing >5 years	3
	Fallowing ≤5 years	5
2. Permanent upland	Non-Project Demonstration Farmers	2
	Project Demonstration Farmers	5
3. Highland paddy	Cropping for ≥ 3 years	3
	Newly open up field	3
4. Mixed Annual-Perennials	Early establishment (1-3 years) with upland rice component	2
Total:		23

Notes: There will be 3 sub-samples for each plot. A quadrat of 1m x 2 m will be placed randomly and rice will be harvested at ground level to measure grain yields and above ground biomass. There will be 69 samples in this crop cutting survey.

5.2.2 Fallows regeneration

Farmer's plots with fallow regrowth of 5, 7, 12 years were chosen in conservation with local people and key informants in the villages. Preliminary field appraisals were made to ensure the representation of the typical fields in the village landscapes. An additional natural forest (or undisturbed forest) plot is included as control plot for comparison. This natural forest is considered as undisturbed from village clearing for rice production but somehow this forest is use by villagers for wood collection.

Species diversity was taken in sample quadrats with 20x20 m dimension. These quadrats were placed in each fallows field to count number of mature trees, saplings and seedlings (Figure 5.2). Plant counts were made in nested quadrats as follow:

- **Mature tree**: Living tree with diameter at breast height (DBH) equal or exceeding 4.5 cm. and height >1.30 m will be measured in 20 m x 20 m of all 16 quadrats.

- **Sapling**: Living tree with diameter at breast height (DBH) less than 4.5 cm. and height > 1.30 m will be measured in 10 m x 10 m of one selected quadrats.

- **Seedling**: Living tree with height < 1.30 m will be measured in 5 m x 5 m of one selected quadrats.

The overall numbers of samples were 12 samples in total.

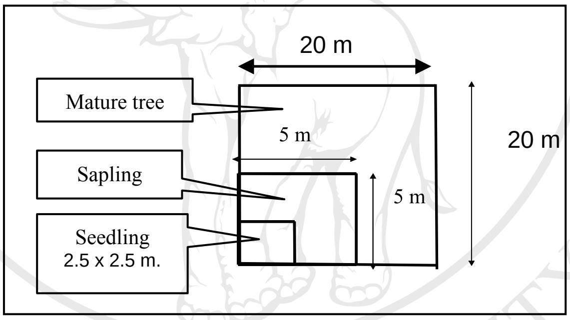

Figure 5.1 Nested sample quadrats for forest inventory and measurement.

Tree species were identified locally and scientifically. Key informants were invited to join the field inventory and measurement to assist in tree identification. Plant parts and photograph were undertaken for botanist at the Faculty of Forestry, Lao National University for scientific identification and description.

Margalef index was derived species diversity and Shannon index for species richness and evenness (Magurran, 1998).

for Margalef index (Dmg):

$$Dmg = (s-1)/\ln N$$

Where:

S = Number of species
N = Number of individuals

for Shannon index (H):

$$H = -\sum_{i=1}^{s} P_i \ln P_i$$

Where:

Pi = Relative abundance of the i th species = (n_i/N).
n_i = Number individuals in the i th species.
N = Total number of individuals.

These calculations and original data are given in appendix G.

5.3 Rice Production Systems

From field survey and consultations with key informants, four production systems were arrived at the end of overall field study processes. The description and management of the production systems may be described below.

5.3.1 Bush fallow rotational system

This particular production system ought to be virtually stopped around 2003-2004 due to external support for alternative permanent rice production systems. It is traditional shifting cultivation but fallow periods were already shortening for the past 10-15 years. Previously prior to completion of Theun-Hinboun Hydropower Project, the slash and burn agriculture in Sobngouang was similar to other villages in Project area. A household may occupy 5 to 7 pieces of land for rotation. A typical household would occupy two types of fields for shifting cultivation; Bon Phu (Sloping land) and Bon Phieng (relatively flat land or plateau).

Shifting cultivation in BonPhou would require of more than 5 years of fallow regrowth to give reasonable rice production. After resettlement, land was relatively limited, maximum fallow period in BonPhou could only be up to 7 years. In BonPhieng where land were more fertile with less risk to soil erosion after heavy rain and better soil moisture holding capacity, farmers adopted less rotation period, up to 5 years maximum. In certain case, farmers might intensively crop upland rice for 2 consecutive years before leaving land for fallow.

The entire operation of upland rice in bush fallow rotational system may be summarized in table 5.2. Household labors were highly crucial in management of upland rice in this system. Traditionally, site selection, clearing and burning, planting and harvesting were made on the basis household arrangement.

Tools for slashing (Knives or machete), clearing and weeding would have to be prepared well advance before the growing season. Village blacksmith would be very busy during this time of the year but return to his labor would also be quite significant, especially the small land holders. Clearing and burning would have to be carried out in February to March. In Sobngouang there were no fire break has been set during burning. This is quite dangerous and could have led to forest fire. One case of field burning in the Thasala, a village on the upstream of Sobngouang around 5 kilometers, in 2004 more than half of houses in the village were burn due to bush clearing and burning for rice cultivation. Weeding depended so much on household labors as weed infestation varied from field to field. With decreasing fallow periods, weeding was carried out 3-4 times after planting. Shortage of family labor would result in low rice productivity due to weed build up. Pests and diseases were unpredictable, measures to control the problems were based on risks.

Table 5.2 Cropping calendar for slash and burn rice production system.

Activities	Periods
- Site selection	November/December
- Tool preparation	January
- Slashing	January/February
- Clearing and burning	March
- Fencing and building field hut	March/April
- Sowing	May
- Weeding	June-August
- Harvesting	September/October
- Transporting	October/November

Source: Farmer in-depth interview.

5.3.2 Permanent upland fields

The system was recently introduced by the project as one of the alternatives to slash and burn production system. The system might be applied to both BonPhou and BonPhieng but majority of farmers saw it as a suitable system for BonPhieng site. Bench terracing was introduced for soil and water conservation measures in this area. Where water is available, the land may be modified for paddy, otherwise upland rice may be grown as rainfed crop. The experiences in three years of doing this permanent upland rice can be summarized in the following:

The first year (2003), the areas were cleared and planted the rice. According to the discussion with the villagers, this first year is giving quite good yield because of land just have been opened. At the same time EMD's program has encouraged farmers to develop the land to be a paddy field by terracing. Technical support is provided to the farmers together with tools and necessary equipment. Chemical fertilizers were provided as well. The second year (2004), weed has become a serious problem to the farmers in the permanent fields. EMD has assisted villagers by provide a hand tractor to clear the land. The third year (2005), EMD has provided assistant by hiring a tractor to clear the field with cost sharing agreement where EMD paid 60% and owner paid another 40%. Only 10 households can afforded for this assistance. EMD is now changing the assistance strategy by setting up demonstration households. These households will be provided extra technical assistant and input from the EMD for rice production and their results are being used to demonstrate to other household in the village for future expansion.

5.3.3 Highland paddy system

This system was independently developed by farmer who had an idea from the project to develop paddy terraces in the permanent upland production system. Mr. Khenthong was actually one of the first group who participate in development of paddy terraces on the upland. In 2003, the first crop failed completely as the result of grain set failure. Before the second season, he went out to one of neighboring village where people are like to grow paddy somewhat in different ways. Paddy site was observed to be located in the small valley from with water from above natural spring. Paddy variety was also different and probably more suitable and adaptive to the local environment.

With this experience from outside village, he brought in the new seed and started the new land for second crop in 2004. At the end of the growing season, an amount of 3,600 kg of seeds was harvested and provided adequate rice for household consumption for the whole year. The plot was also serving as demonstration for both other people in the village and Project staffs for further development.

In 2005, Bon Homhuai has become a target of the farmers for development of paddy land in the village. Many people searched for the land and extended Na Homhuai in most of the suitable land available. EMD support big equipment, i.e. two-wheel tractor to open up new land for bundled fields. There are some 12.9 ha of paddy land in Sobngouang and distributed of among 25 farming households. Potential development for highland paddy remains to be high but evaluation of land suitability and capability has yet to be carried out in the near future.

5.3.4 Mixed annual-perennials fields

As many people lost their river bank gardens after the completion of Theun-Hinboun dam due to rising water level in the river, Project has attempted to compensate the people with more or less similar production system to the former gardens. Bon Phieng on a higher ground above the river was chosen to develop the new system with pump irrigation provided by the project. A total 7.84 ha was adequately distributed to the total households in the village with an average area of 0.16 ha (40x40m) per household.

To assist in the development of production the production system, Project has provided many new and introduced crops, vegetables as well as fruit tree seedlings for permanent practice with potential income from external markets. Farmers have to decide which parcel of land to plant those species they want. The systems have been developed with traditional management of diverse and complex intercropping of annual and fruit tree combinations. The design of the production system then varied greatly from one field to the other with different levels of land use intensification. The complexity of the production system also varied with distance from the living shed or small huts in the field. Intensive cropping of vegetables, spices, herbs and medical plants under fruit trees and banana could be easily observed around the huts. These serve principally for household uses. Cash crops are grown some distance away from the hut with less crop combination. Many are grown in monoculture with various system of crop rotation, developed on demand from external markets.

Annual crops and vegetables are normally grown in the dry season and farmers incorporated upland rice in the wet season to maintain the overall production for their households. At present, the systems are mainly newly established with young fruit and perennials. Future development for complex agroforest systems is highly possible but less emphasis on cash income should be considered. The negative impact on diversity of plantation system in the region is well documented, i.e. the Javanese home gardens in Indonesia (Soemawoto, 1984 and Abdoellah and Morten, 1986).

No.	Crops/Activities	Months											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	**Upland Rice Cultivation**												
	- Field selection and tree cutting		■	■									
	- Burning				■								
	- Planting					■							
	- Weeding								■				
	- Harvest										■		
	- Storing											■	
2	**Paddy Field**												
	- Plowing						■						
	- Planting							■					
	- Weeding									■			
	- Harvesting										■		
	- Storing											■	
3	**Rainy season cash crop**												
	- Land preparation						■						
	- Planting							■					
	- Weeding								■				
	- Harvesting									■			
4	**Dry season cash crop**												
	- Land preparation										■		
	- Planting											■	
	- Weeding												■
	- Harvesting		■										

Source: Village PRA, 2005.

Figure 5.2 Seasonal calendar

5.4 Technological change and intensification

In consistent with the natural upland development policy, Project has introduced many new ideas and practices to intensify land use with permanent fixed cultivation on the same pieces of land. In this section, the major technologies that support land intensification for rice production systems will be discussed.

5.4.1 Seeds system

Traditionally, farmers in Sobngouang produced their own seeds for upland rice in traditional bush fallow rotational system. Many local cultivars were maintained for maximum utilization of biophysical as well as micro environment of the field as results of variation in soil and slope as well as aspects of the upland (Table 5.3). Others were conserved to overcome pest and disease problems. For household food security, individual household grows more than one cultivars and certain households may keep multiplying their local seeds by growing >5-6 cultivars in their fields. Seeds were collected from the best spot in the field with panicle harvesting. Total amount of 5-10 kg of seeds will be collected for the next crop. This depends on the size of land available for opening up. Seeds were kept in traditional way with bamboo basket in the neat wrapping and placed above the stove in the kitchen for drying. However, rice seeds can not be kept over one year due to poor seed viability. Traditional maintenance of large germplasm also depended on local seed exchange system. Farmers could obtain rice seeds from neighboring households within and between the villages without any payment. Their choice would go to those households within the same kinship. However, rice seeds might be obtained from a short visit to other households outside the kin. In general, if a farmer visited any household in and outside village, there might be a request for seeds of preferred cooking quality, taste and soft starch. Today, any rice seeds would have to pay in cash at a price of 1,000 kip/kg. The situation now is based on the fact that most of seeds are newly introduced cultivars, most of traditional cultivars, especially upland rice virtually disappeared (Table 5.3). Only 2 cultivars, KhaoBout and KhaoHin, have survived as most farmers have returned to upland fields which were former shifting cultivation plots to grow upland rice to ensure adequate production for household consumption in 2005. As niches for upland rice production have been reduced greatly due to alternative development of permanent terraces for rainfed and/or irrigated rice. It appears that these two cultivars are the most suitable to the types of uplands available for short fallow and/or permanent cultivated fields. Many early maturing types (KhaoDaw) also served the farming households during the peak of rice deficit before the harvest of main crop. Whatever the reasons are, diversity of local rice in Sobngouang has declined greatly for the past few years.

When terraces were developed for permanent rice production, rainfed upland and irrigated paddy could be possible. While Project was prepared for development of paddy terraces, farmers was able to find KhaoPhae and KhaoMayThae for permanent rainfed terraces. These two cultivars are found in nearby villages, i.e. Laksao for KhaoPhae and KaAn for KhaoMayThae. No further efforts were made to develop and sustain rainfed terraces.

With potential paddy development as alternative to upland rice production in shifting cultivation, Project introduced Khao Pom for the first growing season.

However, the result was disappointed with low yield less than 1 t/ha due to severe sterility problems. At the same time, farmers also independently introduced Khao Kai Noi, Khao Tia and Khao Yuan in the neighboring rice growing villages in the district, i.e. Ban Phol tan. Initial farmers' trails have shown that Khao Kai Noi was the most adaptable cultivar to Sobngouang with yielding ability as high as over 3 t/ha. Nevertheless, Khao Kai Noi appears to be sensitive to stem borer with high proportion of white head in the field. Further improvement could be made to increase paddy productivity. More discussion will be made in the following section.

Table 5.3 Change in rice diversity before and after the completion of Theun-Hinboun Hydropower Project in 1998.

Before 1998		After 1998	
Name of rice seed	Location	Name of rice seed	Location
Khao Bout	Upland field	Khao Bout	Upland field
Khao Hin	Upland field	Khao Hin	Upland field
Khao Leu	Upland field	Khao Phae	Permanent upland field
Khao Yan	Upland field	Khao May Thae	Permanent upland field
Khao MakThoua	Upland field	Khao Kai Noi	Paddy field
Khao Kam	Upland field	Khao Tia	Paddy field
Khao Hin Lai	Upland field	Khao Yuan	Paddy field
Khao Chao	Upland field	Khao Pom	Paddy field
Khao Wai	Upland field	Khao Tha Dok Kham	Paddy field
Khao Nong	Upland field		
Khao Tam	Upland field		
Khao Ngeun	Upland field		
Khao Mai Yang	Upland field		
Khao Leuang Lai	Upland field		
Khao Pouang	Upland field		
Khao Ngeun Louang	Upland field		
Khao Leuang Kon	Upland field		
Khao Do Don	Upland field		
Khao Hinhout	Upland field		
Khao Ma Lo	Upland field		
Khao Khua	Upland field		
Khao Yuai	Upland field		
Khao Mon	Upland field		
Khao Dak	Upland field		
Khao Nam Man	Upland field		
Khao Hao	Upland field		
Khao Phang	Upland field		

Source: Focus group meeting, 2005

5.4.2 Mechanization and chemical application

With assistance from Theun-Hinboun Hydropower Project, farm tools and heavy equipments have been provided to support development of alternative land use for permanent cultivation of rice and other cash and non-rice subsistence crops (Table 5.4). Farming practice had also changed dramatically from land preparation to harvesting. Tractors were introduced to build terraces and level field for paddy growing. Large tractors were recently hired to plough in weeds as they build up enormously in fixed cultivation without fallow regrowth and also make bund for paddy fields.

In contrast to traditional bush fallow rotational system, chemical fertilizers are needed to restore soil fertility and sustain rice production in fixed cultivation systems. Pesticides and herbicides were applied to control pests and weed infestation. The rates of fertilizers were determined analytically from soil laboratory in Vietnam. The results indicated that soil in NamTheun area is severely deficit in Phosphorus and hence the application of Phosphorate (P_2O_5) is recommended. The recommendation was however not adopted due to local confidence. Farmers do not belief in the use of phosphate for their soil. As the results, EMD had adjusted fertilizer use with provision of mixed chemical (15-15-15) and urea (64-0-0) as basal application and topdressing for rice respectively. Fertilizers are targeted to rice production in upland rainfed terraces and paddy land as strategic demonstration of alternative land use to upland rice in traditional shifting cultivation. Assessment of rice productivity will be discussed in more detail later. In 2005, EMD has provided small amount of fertilizers and pesticides for rice production (Table 5.5). Increasing use of chemical is already aware of, organic fertilizers are currently encouraged for save use of fertilizers. Training has provided. However, farmers have started to buy pesticides and herbicides from near by market in Laksao which was established recently around 1994-1995.

5.4.3 Intensification of land use

Increasing use of chemicals may be expected as the results of short-term economic benefits, i.e. positive return to investment both in terms of capital and labor (Brookfield, 1972). However, doubts remain with respect to long term sustainability as marginal productivity falls and approaches zero (Brookfield, 1984). Declining yields with increasing chemical inputs have been experienced in many intensive production systems, e.g. rice-based cropping system in ChiangMai Valley (Multiple Cropping Centre, 1980) and other rice growing area in the subregion (KEPAS, 1983). Sustainability problem associated with agricultural intensification has yet to be dealt with in the near future. On the other hand, promotion of organic farming may be successful with small scale due to high labor demand. Trade off between labor productivity and marginal income would have to be managed for maximum benefit.

Household labor is becoming to be a major constraint in rice production and intensification. As agriculture is now intensified with constant land, exchange labor to overcome the demand peak has been reduced significantly for the past few years. Cash crop are virtually managed by household labor and only limited scale of labor exchange is applied to rice production, especially the upland fields previously used for slash and burn systems.

Staggered planting and variable harvest seasons of various crops have distributed household labor through out the year (Figure 5.3). In a typical household with 6 persons in the family, 3-4 persons would be available for agricultural labor. With labor exchange for harvesting of the main season rice, family labor would be released to work in other production systems such as planting of dry season cash crops in mixed annual-perennial production plots allocated to individual household.

Rice harvesting has virtually shifted from panicle collecting to hand harvesting with sickle and threshing (Table 5.6).

Shortage in households' labor due to, say, sicknesses, could have negative impact on rice production and hence inadequate rice for year-round consumption. This was the case of one family in 2005 when a women in the family was sick and sent to distant hospital in Thakhek on even as far as Nakhonphranom in Thailand. Much time was spent in traveling and took care at the hospital.

In summary, demand for household labor increase greatly as intensification increases. Farmers give priority to ensure sufficient rice production when presumably given maximum return to labor. Positive return to labor from cash crops has yet to be seen. As marketing structure has yet to be fully developed and extended with wide networks, positive returns from cash crops remain marginal.

5.5 Assessment of rice productivity

5.5.1 Yields

With exception of highland paddy, grain yields in other production systems were quite low, varying between 1.23 t/ha in traditional bush fallow rotational system to 1.96 t/ha in newly development mixed annual perennial system (Table 5.4). Terracing for upland rainfed rice in the permanent upland plots gave fairly small yield advantage over traditional shifting cultivation. However, rainfed rice in relatively flat land in mixed annual perennial system could increase grain yield by as much as 60% in comparison to those in traditional production system. With regular supplementary of irrigation water from natural waterway, rice grown under highland paddy gave the highest yield at 3.5 t/ha. However, grain yield of the highland paddy is still relatively low as comparing to other highland paddy in sub-region of the mountainous area in mainland Southeast Asia. In Northern Thailand, grain yield of 4.8 t/ha was recently recorded in a Karen community in Mae Hong Son province (Boonma, et al. 2005). It should be noted that this community is located at high elevation about 1,300 meters above sea level where low temperature has limitation on grain yield.

Different practices in each particular production system were not significantly different, however. Although, a few long fallow plots in traditional shifting cultivation were included in this assessment, there appears to be unexpected results with increasing trend to shorter fallow. The data suggested that traditional shifting cultivation in Sobngouang is fairly low productivity. Regeneration of long fallow could not restore productivity to a satisfactory yield level. A survey conducted in Louangprabang and Oudomxay has shown high variable yields between 0.04-3.8 t/ha with no correlation with fallow periods up to 13 years (Roder, et al. 1998). However, positive contribution of fallow regeneration to upland rice productivity has been fairly established else where (Kunstadter, et al. 1978, Nye and Greenland, 1960, Sanchez, 1976 and Ruthenburg, 1980). The effects of fallow on productivity of upland rice remains to be well established in the near future.

Considering above ground biomass production (Table 5.4), rice in Sobngouang appeared to be quite normal with total production between 5.6 t/ha in traditional shifting cultivation up to 12.9 t/ha in highland paddy. The problem is much of the production remains in straw, not in grain, giving uniform harvest index with an average of only 0.23 or 23% of total biomass that converted into grain. Theoretically, grain yield of high yield variety could give as much as 50% of total biomass (De Datta, 1980 and Yoshida, 1981). Potential for yield improvement of rice in Sobngouang is widely opened, with suitable varieties tested and fitted to a wide range of adaptability for different production systems with varying biophysical environment. Expansion of rice germplasm in the village is urgently needed to provide options for local people (see Table 5.3).

Table 5.4 Grain yields, straw weight and total biomass of rice in different production systems.

Production Systems	N(1)	Rice Yields (t/ha)	Straw (t/ha)	Total Biomass (t/ha)
Bush Fallow Rotational	**8**	**1.23±0.09[a(2)]**	**4.46±0.072**	**5.69±0.16**
- 9 years of fallow regrowth	1	0.85±0.04[(3)]	4.22±0.226	5.08±0.19
- 6 years of fallow regrowth	2	1.39±0.19	3.66±0.264	5.05±0.45
- 5 years of fallow regrowth	5	1.44±0.04	5.51±0.162	6.95±0.18
Permanent Upland	**6**	**1.75±0.15[b]**	**6.16±0.507**	**7.91±0.37**
- Non Project Demonstration field	2	1.63±0.11	5.57±0.464	7.2±0.42
- Project Demonstration field	4	1.87±0.23	6.75±0.555	8.62±0.59
Highland Paddy	**7**	**3.5±0.09[c]**	**9.43±0.492**	**12.93±0.57**
- Cropping for >3 years	4	3.47±0.28	9.32±0.874	12.79±1.13
- Newly open up field	3	3.53±0.15	9.54±0.378	13.08±0.41
Mixed Annual-Perennials	**2**	**1.96±0.15[d]**	**6.86±0.982**	**8.83±1.1**

Source: Field survey, 2005

Note: (1) Number of farmers' fields in crop cut survey.

(2) Different letters designate significant different by t-test ($P \leq 0.05$) between production systems.

(3) Standard deviation

Rice in Sobngouang is also suffered severely from gain filling. In almost all of production systems, high proportion of empty glumes was observed with the highest value of 35% in mixed annual perennial system (Table 5.5). Sterility might be one of the problems to be overcome. Pest such as stem borer (*Chilo spp*) could cause damage with dead heart symptom and eventually cause "white head" during the flowering period. Grain filling was completely failed in borer affected tillers. Identification of the key problem would increase grain filling, hence grain yield increase.

Table 5.5 Percentage of unfilled grains in different production systems.

Production Systems	N	% Unfilled grains
Bush Fallow Rotational	**8**	**25.18**
- 9 years of fallow regrowth	1	29.11
- 6 years of fallow regrowth	2	21.82
- 5 years of fallow regrowth	5	24.62
Permanent Upland	**6**	**17.59**
- Non Project Demonstration field	2	18.22
- Project Demonstration field	4	16.96
Highland Paddy	**7**	**28.37**
- Cropping for >3 years	4	31.56
- Newly open up field	3	25.17
Mixed Annual-Perennials	2	35.55

Source: Field survey, 2005

5.5.2 Nutrient content and uptake

Apart from water limitation and sterility problem on productivity of upland rice previously described, certain nutritional problems appeared to have significant effects.

Although there are some slight differences in nutrient content between different production systems with respect to fertilizer application and management practices, nitrogen and potassium content seemed to be adequate in both grain and straw of rice in all production system with average values of 1.23 and 0.33% in grain and 0.62 and 3.38% in straw for nitrogen and potassium respectively (Table 5.6).

Table 5.6 Nutrient content and uptake.

Production Systems	N	Nutrient Content (%)					
		in Grain			in Straw		
		N	P	K	N	P	K
Rotational Shifting Cultivation	**8**	**1.29±0.03**	**0.05±0.01**	**0.27±0.00**	**0.60±0.04**	**0.11±0.01**	**3.21±0.08**
- 9 years of fallow regrowth	1	1.27±0.05	0.06±0.01	0.27±0.00	0.67±0.10	0.13±0.03	3.13±0.13
- 6 years of fallow regrowth	2	1.25±0.04	0.05±0.00	0.27±0.01	0.55±0.02	0.10±0.01	3.47±0.05
- 5 years of fallow regrowth	5	1.35±0.00	0.04±0.00	0.28±0.00	0.58±0.03	0.08±0.01	3.02±0.12
Permanent Upland	**6**	**1.18±0.01**	**0.09±0.00**	**0.3±0.00**	**0.65±0.05**	**0.21±0.01**	**3.03±0.09**
- Non Project Demonstration field	2	1.21±0.00	0.09±0.00	0.3±0.00	0.65±0.03	0.19±0.01	3.08±0.13
- Project Demonstration field	4	1.15±0.02	0.1±0.01	0.31±0.00	0.65±0.07	0.22±0.02	2.98±0.08
Highland Paddy	**7**	**1.23±0.03**	**0.08±0.01**	**0.40±0.00**	**0.53±0.01**	**0.15±0.02**	**3.61±0.12**
- Cropping for >3 years	4	1.33±0.04	0.08±0.01	0.38±0.00	0.67±0.01	0.15±0.03	3.24±0.27
- Newly open up field	3	1.13±0.03	0.08±0.00	0.41±0.01	0.39±0.02	0.15±0.01	3.99±0.08
Mixed Annual-Perennials	**2**	**1.25±0.06**	**0.22±0.02**	**0.36±0.01**	**0.69±0.05**	**0.44±0.04**	**3.67±0.10**
Average	23	1.23±0.03	0.11±0.01	0.33±0.002	0.61±0.037	0.22±0.02	3.38±0.09
		Nutrient Uptake (Kg/ha)					
Rotational Shifting Cultivation	**8**	**15.72±0.87**	**2.22±0.21**	**3.35±0.26**	**26.52±1.85**	**2.08±0.29**	**140.94±5.04**
- 9 years of fallow regrowth	1	10.79±0.13	1.60±0.26	2.28±0.14	28.48±5.45	2.38±0.63	131.61±5.32
- 6 years of fallow regrowth	2	17.11±1.81	2.56±0.41	3.79±0.56	19.72±0.71	1.69±0.17	126.63±9.75
- 5 years of fallow regrowth	5	19.26±0.77	2.50±0.11	3.98±0.12	31.36±2.15	2.18±0.07	164.58±1.99
Permanent Upland	**6**	**20.48±1.99**	**4.33±0.45**	**5.31±0.42**	**40.36±5.79**	**5.93±0.23**	**183.11±15.05**
- Non Project Demonstration field	2	19.52±1.48	4.04±0.35	4.87±0.39	36.14±2.95	5.48±0.63	165.71±18.82
- Project Demonstration field	4	21.43±3.09	4.63±0.63	5.76±0.63	44.58±8.56	6.38±0.83	200.51±11.83
Highland Paddy	**7**	**43.30±2.76**	**8.31±0.19**	**13.82±0.29**	**49.19±3.52**	**7.6±0.41**	**337.94±27.4**
- Cropping for >3 years	4	46.76±5.32	7.29±0.76	13.05±1.12	62.94±7.48	7.07±0.59	285.32±36.06
- Newly open up field	3	39.84±1.33	9.34±0.38	14.6±0.58	35.44±0.5	8.13±0.39	390.56±18.76
Mixed Annual-Perennials	**2**	**23.99±0.70**	**4.70±0.27**	**7.00±0.40**	**47.83±6.66**	**13.11±3.66**	**242.14±35.28**
Average	23	24.83±1.82	4.58±0.39	6.91±0.49	38.31±4.30	5.80±0.87	213.38±17.22

Source: Laboratory analysis in Chiangmai University, 2005

The values are comparable to those recorded for traditional rice (Peta) at the International Rice Research Institute (IRRI) where nitrogen and potassium content were:

	N (%)		P (%)		K (%)	
	Straw	Panicles	Straw	Panicles	Straw	Panicles
High yielding variety(IR8)	0.60	1.27	0.09	0.42	3.07	0.68
Traditional variety (Peta)	0.62	1.07	0.18	0.20	2.43	0.27

(Grain yields of IR8 and Peta were 8.70 and 6.09 t/ha respectively)

With exception of phosphorus content in mixed annual perennial system, the values in other production system in both grain and straw were fairly low, comparing to those of presented data above. This implies that phosphorus could have limited rice growth in those production systems. The results lend themselves to support early finding from laboratory analysis which strongly indicated low phosphorus in these soils. The present results also suggest that there is no need to apply potassium and to a large extent nitrogen as well. It is not clear how management practices, eg burning, incorporation of straw back to the system, use of manure, crop residues and all alike have contributed nutrient cycling in the systems. Large amount of potassium in the rice straw, ranging from 140-338 kg K/ha could be conserved and recycled back to production systems.

Phosphorus can be cheaply managed with biological mechanisms. In Tea Cha of Northern, Thailand, *Mecaraca denticulata* was used to enrich highly degraded soil in traditional bush fallow system of Karen community (Yimyam, et al. 2003). With effective arbuscular mycorhizal fungi in rhizosphere of *M. denticulata*, growth of the plant has fully recovered from very poor growth in the severely phosphorus deficit soils (Youpensouk, et al. 2004). The role of mycorhiza fungi in maintaining productivity of rice under intensification could have potential to sustain intensive production and become less dependent of external inputs, i.e. chemical fertilizer (Yimyam, et al. 2004).

In Sobngouang, soil management is crucial in sustaining productivity of rice and other cash crops. Increasing the dependency on external inputs, example of chemical inputs, may be benefited productivity on a short term but long term productivity is very doubtful. Traditional agriculture with slash and burn practice is also providing low productivity. Alternative systems with higher productivity are attractive to local population. However, the importance of rice component in production systems should not be over looked.

5.6 Assessment of fallow regeneration

As expected, number of species reduced from early maturing to late maturing stages of forest regrowth. At early stage in 5 years fallow regrowth, the number of species was fairly high at 52 species with highly abundance of almost 15,000 trees/ha

(Table 5.7). At more mature stages, number of species was regulated at more or less constant number of 30 species with about 45,000 trees/ha.

The composition of forest in Sobngouang appears to have the dominant abundance of bamboo and a few shrub species i.e. Cephalostachyum virgatum, Oxytenanthera parvifolia, Euodia lepta, throughout regrowth periods upto >12 years in undisturbed secondary forest (Table 5.7). Some pioneer and succession tree species were established and remained throughout regrowth periods (Table 5.8). These were Albizia lucidior, Aporosa ficifolia, Diospyros malabarica, Diospyros sp, Engelhardtia chrysolepis, *Macaranga kurzii*, Peltophorum dasyrhachis and few unidentified species. Some climbers, i.e. Mussaenda rehderiana, also survive in the mature forest.

Table 5.7 Comparison of indices of different years of forest fallows.

Indices	Species richness(S)	Abundance (N)(trees/ha)	Margalef Index	Shannon(H)
5 years fallow	52	14,602	4.14	0.600
7 years fallow	40	20,175	3.90	0.205
12 years fallow	30	4,517	3.45	0.215
Undisturbed forest	33	4,450	3.81	0.212

Source: Field survey, 2005

As the number of tree, bamboo and shrub species decreased with increasing regrowth periods, the relative number of bamboo, some shrub species and few succession tree species remained dominant. Low values of Shannon and Margalef indices have reflected this dominance. The dominance of shrub and bamboo species may be seen as the formation of second layer canopy of forests. Other dominant succession trees are dominant on the top of forest canopy. However, distributions of tree species remain unequal with high number of few tree species.

As regeneration progressed, less number of trees reached large tree size with DBH of about 50 cm (Figure 5.4). The distribution of tree size was fairly skew with large proportion of small tree size. Less than 20 trees/ha could reach DBH>75 cm in undistributed forest >12 years of regrowth.

Table 5.8: List of species, names and number of tree in different forest fallow regrowth.

No.	Scientific Name	Local Name	Tree type	5 years fallows	7 years fallows	12 years fallows	Undistur-bed
1	Aglaia grandis Korth ex Miquel	ໄມ້ເອັນຄວາຍ	ST				1
2	Albizia lucidior (Steudel) Nielsen	ໄມ້ເອັນຄວາຍ	ST	75	52	33	29
3	Alstonia rostrata Fischer	ໄມ້ຕີນເປັດດົງ	ST	1			
4	Alstonia scholaris (L.) R. Brown	ໄມ້ຕີນເປັດ	ST	2	2		2
5	Ancistrocladus tectorius (Loureiro) Merrill	ໄມ້ຫາງກວາງ	ST	7			
6	Anneslea fragrans Wallich	ໄມ້ແກ້ມອຶ້ນ	ST	4	5		
7	Antidesma acidum Retzius	ໄມ້ເມົາ	PS	2			
8	Antidesma cochinchinense Gagnepain	ໄມ້ສົ້ມສ້ອຍ	S T			18	7
9	Aphanamyxis cochinchinensis Pierre	ໄມ້ລີງໃຫ້	ST	2			4
10	Aporosa dioica (Roxburgh) Müll-Arg.	ໄມ້ເຫືອດ	ST				1
11	Aporosa ficifolia Baillon	ໄມ້ເໝືອດຂົນ	ST	619	125	85	26
12	Aralia armata Seemann	ໄມ້ຕ້າງ	PS				1
13	Archidendron clypearia (Jack) Nielsen var. clypearia	ໄມ້ດູກງູ	ST		1		
14	Ardisia graciliflora Pitard	ໄມ້ຕີນຈຳ	ST	2			
15	Ardisia verbascifolia Hance	ໄມ້ຊ້າເຮ້ຍ	ST			1	12
16	Artocarpus lakoocha Roxburgh (?)	ໄມ້ຫາດເຟືອງ	ST	7	1	2	2
17	Baccaurea oxycarpa Gagnepain	ໄມ້ໝາກໄຟ	ST		10	2	
18	Bambusa sp.	ໄມ້ແຫ້	PB	9			

19	Barringtonia annamica Gagnepain	ໄມ້ນິມຍານ	PS	109	11	11	21
20	Blumea balsamifera (L.) DC.	ໄມ້ຊ້າໝາດດຳ	PS				1
21	Calophyllum sp.	ໄມ້ສິງ	ST				1
22	Canarium subulatum Guill.	ໄມ້ເກືອມ	S T				3
23	Capsicum sp.	ໄມ້ໝາກເຜັດນ້ຳ	PS			5	
24	Cephalostachyum virgatum Kurz	ໄມ້ເຮ້ຍ	P	21	14	4	2
25	Choerospondias axillaris (Roxburgh) Burtt. & Hill	ໄມ້ມື	ST	2		1	
26	Cinnamomum bejolghata Sweet	ໄມ້ເມືອກ/ກະແວໝູ	ST			1	
27	Cinnamomum iners Reinw. ex Blume	ໄມ້ກະແວ່	ST	2	2	5	31
28	Cinnamomum scortechinii Gamble	ໄມ້ເມືອກ	ST	1		1	
29	Clausena excavata Burm. f.	ໄມ້ຊ້າມັດ	SS		12	12	10
30	Clausena sp.	ໄມ້ຊ້າມັດຂຽວ	SS	4			2
31	Clausena sp.	ໄມ້ຊ້າມັດຂາວ	SS	3	2		
32	Cratoxylum cochinchinense Blume	ໄມ້ຕິ້ວເຫຼືອງ	ST	16	4	7	
33	Cratoxylum formosum (Jack) Dyer	ໄມ້ຕິ້ວ	ST	15	8	7	1
34	Cratoxylum sp.	ໄມ້ຕິ້ວຂາວ	ST	18	3	10	
35	Cratoxylum sp.	ໄມ້ຕິ້ວປັບ	ST	1			
36	Cratoxylum sp.	ໄມ້ຕິ້ວກ້ຽງ	ST		2		
37	Cratoxylum sp.	ໄມ້ຕິ້ວໜາມ	ST	28	50		
38	Cratoxylum sp.	ໄມ້ຕິ້ວຂິນ	ST	1	1		
39	Crotalaria bracteata Roxburgh	ໄມ້ໝາກແຫ້ງມ້າ	PS	1			

40	Croton argyratus Blume	ໄມ້ຊ້າຫູອດ	PS	24	6	1	7
41	Cynometra craibii Gagnepain	ໄມ້ຫູກາລີ່	ST			1	
42	Dalbergia cultrata	ໄມ້ຊໍ້ເຂົາຄວາຍ	ST	1			
43	Dalbergia sp.	ໄມ້ຊໍ້ຜ້າ	ST	4	1		
44	Dialium sp.	ໄມ້ແຂ່ງໄກ່/ ໄມ້ໝາກຂາມແພບນໍ້າ	ST	97	16	1	
45	Dillenia indica	ໄມ້ສ້ານ	ST	9	3		
46	Dillenia parviflora	ໄມ້ສ້ານແກ່ງ	ST	24	5	11	
47	Diospyros gardneri Thwaites	ໄມ້ຮັງຮ້ອນ	ST	3			
48	Diospyros malabarica (Desr.) Kostel.	ໄມ້ໜັງດໍາ	ST	291	106	83	42
49	Diospyros sp.	ໄມ້ໜັງດໍາຂີນ	ST	45	13	53	16
50	Diospyros sp.	ໄມ້ໜັງຂາວ	ST				1
51	Diospyros sp.	ໄມ້ໜັງແດງ	ST	38	22	3	7
52	Diospyros sp.	ໄມ້ໜັງດໍາເຫຼືອງ	ST	3			
53	Dipterocarpus alatus Roxburgh ex G. Don	ໄມ້ຢາງຂາວ	ST			1	
54	Dipterocarpus costatus Gaertner f.	ໄມ້ຢາງ	ST	9	5	3	27
55	Dracontomelon mangiferum (Blume) Blume see D. dao	ໄມ້ກູ່	ST			1	
56	Elaeagnus conferta Roxburgh	ໄມ້ໝາກຫູອດ	PCl	1			
57	Elaeocarpus floribundus Blume	ໄມ້ມູນ	ST	2			
58	Elaeocarpus robustus Roxburgh	ໄມ້ບີເໜືອຍ	SS	20	8	2	9
59	Elaeocarpus stipularis Blume	ໄມ້ສີ້ນມຸ້ນ	ST	8	4	1	4

60	Embelia ribes Burm. f.	ໄມ້ຂີ້ມ້ອນ	ST	6		4	4
61	Engelhardtia chrysolepis Hance	ໄມ້ປ່າວ	ST	43	26	22	1
62	Euodia lepta (Spreng) Merr.	ໄມ້ລະວານ/ໄມ້ເຕ້ຍຫອກ	PS	28	36	29	2
63	Eurycoma longifolia Jack.	ໄມ້ຢິກບໍ່ຖອງ	PS	1	1	1	9
64	Ficus semicordata Buch.-Ham. ex J.E. Smith	ໄມ້ນອດ	PT	2	2	2	1
65	Ficus sp.	ໄມ້ຫໍາປູ່	PS	1	1		1
66	Garcinia oliveri Pierre	ໄມ້ກີ້ນບ້ຽວ	ST		1		
67	Garcinia sp.	ໄມ້ປ່ອງໄກ່	SS	1	12	2	7
68	Gardenia erythroclada Kurz	ໄມ້ຄັ່ງຍອດ	ST			1	
69	Gardenia obtusifolia Roxburgh	ໄມ້ໂອ້ຍປ່າ	ST	17	1	1	
70	Glochidion fagifolium Miquel	ໄມ້ຂີ້ມອດ	ST	2	2	1	
71	Glochidion fagifolium Miquel	ໄມ້ຂີ້ມິດ	ST	7	25	4	2
72	Gmelina arborea Roxburgh	ໄມ້ຊໍ້	ST	3			6
73	Gonocaryum lobbianum (Miers) Kurz	ໄມ້ກ່ານເຫຼືອງ				6	
74	Gonocaryum lobbianum (Miers) Kurz	ໄມ້ເຫຼືອງ	ST	2	1		
75	Hopea ferrea Pierre	ໄມ້ແດນ	ST				18
76	Irvingia malayana	ໄມ້ກະບົກ	ST	11	4		1
77	Ixora cuneifolia Roxburgh	ໄມ້ເປົ້າກໍ	PS	2	5	3	1
78	Ixora cuneifolia Roxburgh	ໄມ້ເຂັມປ່າ	PS	8	8	1	10
79	Knema oblongifolia (King) Warb.	ໄມ້ເຫຼືອດ	ST	1	1		2
80	Lepisanthes rubiginosa (Roxburgh) Leenh.	ໄມ້ໝາກຫວດ	PS	12	3	9	

81	Litsea glutinosa (Loureiro) C.B. Robinson	ໄມ້ໝີໂຊ່	ST	1			
82	Litsea sp.	ໄມ້ມີ່ຫອມ	ST	28	12		1
83	Macaranga denticulata (Blume) Müll.-Arg.	ໄມ້ເຕົ້າ	PT	2	1		2
84	Macaranga kurzii (O.K.) Pax & Hoffm.	ໄມ້ເບັ້ນ				1	1
85	Macaranga spp	ໄມ້ແສ້	PT	112	6	14	35
86	Maesa ramentacea Wallich	ໄມ້ຄັດ	PS	2			
87	Mallotus barbatus (Wallich) Müll.-Arg.	ໄມ້ເຕົ້າຄາຍ	PT	1			
88	Mangifera oblongifolia Hook. f. see M. odorata	ໄມ້ມ່ວງປ່າ	ST				3
89	Mansonia gagei Drummond	ໄມ້ມ່ອນຈັ່ນ				1	3
90	Microcos paniculata L.	ໄມ້ກ້ານເຕົ່/ໄມ້ໝາກຄອມ	ST			6	
91	Microdesmis caseariaefolia Planchon ex Müll.-Arg.	ໄມ້ກະດູກໄກ່	ST	3	1	12	5
92	Morus indica L.	ໄມ້ມ້ອນ	ST			1	
93	Muntingia calabura L.	ໄມ້ຕາກົບ	SS				1
94	Muntingia sp.	ໄມ້ຕາກົບດົງ	SS				1
95	Murraya koenigii (L.) Sprengel	ໄມ້ຂີ້ແບ້	ST				2
96	Mussaenda rehderiana Hutchins.	ໄມ້ຕັ້ງເບີ້	Cl	60	21	31	9
97	Ormosia cambodiana Gagnepain	ໄມ້ຂີ້ໝູ	ST	27	8	15	
98	Oxytenanthera parvifolia Br. (gigantochloa ?)	ໄມ້ຊອດ	PB	98	32		10
99	Parkia sumatrana Miquel	ໄມ້ຫົວໂລ້ນ	ST				2
100	Peltophorum dasyrhachis	ໄມ້ສະຝາງ	PT	137	47	19	
101	Phoebe lanceolata Nees	ໄມ້ກະບານ	ST	29	6	4	1

102	Phyllanthus emblica L.	ໄມ້ຂາມປ້ອມ	ST	3			
103	Polyalthia evecta (P.) Finet & Gagnepain	ໄມ້ບຳ້ເຕົ້າ	ST	1			
104	Prunus cerasoides D. Don.	ໄມ້ໝາກເທີ່ນ	ST				8
105	Rhus chinensis Miller	ໄມ້ສົ້ມເຮົ້າ	P	12	6	13	8
106	Rhus spp.	ໄມ້ພິດ	PT	53	2	1	
107	Salacia chinensis L.	ໄມ້ຟານປີບ	PS	48	14	33	6
108	Salacia verrucosa Wight	ໄມ້ຄ້ອນກອງ	SCl	3			
109	Schefflera alongensis Vig.	ໄມ້ຕັ້ງເສົ້າ	PS				1
110	Schefflera elliptica (Blume) Harms	ໄມ້ຕັ້ງພວງ	PS	2	1		1
111	Schima wallichii (DC.) Korth.	ໄມ້ໝີ່	ST			1	6
112	Sindora siamensis Teysm. ex Miquel var. siamensis	ໄມ້ແຕ້	ST				2
113	Spp.	ໄມ້ກໍ່	ST	69	36	30	39
114	spp.	ໄມ້ເຫຼືອງເລົ່າ		82	27	7	5
115	Syzygium cumini (L.) Skeels	ໄມ້ຈະຮ່າ	ST	4			
116	Syzygium sp.	ໄມ້ຈະຮ່າດິງ	ST	54	36	16	16
117	Terminalia catappa L.	ໄມ້ຫູກວາງ	ST	4			
118	Tetrameles nudiflora R. Br. & Benn	ໄມ້ພຸງ	ST				4
119	Triadica cochinchinensis Loureiro	ໄມ້ປັງແດງ	PT	2	6		
120	Unknown	ໄມ້ຕີບຂາວ		1			
121	Unknown	ໄມ້ລາຍຕອມ		39	4	1	11
122	Unknown	ໄມ້ຕີນ		133	24	6	1

123	Unknown	ໄມ້ອັ້ນ					8
124	Unknown	ໄມ້ໝອກ		2			
125	Unknown	ໄມ້ກ້ານບ່ວງ		1	2		
126	Unknown	ໄມ້ໝາກທູຫໍ່		1			
127	Unknown	ໄມ້ກໍເຂົ້າໜຽວ		1			
128	Unknown	ໄມ້ກ່າວມ້າ		16	15	9	8
129	Unknown	ໄມ້ກະແວ່ໝູ		1	1	1	14
130	Unknown	ໄມ້ການດຳ		1			
131	Unknown	ໄມ້ລັງລິງ			6		1
132	Unknown	ໄມ້ແກ່ງໄກ່				6	
133	Unknown	ໄມ້ຊ້າຕີນ					1
134	Unknown	ໄມ້ຮຳ			2		
135	Unknown	ໄມ້ມອນມ້ານ			5		
136	Unknown	ໄມ້ບໍ່ຮູ້		1		1	
137	Unknown	ໄມ້ບີໝູ					2
138	Unknown	ໄມ້ເຂົ້າໜຽວ		3	3		
139	Unknown	ໄມ້ແກ່ງກວາງ		2			
140	Unknown	ໄມ້ເບ່ນ					1
141	Unknown	ໄມ້ປ່ອງ		3			
142	Unknown	ໄມ້ປ້າງ				1	11
143	Unknown	ໄມ້ຄົ້ນເຕົ່				26	

144	Unknown	ໄມ້ເຊົ້າເບືອ					14
145	Vitex pierrei Craib	ໄມ້ຈະຄ່າງ	ST			1	
146	Vitex pinnata L.	ໄມ້ຕີນນົກ	ST	1			
147	Wrightia pubescens R. Brown	ໄມ້ມຸກ	ST		2		2
148	Xerospermum laoticum Gagnepain	ໄມ້ໝາກຍຽວ (ງຽວ)	ST	29	2	23	17

Source: Field survey, 2005

Abbreviation: PT – Pioneer trees PS- Pioneer shrubs
ST –Succession trees SS- Succession shrubs Cl-Clambers

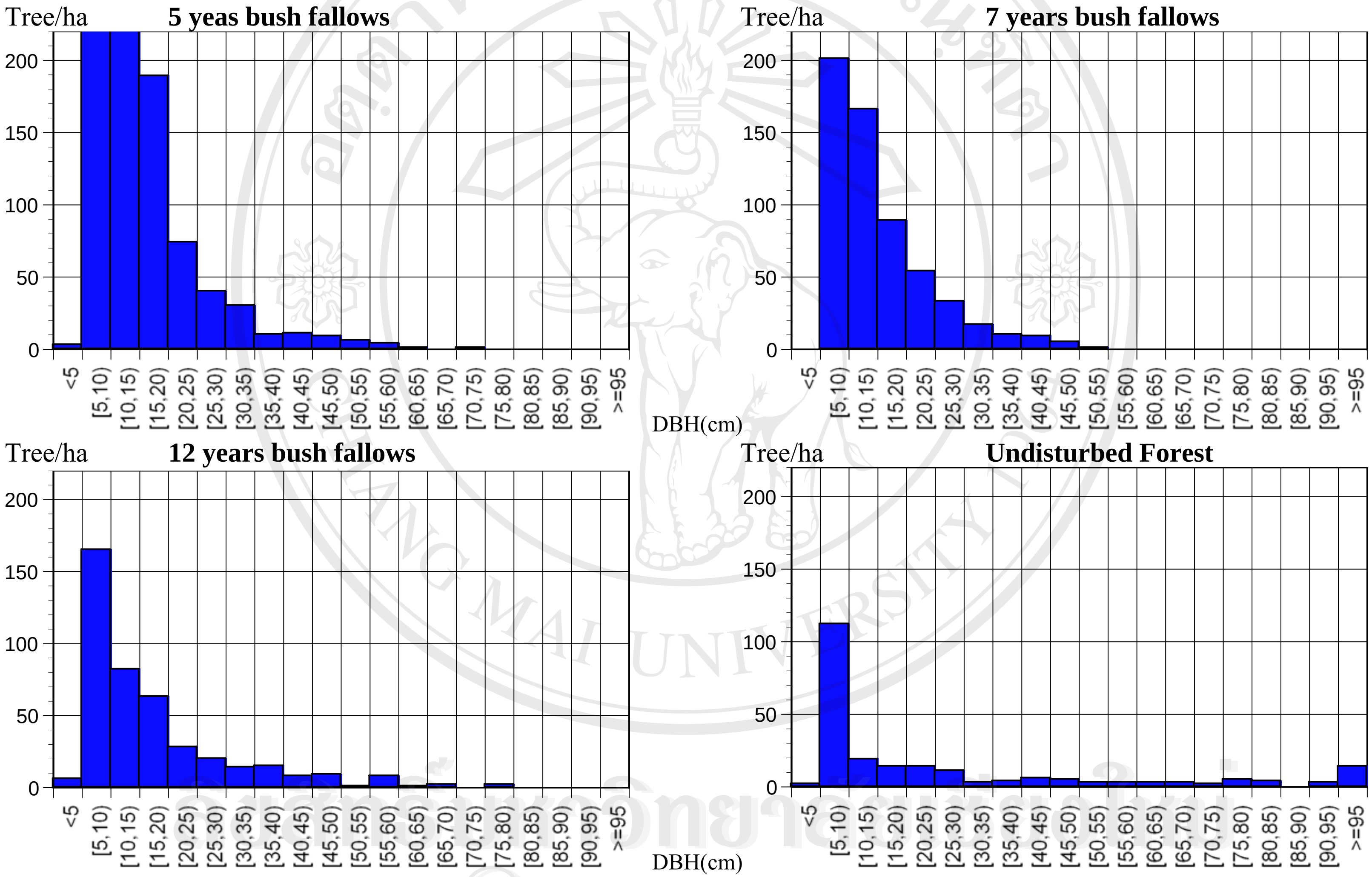

Figure 5.3 Diameter at breast height distribution (DBH)

In summary, regeneration of fallows in Sobngouang is relatively slow with less plant diversity as compare to other parts of Lao PDR e.g. Luangphabang and Udomxay (Roder, 2001). In Northern Thailand, regeneration of fallow forests are much faster with more plant diversity. For example in Tee Cha village of Karen community where 25 species were recorded in 6 years of fallow regrowth but diversity indices have shown to be much higher, e.g. Shannon index of 2.11. This fallow was also managed with abundance of *Macaranga* for soil enrichment. Therefore, degradation of natural forests in Sobngouang will have to take into consideration for field study in the future.

5.7 Conclusions

With effective implementation of government policies on upland management and development, shifting cultivation was almost out of practice with some 50% of former fallow fields for upland rice in 2005. Total suppression of shifting cultivation may not be feasible if rice deficit continues, despite the development of alternative systems for cash crop production.

At least, rice was incorporated as the dominant and/or associated component in newly developed systems; the permanent upland terraces, paddy and mixed annual-perennial production systems. With exception of paddy, upland rice was transferred to permanent upland terraces and mixed annual-perennial production systems. However, productivity of the new upland rice systems is not superior to these traditional bush fallow systems. Overall productivity of rice in Sobngouang is still fairly low and improvement could be made to overcome production constraints, e.g. soil fertility, sterility, drought, pests and management practices. More understanding should be made to over come the problem of low harvest index. Rice yields should be monitored in Project area.

The situation of forest resources in Sobngouang is fairly poor as comparing to other part of country and other countries in sub-region (Roder, 2001, Sabhasri, 1998, Senmidt-Vogt, 2001 and Yimyam, 2006). With increasing annual weeds, shrubby perennials and bamboo in reduced fallows, upland rice productivity is found to be very poor. On the other hand, natural regeneration of fallow forests up to 12 years is show with less abundance of major tree species. It is not clear, however, how much shifting cultivation had the direct impact on degradation of natural forest. The overall forest situation of Sobngouang is likely to be highly degraded, despite the practice of shifting cultivation. Soil fertility is also poor with phosphorus deficiency. Natural and biological processes in improving soil fertility are needed to be better understood, so that further degradation and/or rehabilitation of existing forest could be restored on sustainable basis.