

Farmers and Forests: A Changing Phase in Northeast Thailand

Buared PRACHAIYO *

* The author was a forest ecologist at Khon Kaen Regional Forest Office of the Royal Forestry Department of Thailand, and joined CSEAS as a visiting research fellow from May 1995 to April 1996. On October 28, 1996 he passed away in Thailand.

Contents

Preface	(5)
1. Introduction	(6)
2. Northeast Thailand	(14)
1. Area	(14)
2. Farmers	(22)
3. Forest	(29)
4. Land Utilization	(38)
5. Paddy Fields	(43)
3. Farmers' Use of Forest and Encroachment into the Forests	(50)
1. Wood Products	(50)
2. Non-wood Forest Products	(53)
3. Forest Degradation	(61)
4. Man and Forest Interaction	(72)
1. Fuel-wood	(72)
2. Community Forest	(79)
3. Forest Conservation by the Farmers	(92)
4. Trees on Paddy Fields	(105)
5. Mitigation of Forest Degradation	(122)
5. The Role of Forest in the Socio-economic Life of the Farmers	(134)
1. Trees and Farmers	(134)
2. Trees and Paddy Fields	(137)
3. Farmers, Trees and Paddy Fields	(138)
4. Trees and Home Economy of Farmers	(141)
5. Farmers and Society	(144)
6. Conclusion and Proposals	(146)
1. Conclusion	(146)
2. Recommendations	(148)
Bibliography	(153)
Appendix I	(157)
Appendix II	(176)

Preface

Writing a preface for this special paper by the late Mr. Buared Prachaiyo is a sorrowful task for me. This paper would have been his doctoral dissertation if he were alive.

I met Mr. Buared for the first time on January 19, 1991 at Khon Kaen Regional Forest Office of Royal Forestry Department of Thailand, where he worked as a forest ecologist. We had been assigned by the Mekong Secretariat to find the cause of and countermeasures to soil salinization in Korat Plateau. Close collaboration between a pedologist and a forest ecologist was strongly needed to achieve this goal, and it was the late Mr. Buared who was chosen to tackle the task. A Thai soil expert, Mr. Manop Tandatemiya of Department of Land Development, and a Japanese forest ecologist, Dr. Yamada Isamu, also joined the team.

Mr. Buared's extensive knowledge of the phytogeography of the Korat Plateau was very effective for discovering how vegetation types and index plants correlated with the pedo-geomorphological nature of terrains.

Mr. Buared was familiar with many Japanese scholars as a result of his enthusiasm for collaboration, which was based on his love of disclosing nature's truths and his respect for his countrymen.

In May 1995, Mr. Buared came to Kyoto to stay at Center for Southeast Asian Studies of Kyoto University for one year in order to write a doctoral dissertation on man's role in managing and recreating the forest in Korat Plateau. He ambitiously studied the topic: disclosing the ecology of various forest types; inventorying the traditional ways of forest use; studying the history of deforestation, creation of rice fields and community forest build-up; respecting the religious beliefs that have been fostered in the forest environment.

His paper was almost completed at the end of April 1996, when a heart disorder struck him. He returned to Thailand for a heart operation, and in July we received a letter from him saying that he was feeling better. He wrote love of his work and his wish that we could work again together like in the old beautiful days, and he wrote his hope to see us soon both in Khon Kaen and Kyoto.

On October 28, 1996, to our great sorrow, he passed away suddenly at his home. According to his will, a forest park and forestry library were created at his home school. It is a small consolation to us that we can now dedicate his last publication to Buared Memorial Forestry Library. May he sleep peacefully embraced by our common great teacher the Buddha.

Furukawa Hisao
Professor of Ecological History
Graduate School of Asian and African Area Studies
Kyoto University

Chapter 1

Introduction

1.1 *Preface of the Study*

Forests and farmers are an old combination which depends very much on the complementary relationship between them. Forests play important roles that precede the start of human activities. Trees as the main component of forest provide many products to satisfy the farmers' needs. Farmers have learned step by step from trees and forests and gradually created ways of handling them, which finally transformed into the tradition of each community and remain alive in the processes of performances and rituals necessary for living.

1.1.1 *Justification of the Study*

The main idea of the study is motivated by observing the fact that the farmers are strongly supported by forest and non-wood forest products. The significance of the forest seems to have deep roots in time immemorial when the trees in natural forests were plentiful. The importance of the forest seems to be blurred in the modern times. But due to the increase of the farmers' population and the controversial decrease of trees and forests, the significance of forests has become more clearly among many people. The community forest is now frequently referred to as the proper method to manage the national forests. Community forest, indeed, is not new at all. Many indigenous people realize the important role of trees and create many forms of community forests for the benefit of their community. The changing condition of forest is the main reason that this topic has attracted wide interest.

Farmers are normally concerned with four types of trees: trees in natural forests, trees in home compounds, trees in paddy fields, and trees in community forests. The trees of each type are all important to their living. They use various kinds of products, such as timber from trees in natural forest, vegetables from trees planted in the home compound and so on.

I was born in a rural village, and I spent my childhood years among circumstance where trees and forests were flourishing around my village and provided my neighbors with many products. I spent some days in collecting fuel-wood, mushrooms, and vegetables with my ancestors, spent days in the paddy field during the cultivating season. The farmers' ways of living is one of my favorites. Studying in the Faculty of Forestry in an academic institution was not only my duty but really made my life. For nearly two decades I worked to serve this particular need in both carrying on many research works in Forest Ecology, Management, Social Forestry, learning through personal contacts with most of my farmer friends, and through my own observation. All of the work done was reported at many seminars and meetings at both national and international levels in order to foster a better understanding about the relation between trees and the farmers and how to maintain them.

This paper is a part of my previous works done in community forest studies. The compilation

into one document will give a clue for people to learn about the importance of the relations between farmers and the forest.

1.1.2 *Scope of the Study*

The study is focused on the farmers' roles in changing the forest conditions. The farmers' roles are mainly the results of living in their communities such as daily activities, land occupations, social events; and the changes in the forest are mostly forest disappearance, decreasing of forest products; also formulation of the rules for the community to maintain their forest.

1.1.3 *The Objective of Study*

There are four main targets of this study: the compilation of the farmers' ways of maintaining their community forests, such as community organization, duties and rules; facts concerning the existing forests and forest products; possible methodologies to increase the number of community forests, forest plantations; and protection of natural forests. With these objectives, I hope very much to see some outputs such as cordial cooperation among the farmers, officials and private sectors to carry on activities to protect the natural forests for farmers' use; fruitful community forest projects in every community; and the willingness of the farmers to plant trees for their own use and to increase the number of commercial forests.

1.2 *The Importance of the Study*

1.2.1 *Trees and Buddhists*

Since before the Buddhist Era, trees and people have had a very close relation, and many works of literature describe in detail that our King Buddha was born in the middle of the forest on the way to his grandfather's home. During the beginning of his monkhood period he spent a lot of time meditating within the dense forest. On the last night in his self-learning he sat under the big canopy of *mujarintara* tree (*Eugenia cumini*) for one week with the final meditation after his enlightenment. His first teaching on *makabucha* night (the full moon night of the third month in lunar calendar) among the 1,250 monks was done in a bamboo grove. He spent his last day under the couple of *sal* tree (*Shorea robusta*) in his last teaching and then passed away. The *Ficus religiosa* tree was native to his funeral place at Kusinara city in Nepal. The tree now plays an important role as the Buddhist tree of the world. The propagation of massive planting has continued for centuries and the tree is now flourishing in nearly every Buddhist temple, especially in Thailand.

Buddhist temples were established later on both inside and outside of the forests. Most temples were planted with trees, and the temple forests are one of the green features in the community. People never cut the trees because they believe in the holiness of the trees since the time of the King Buddha. In some villages, the trees were too old, big and tall. The villagers who are afraid of the trees would fall during a heavy storm in the rainy season cut them down but do not use them for any purpose. Many tree species are planted in the temple grounds for fruit, shelter, and recreation. These groves become the specific system where people and trees live

together and give a good example of symbiosis between forests and people in the region.

The King Buddha spent six years in the forest before his enlightenment. This is the original idea for the foundation of many *wat pa* (forest temples) in the country. The monks in these temples study in similar ways as the King Buddha did two thousand years ago. The monks and the villagers work hand in hand to keep the temple forests as calm as possible.

1.2.2 *Trees in Thai Historical Events*

When we look back to the Ban Chiang period 4,000-5,000 years ago, the remaining famous ramnant pottery is colored red, and many people believe that the color might be extracted from some specific tree species, which no one knows. Some pieces of pottery shown in the exhibition room at the Udon Thani museum seems to have the pressing marks of some bamboo mat on the surface. Also some pressing traces of some fabrics made from tree fiber are impressed on another piece of pottery.

Vallibothama[1990] studied a lot about the northeast communities which he found mostly were salt production communities. To produce salt a lot of wood was needed. All parts of trees were used in this process, leaves, stems and branches. Leaves were used for salt storage, trunks for keeping brine and branches for fuel. These communities are located close to the forest. I have an idea that salt might have been important not only for export to other communities but also for food preservation. Whether for meat of wild animals and fish in the rainy season, salt would have played a big role for making salted fish or dry beef. One simple dish normally seen in the rural areas of the region is to put on a little salt on freshly steamed glutinous rice.

The stone inscription made by King Ramkhamhaeng the Great of the Sukhothai Dynasty gives a clear description about the patch of *mak* (*Areca catechu*) and *tan* (*Borassus flabellifer*). In my opinion, *mak* fruit is the main component for traditional chewing, together with lime, tree bark, tobacco, *phlu* (*Piper betel*) leaf and heartwood. Small amounts of these components are mixed together and chewed. If we look in detail at the production process of each chewing component we might see that *phlu* leaf is produced mainly in gardens. Seedlings are planted close to a wooden post up which they climb. Each family uses 3-7 wooden posts for this kind of planting. *Mak*, a tree species of Palmae, is normally planted in the home garden and also in the plantation run by rich families for mass production and export. To produce lime for chewing, the skeletons of specific shellfishes which contain more carbonate compound will be burnt by firewood. The ash of shellfishes is then used as a lime for chewing. The ash is normally white, but it may be made reddish by mixing with the ground powder of fresh tuber of *khamin* (*Curcuma longa*). Tree bark for chewing comes from the fibrous inner bark of *sisiat* (*Pentace burmanica*) and *takhian thong* (*Hopea odorata*). To take the bark, people seek a mature tree and cut only part of the bark in a proper amount. Heartwood of *khun* (*Cassia fistula*) is used for chewing only. Wood is gathered by cutting down the whole tree. It is then chopped into small logs for convenient transportation and selling. For chewing, a small piece of wood is pared with a knife as needed. Tobacco is mostly home-produced.

Tan, a big palm tree, called a sugar palm, is planted for many purposes. Leaves are used for

making various kinds of household utensils, roofing materials, fans for rice grain separation. Farmers' hats are normally made from this leaf. The trunks are used for construction and high-class furniture. Fruit is for eating fresh and for making a Thai sweet with the ripe fruit. The syrup from male flowers is favored for making sugar, fresh soft drink and local whisky. Sugar is produced by boiling the syrup. This process consumes a lot of firewood. Local whiskey, on the other hand, is fermented with some amount of yeast. The catalyst for this fermentation process is the heartwood of *phayom* tree (*Shorea roxburghii*); a small piece of wood is added to the syrup during the fermentation.

The Ramkhamhaeng inscription also tells about the Dhamma speeches periodically made by the high-ranking monks on full moon day at *phra tinang silat*. The stone inscription was placed among the trees close to the palace. The inscription is now kept at the National Museum in Bangkok. The impressive speech on Dhamma made in the Sukhothai period is similar to those made by the King Buddha in 2,000 years ago when the forest was still a cool, calm and nice place for Dhamma listening. The famous passage tells that fish is found everywhere in the water and the paddy fields are always full of rice. This really means that sufficient water is supplied by normal rain. The coming of rain each year may be affected very much by the surrounding forests.

In the Ayudhaya period (1350-1750) and the beginning of the Bangkok period (1830), the white elephant was the symbol of the power of the king in many countries, especially in Thailand and Myanmar. Hunting white elephants was among the assignments of governors in some rural cities where forest was still abundant. To make traps for the hunt many poles from big trees were used. The wild elephants were then forced into these traps. The remains of one such trap still exist in Ayudhaya.

The temples and royal palaces in these two cities were mainly constructed from timber and susceptible to fire, very much as in the case of the collapse of Ayudhaya city in 1750. The repair of these places in later days in the beginning of Bangkok period also used a lot of timber, both teak and non-teak. Teak timbers were from the northern cities and other timbers from the nearby forests.

1.2.3 *The Basic Needs of the People*

Generally, the people obtain four basic materials for living, food, shelter, medicine and cloth, from trees [Komkris 1966]. Food is normally obtained from various kinds of non-wood forest products. The poorer the farmers are, the more food products they need from forests. Shelter may trace back to the temporary living in rough houses made from simple wood. Many rural people nowadays seek the timber for house construction. They enter any forest and cut down the trees. Not only today but from long ago the rules and regulations on forest tree cutting have been neglected. House construction is the first priority in the farmers' settlement. Most houses in rural areas are made of wood. Since 1940, wooden roofs have become rare and expensive. For roofing a piece of wood measuring of $16 \times 30 \times 0.5$ cm made from *tabaek yai* (*Lagerstroemia calyculata*) and *phluang* (*Dipterocarpus tuberculatus*) was common previously, prepared by the farmers after the rice harvest.

Medicinal plants might not be evident in present-day living. But before the second half of this century, medicinal plants played a big role in rural people's health. Nearly every village had a rural medical doctor. Usually a man, he spent many years in the monk-hood and learned how to use plants as medicine. He traveled often the forests to find plants for this purpose. He collected many parts of several tree species for each typical use. Like modern pharmaceutical formulas, specific parts of specific trees are effective only for one symptom, while other parts are good for others. This knowledge is fading since the coming of the modern medical doctor. But many people still use medicinal plant for particular problems.

The use of plants for clothing may be more clear if we look at the processes of cotton and silk thread production, which become customary skills for many rural women. To produce silk, trees are used not as fuel-wood but in the dying process. The natural and durable brown color of silk is obtained only from soaking the silk thread in a solution of coconut leaf ash. The solution will protect silk thread from fading. The dark brown color might also be obtained from the dying process by boiling with the heartwood of *kae lae* (*Maclura cochinchinensis*). The royal blue color of cotton is from the solution of *khram* (*Indigofera suffruticosa*), a shrub planted for this dying material only. Women gather only the leaves of this shrub, put them into the earthenware and keep them soaked with water for months until the color of the solution changes to blue. The leaves are then removed and the solution is kept for another month for sedimentation. The water is then drained off. The remaining substance becomes the solid blue dye, which is used for dyeing any cloth except silk. The dark yellow-brown color for monk's robes is obtained from the heartwood of *khanun* (*Artocarpus heterophyllus*), which is normally planted in temple compound for fruit.

1.2.4 Forest Utilization by the Farmers

The farmers use the forest in two distinct ways, aggressively and conservatively. The former is not so extensive but causes serious alteration of the national forests. The cutting down of *phak wan* tree (*Milientha suavis*) only to collect young leaves is one good example, as is the felling some big trees for catching tree lizards or the burning of bush for catching mice, hares and reptiles. The most severe damage by people is to cut and burn to change the forest into a dwelling and planting area in their settlement. This type of forest use fundamentally originates from the need for land for living and planting of each family. The scarcity of income generating jobs in the region forces people into such aggressive forest use. Farmers may have some sense of common resources, but the basic needs for family livelihood force them to cut the trees and burn them illegally. Many said that during the massive decrease of national forest land of 5,335 km² between 1978 and 1981 in the Northeast, timbers worth about 17 billion baht (1 baht = 0.04 US\$) had been burnt. The poverty and scantiness of cash income are the two main factors for changing the farmers' behavior from calm and considerate to senseless. The farmers' activities in cooperation with efforts of the RFD (Royal Forest Department) staff to protect the national forest are on-going but far from reaching a good goal.

The preservative utilization is the common case seen in the old and permanent communities

where most of the farmers are well-off. They have a large area of paddy land, fruit garden, and home (kitchen) garden. The remaining patch of forest for communal use is customarily preserved in these communities. They pay good attention to the rules and regulations of the community. They enter the forest only for gathering some non-wood forest products and are well aware of the role of the forest for these products. Their way of collecting the young leaves of *phak wan* is quite different from the former ones. They have a sense of conservative gathering by picking only the young leaves for daily consumption. Many forest products are obtained from their community forests as well. Their gardens where many fruit trees were planted provide the fallen stems and dried branches good for fuel. The home garden is an important source of fresh food for the family. Their life style is the important factor for preserving the forest in the region.

A good practice is the planting of *phai ban* (*Bambusa blumeana*) around the villages as a fence. This bamboo serves not only as a fence but as a good wind-break at the beginning of the rainy season when storms always cause hazards. This bamboo is really a multi-purpose species. The young shoot is normally cooked in a local curry and salted bamboo shoot is used for preparing various kinds of food. Customarily, a bamboo clump planted close to a family house is mainly used by that family, but the others can share this benefit as well. The bamboo stem is used for making many kinds of cultivation tools, fishing poles, handicrafts and as construction material of temporary houses. Recently, the bamboo products have become famous for high-class furniture. Food containers using the inter-node were common in the old days before plastic bags became available. The dry sheath of bamboo shoot is good for rice seed storage, and wall of temporary house. The use of bamboo poles for carrying the coffin from the household to the cremation place is still popular in the region even today. The kind of bamboo that is only used for coffin carrying is normally planted in the village border in their farms but not in the household compound. In general, bamboo is an area-consuming plant because, after planting, it covers an extensive area in a very short time and prevents the growth of any crop by root penetration and by canopy covering. The popularly planted bamboos are *phai liang* (*Bambusa nana*), *phai dam khwan* (*Thyrsostachys oliverri*), *phai bong* (*Dendrocalamus brandisii*), and *phai tong* (*Dendrocalamus strictus*).

1.2.5 *The Changing of Forests*

The famous statement made by Sono [1977] is one of the nation's highlights on the forest management in the country. He divided forest development into three phases: heavy encroachment, awareness of crisis, and development. The first phase occurred during the time when forests and trees were abundant. People had no hesitation in cutting the trees as they needed. They did not think so much about the shortage and decrease in both amount and quality of the forests and forest products. They concentrated on only tree harvesting as much as they could. Not only the products from forests but also the lands in forests were what they most needed. Trees were cut and burnt by many people. Forests changed to dwelling and agricultural lands. To consider the merits of forests as an environment was far from their minds. The second phase came when forests were in a severely damaged stage and could not produce products to

meet people's need. The degradation of the forest became widespread and many disastrous events happened. Some people began thinking about the damage of forests and tried to stop it or do something to preserve the remaining forests and trees. Works were initiated mostly in conservational prospects, training seminars and extension. These works stimulated the people to recognize the danger faced by trees and forests. The last phase is normally taking place after the complete disappearance of natural forests. The tree planting program is the main job to create the new artificial forests as seen in many developed countries.

The forest degradation in Thailand is related to the neglect of the Forestry Laws by the people. There are five laws with the objective of forest protection, but few people pay attention to them. The poverty of people might be one of the reasons for this situation, but most people need a land for housing and cultivation. Work for forest protection seldom gets any cooperation from people. Forest is common property of which many people want a part, especially in case of the land in the forest, and this situation leads to the destruction of forests and degradation of the national forests.

From this point of view, one may agree that human activities caused many troubles to the forests, as mentioned by Yoda and Sahunalu [1991], Prachaiyo [1983a], and Chuntanaparb and Wood [1986]. The main human activity causing the huge alteration to the forests is the land hunger, the need for land for living and planting. Other human activities may comprise gathering of timber and non-wood forest products, especially fuel-wood, illegal logging of timber for house building, road and dam construction for the national economic and social development. These activities play different roles in the disappearance of the natural forests.

When the forests were naturally flourishing in the country and the population was low, in the 1960s, for example, when the total population was about 20 million with 60% of forest cover in the country, the forest cover was everywhere around the communities. The villages were located at the heart of the forest area. Every village was a small living area surrounded by trees, animals and good circumstances. Water flowed regularly throughout the year not only in the rainy season. Flood and drought seldom occurred. On the other hand, in 1990, 30 years later, forest cover fell to only 26% while the population increased to 55 millions. Forest became a small green spot among the human communities where paddy fields predominate. The main remaining forest is seen only in the mountainous areas, and it is attacked by frequent natural disasters. People formerly needed only small amount of forest products for their daily consumption. The forest was not the single source of supply because they could collect many foods from any source near their villages. But the need of forest land in the present has made the situation more severe.

1.2.6 *The Trees in Paddy Fields*

Many people now pay due attention to the sustainability of the paddy field system of the region. They began to notice the importance of the trees remaining in the paddy fields. The role of these trees is interesting. In the last decade several investigations have clarified why people have to keep trees in their paddy fields. Adulprasertsuk [1993] found that the tree leaves that fell in the paddy fields contained some degree of plant nutrients. The farmers themselves might not be

concerned with the actual figures, but they understand how important the trees are by carrying on the same practice as their ancestors have done since the former days. Paddy fields have traditionally been opened by transforming the forest. The trees standing in paddy fields are the remnants of the old site. These trees play the role of the farmers' treasure, giving many products to meet the farmers' needs to that. This role of trees may be comparable not to their role in the natural forest but in convenient sites. The paddy fields, produce not only rice but also many kinds of foods, animals and vegetables. The farmer-paddy field system in Northeast Thailand may be important for reestablishing an efficient way of resource use in the country if the people begin to manage trees in the rice fields for their own use.

1.2.7 *The Community Forest*

Farmers' customary practices might be more important to them than governmental aid. Most customary practices have been transformed into social traditions with no written records, which reveal themselves through community practices. The community forest, for example, is in a very contrasting condition with the national forests. The importance of reinforcing the community forest should be fully evaluated.

The trees and people in Northeast Thailand are in a situation where people depend heavily on trees and trees need tending by the people to maintain their role as providers of resources. People and trees can not be separated for any reason. On the other hand, a full understanding about the merit of trees may be more important for people than any other thing, because they never stay without any trees and tree products.

Chapter 2

Northeast Thailand

2.1 Area

Thailand is located in the center of the Indochinese peninsula at the latitude of $5^{\circ}27'N$ to $20^{\circ}27'N$ and longitude of $97^{\circ}21'E$ to $105^{\circ}37'E$. It covers an area of 513,115 km², the same size as France. It is bordered in the west by Myanmar and the Indian Ocean, in the north by Myanmar and Lao P. D. R., in the east by Lao P. D. R. and Cambodia, and in the south by Malaysia. The total length from north to south measures 1,620 km, while the width from east to west is about 780 km. Thailand is in a monsoon zone which has three different seasons: summer from March to April, the rainy season from May to October, and winter from November to February.

Geographical conditions in the country differs from part to part. The North is covered with high mountains, the weather is always cool all year round and people can cultivate more rice and vegetables as well as the temperate fruits. Forest covering in this region is still more dense than other parts. The Northeast, a high plateau with sandy soils has typically high water drainage. Weather keeps warm through the year except for two months in winter. Brownish color of the forest occurs everywhere in the region in winter, and all ground cover is dried and burnt in summer. This time of the year is normally called the dry season because of the drought. People grow rice in some amount for family consumption. The Central region, the flood plain area of the country, used to be the best rice production area in the world. The location of many big and capital cities are suitable for exporting agricultural productions, rice, teak, tin, and so on. The South, a cape encompasses mountains and is surrounded by the Gulf of Thailand in the east and the Gulf of Martaban in the west. Ore mining, fishing and fruit plantation are plenty. Rain falls for ten months a year, which sometimes causes flooding in the region.

2.1.1 Location

The Northeast is located at the latitude $14^{\circ}7'N$ to $18^{\circ}26'N$ and longitude $100^{\circ}54'E$ to $105^{\circ}37'E$ and covers an area of 168,854 km², the same size as the whole country of Cambodia and bigger than South Korea or Bangladesh. The surroundings of the region are composed of different features on each side.

North	the Mekong river and the Hueang river
East	the Mekong river
South	Phanom Dong Rak, Sankamphaeng and Dong Phayayen range
West	Petchaboon and Dong Phayayen range

Table 1 The Areas at Different Altitudes in Northeast Thailand

Number	Altitude Class (m)	Area (km ²)	Ratio (%)
1	0- 100	169	0.1
2	100- 200	106,209	62.9
3	200- 500	47,955	28.4
4	500-1,000	11,482	6.8
5	1,000-	3,093	1.8

Source: [Senanarong 1986]

2.1.2 Topography

The whole region sits on the Khorat plateau with the average altitude of 200 meter above mean sea level (Table 1). The easternward aspect starts from Petchabun range and Phu Kra dueng mountain in the west and gradually declines to the east at the Mekong river. The lowest altitude is in the floodplain of the Mun river, and the peak of Phu Kra dueng mountain is the highest point. Most of the ground surface is undulating. Low terraces alternate with the high ones where submerged rice is commonly planted. The field crops and rice are typically planted on even the high terrace. Mountains, covered with more or less amount of forest are scattered all over the region. The famous Phu Phan range divides the region into two natural basins, the Khorat in the south and the Sakon Nakhon in the north. The former covers the flatland and most of the region where Khao Yai mountain is the landmark, and the latter covers the catchment area of the Mun and Chi rivers. Some tributaries originating from Sakamphaeng and Phanom Dong Rak range meet with these rivers and make the largest rice production area in the region. The Sakon Nakhon basin on the high altitude of the region covers the remaining smaller area where some mountains are the watershed of several rivers such as Sri Songkram, Nam Kam, Un and so on. Along the flooding areas of these rivers are the sites of paddy fields in some amount.

2.1.3 Climate

The Northeast has a tropical Savannah climate where the dry season and the wet season are sharply separate from each other. The dry season includes summer and winter, and runs from November to April, while the rainy season is from May to October. The rainfall in the provinces along the Mekong river such as Nong Khai, Nakhon Phanom, Sakon Nakhon, Yasothon is higher than the provinces on the hinterlands in the western part of the region, Chiyaphum, Nakhon Ratchasima, and Khon Kaen (Fig. 2). The temperature of the region is rather cool in the upper part and becomes warmer in the lower (Fig. 1). The details on climatic data of Phu Wiang District of Khon Kaen during 1984-91 are presented in Table 2.

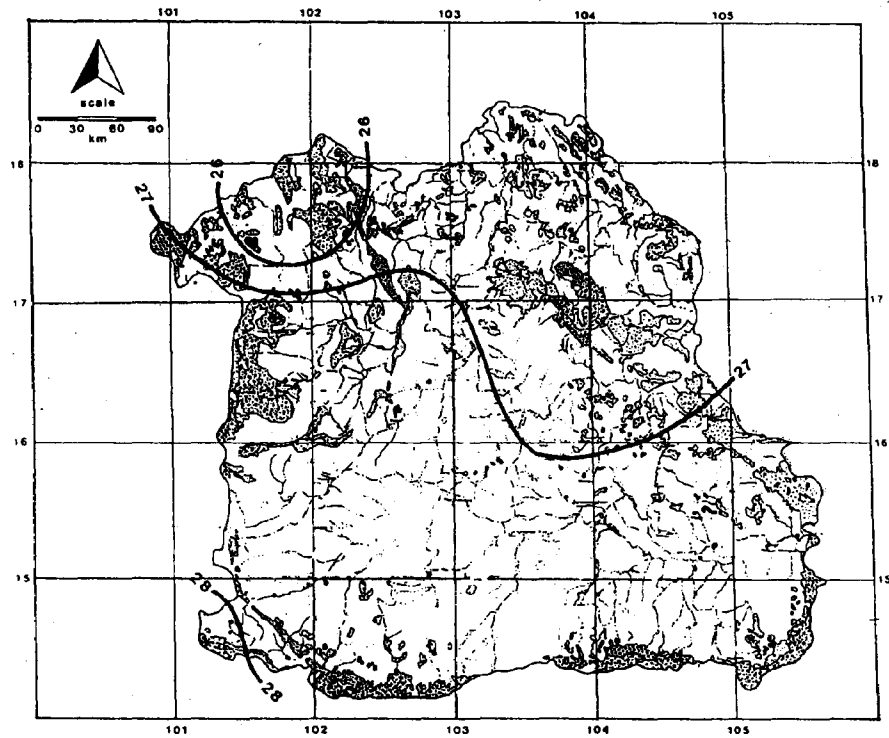


Fig. 1 The Isothermal Lines of the Northeast during 1957-84
Source: [Viriyabancha 1992]

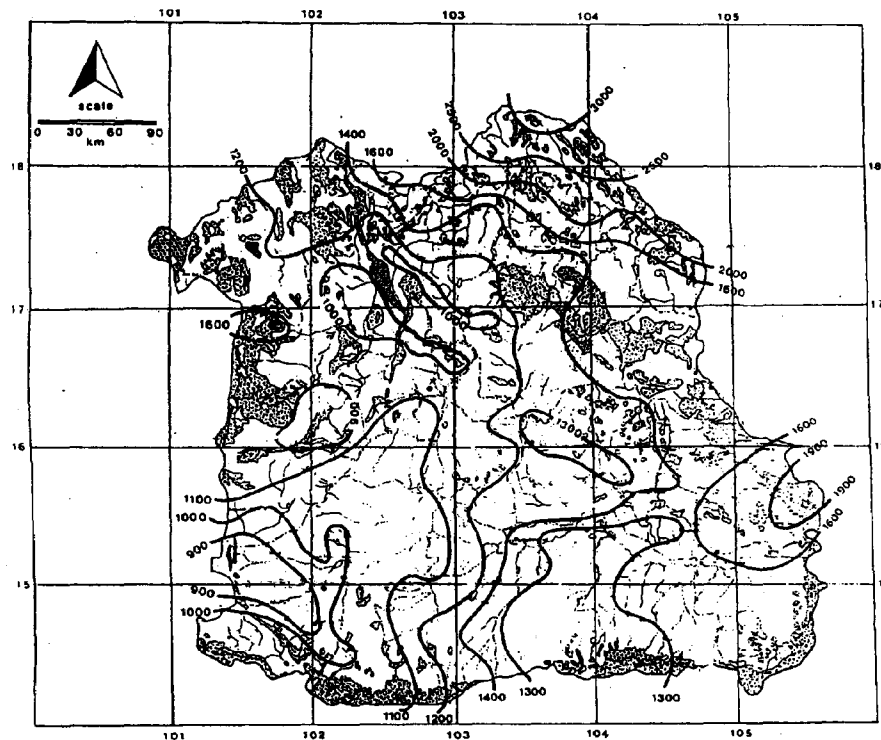


Fig. 2 The Isohyetal Lines of the Northeast during 1977-86
Source: [Viriyabancha 1992]

Table 2 Climatic Data of Phu Wiang District, Khon Kaen, Northeast Thailand

Climatic Condition	Month												Total
	J	F	M	A	M	J	J	A	S	O	N	D	
Rain (mm)	1.1	18.9	33.6	102.3	188.2	143.6	149.9	210.2	209.5	133.8	8.5	8.9	1,208.5
Rainy day (day)	1	3	4	8	14	14	12	16	16	12	3	1	104
Temperature (°C)													
Max	24.04	31.08	32.86	34.32	32.58	31.00	31.26	30.98	30.28	30.08	29.80	28.00	
Min	16.50	19.32	21.32	23.48	24.06	24.42	24.06	24.18	23.22	23.38	19.32	14.58	
Humidity (%)	88	81	80	71	79	82	86	91	93	96	92	95	

Source: [Phu Wiang 1995]

Table 3 The Distribution of Great Soil Groups in Northeast Thailand

Great Soil Group	%	Remark
Loamy paleustults	20	
Loamy paleaquals	14	
Loamy paleustults/paleaquals	12	
Slope complex	12	
Skeleton plinthustults	10	
Clayey tropaquepts	7	
Skeleton haplustalfs	2	
Clayey paleustults	2	
Skeleton paleustults	2	
Clayey paleaquals	1	
Others	17	37 groups
Water body	1	
Total	100.00	

Source: [Vijarnsorn 1985]

2.1.4 Soil

Vijarnsorn [1985] classified soil in the Northeast into 45 great soil groups. These great soil groups distribute all over the region, and the first 5 groups cover most of the region: loamy paleustults, loamy paleaquals, loamy paleustults/loamy paleaquals, skeleton plinthustults, and clayey tropaquepts cover respectively 20, 14, 12, 10 and 7% of the area (Table 3). These soil groups play an important role in the farmers' occupation. The loamy paleustults in particular account for the biggest part of the submerged rice fields of the region and are found in every province. The slope complex, which shares the area coverage of 12%, is the main forest area of the region on the mountainous areas and upper slope and serve as an important source of forest products.

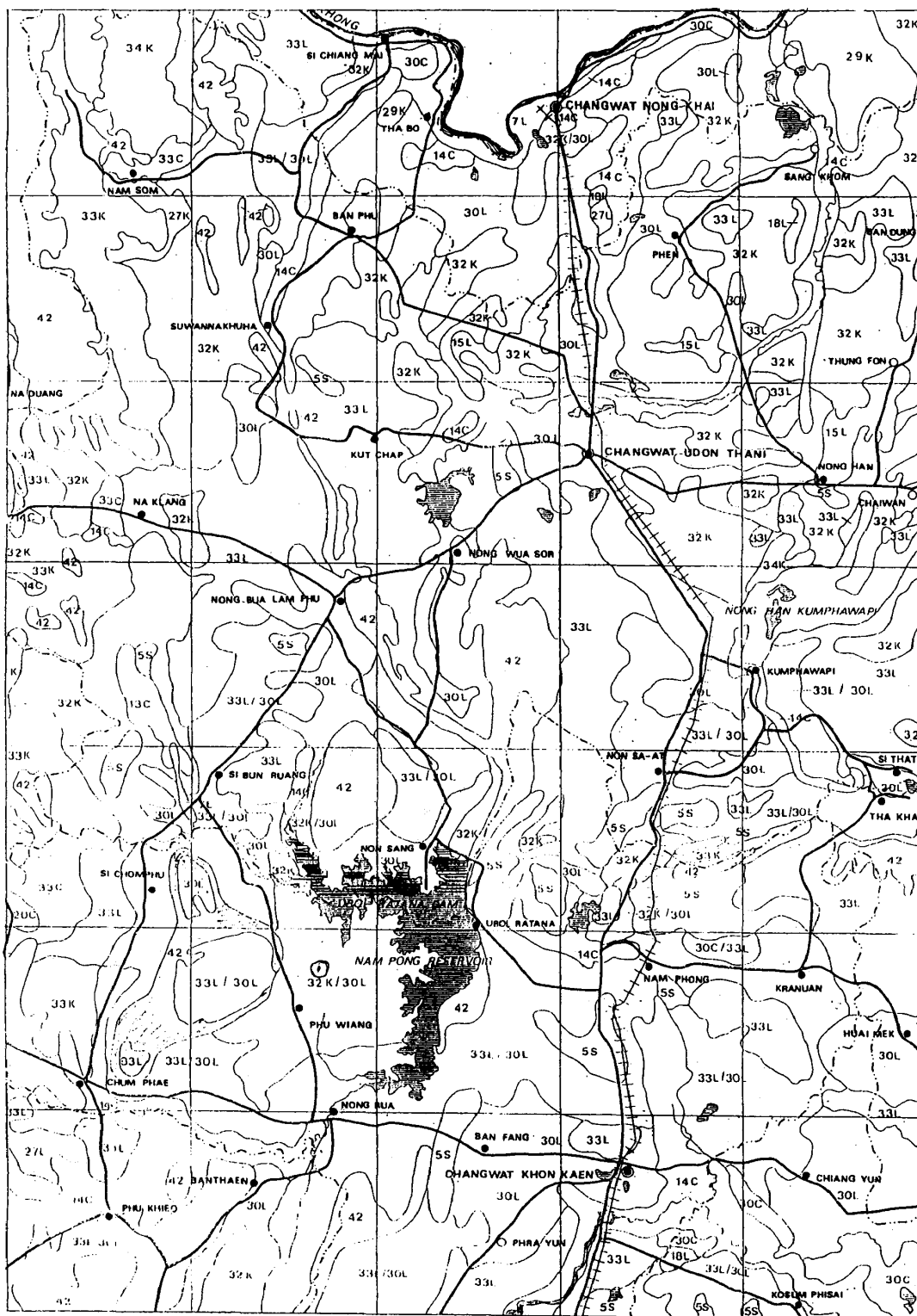


Fig.3 The Topographic Map of Phu Wiang Area to Show the Great Soil Group
Source: [Vijarnsorn 1985]

2.1.5 Population

Most of the Northeastern people belong to the Thai-Lao ethnic group. They have their own language distinct from the Thai language. They live in houses with a high-raised floor and a triangular roof. The style of these houses has several meanings. The region is normally warm through the year especially in summer, the triangular roof is good for aeration, which normally keeps the temperature lower inside the houses. The high-raised floor provides space for cattle at night-time to guard them against theft as well as the place for agricultural tools, a loom for weaving and play space for children. Most of their staple food is glutinous rice from their farm, and drinking water from earthenware container, which is always cool. For economic standardization, cash flow is commonly used as an indicator to measure the family economic status. But in the Northeast, the people regularly lack cash. They have only paddy in the rice barn and many poultry under it, cattle under their house, fish from natural ponds and water bodies and vegetables that are both natural grown and planted. These seem more than enough for them to have a comfortable life.

The region consists of 17 provinces, 233 districts, 2,514 sub-districts (*tambon*), 27,379 villages with 3,771,753 households. The population census in 1993 found that the total population was 20,059,015, composing 10,102,231 males and 9,956,784 females [Thailand, NSO 1994]. The population distribution is simple. The concentration is normally seen along the main rivers of each basin. For Sakon Nakhon Basin, most of the people are living in Roi-et, Udon Thani, Khon Kaen, and Sakon Nakhon situated along the Chi river and its tributaries, and make the total number of each province more than a million. The Khorat Basin shows the same trend: the Mun

Table 4 Population from National Registration Record in Northeast Thailand in 1993

Number	Province	Male	Population Female	Total
1	Buriram	712,597	704,732	1,417,329
2	Chaiyaphum	546,629	539,702	1,086,331
3	Kalasin	465,022	460,232	925,254
4	Khon Kaen	838,421	824,091	1,662,512
5	Loei	305,101	290,343	595,444
6	Maha Sarakham	434,014	435,104	869,118
7	Mukdahan	150,674	148,606	299,280
8	Nakhon Phanom	325,091	324,842	649,933
9	Nakhon Ratchasima	1,241,950	1,225,416	2,467,366
10	Nong Khai	423,522	413,171	836,693
11	Roi-et	622,494	616,436	1,238,930
12	Sakon Nakhon	508,147	506,196	1,014,343
13	Sri Saket	670,731	664,756	1,335,487
14	Surin	675,659	665,726	1,341,385
15	Ubon Ratchathani	981,690	963,489	1,945,179
16	Udon Thani	934,701	911,453	1,846,154
17	Yasothon	265,788	262,489	528,277
	Total	10,102,231	9,956,784	20,059,015

Source: [Thailand, NSO 1994]

river is the main residential area of the people in Nakhon Ratchasima, Ubon Ratchathani, Surin, Sri Saket, and Buri Ram (Table 4). The average population density was 4.5 in 1994.

2.1.6 Environment

Thailand, The Environmental Plan and Policy Office [1993] headlined the national environments into seven categories: forest and wildlife, land, mineral, energy, inland fishery, marine fishery, and water resources. In the Northeast, except for marine fishery, all categories in some degree concern the people. Forest and wildlife region covers 12.91% of forest [Thailand, RFD 1994b] where 15 national parks cover the area of 5,840 km², National Reserved Forest, 352 units, cover the area of 34,457 km². The seven wildlife sanctuaries established in the region for appropriate management for wild animals cover an area of 3,815 km². The forest plantations have been conducted since 1960 but cover an area of only 8,276 km².

Land, the main base of the farmers' living and planting, is undulating with low fertility and low water content. The farmers mostly grow rice on these lands, covering an area of more than 60,765 km². These lands are now facing the decline of their fertility. Rice has been planted on the same piece of land for tens or hundreds years. During this time the soil property maintenance has not been actively pursued, as the cost is far from affordable by the farmers. For a field crop, a total of 21,527 km² of land is now in critical condition, with lack of enough water even in the rainy season, coupled with soil erosion especially on the upper slopes where most of these lands are located. Salinization has become a problem over most of the region as the soil cover is rapidly damaged by land clearing. A heavily saline soil cover almost 0.22% or 376.55 km² of the region on the paddy fields of the farmers.

Available water, which is supplied in the region only by rain, is about 36,700 million cubic meter per year. This water is used for rice cultivation in rained system, vegetable cultivation, animal feeding, and household consumption. Some water stored in man-made reservoirs is partly used for a second rice crop in a limited area. Table 5 shows the water capacity of the man-made dams in the region. The water from these dams is for both rice planting and electricity generating.

Table 5 Dam Capacity and Water Storage in Northeast Thailand

(mil. m ³)				
Number	Name & Site	Capacity	Water Storage	Remark
1	Lam Pao, Kalasin	1,436	1,039	A
2	Lam Takhong, Nakhon Ratchasima	310	43	A
3	Lam Phra Phloeng, Nakhon Ratchasima	152	81	A
4	Nam Un, Sakon Nakhon	520	239	A
5	Ubonrat, Khon Kaen	2,263	583	E & A
6	Sirinthon, Ubon Ratchathani	1,966	637	A
7	Chulaphon, Chaiyaphum	188	82	E & A
8	Huay Luang, Udon Thani	113	80	A
9	Lam Nangrong, Buriram	150	29	A

Source: [Thailand, EPPO 1993]

A = agriculture E = electricity

Table 6 Fish Catch from Ubonrat Dam, Khon Kaen during 1986-92

Month/Year	(ton)						
	1986	87	88	89	90	91	92
Jan	79.8	79.2	187.4	169.0	108.0	135.0	72.7
Feb	102.6	97.7	147.0	156.7	108.2	137.1	105.6
Mar	109.5	82.9	148.9	188.8	103.2	152.8	106.6
Apr	70.5	74.5	126.7	140.1	93.2	116.2	113.0
May	112.9	80.7	169.8	200.2	160.7	187.3	112.1
Jun	87.5	115.0	182.4	210.8	146.4	147.9	138.9
Jul	105.2	91.7	202.2	214.2	120.0	168.4	138.0
Aug	195.0	233.9	136.6	230.3	132.0	140.2	191.7
Sep	585.4	163.5	152.0	265.9	209.3	129.6	89.7
Oct	129.1	179.3	127.3	238.5	128.4	108.2	91.4
Nov	103.4	203.4	62.0	106.6	144.3	72.8	61.3
Dec	69.6	103.9	82.2	151.4	198.0	76.0	50.9
Total	1,750.5	1,505.7	1,724.5	2,272.5	1,651.7	1,571.5	1,271.9

Source: [Thailand, PFO 1995]

These dams provide the farmers with water and fish in a big amount. Ubonrat Dam, for example, located in Ubonrat District of Khon Kaen provide the farmers down-stream with water for second rice planting during December to March each year in the area of about 1,000 km² in Khon Kaen and Maha Sarakham. The farmers who join the project must register as members of the Water Use Association, which is administrated by the Department of Irrigation. The members have to pay a water use charge. Some vegetables instead of rice are also planted in this area.

Fish is one of the main products from this dam. The farmers who live close to the dam bank catch a lot of fish each year for their second occupations. The total amount of fish catch by these farmers appears in Table 6. This is only the official record, and I suppose that the similar amount of fish is caught by local farmers for their household consumption. There are many kinds of fish caught in this dam, and the official value of these fishes is shown in Table 7 for 1988.

The fish is the main protein source and only one raw material to produce *pla ra* (salted fish), a typical food of the people in the region. Fish become one of the important foods, which farmers can easily find in all water bodies. Some farmers are raising many freshwater fish in their ponds or paddy fields in the rainy season. They use many kinds of fish traps made of bamboo and the most common one is *thot hae* (cast net). After the dam construction, the fish catching in dams has become a popular occupation among farmers. They fish all year round, and in the rainy season they catch fish in the paddy fields. Many dams serve the need of the people so appropriately with fish production that some farmers convert their job to be fisherman.

In recent years, prospecting for petroleum has been carried out in the Northeast as well as in other regions. As of 1995, one natural gas field is operating at Nam Phon district of Khon Kaen. Salt is another main product from underground mines at Nakhon Ratchasima and Udon Thani.

Table 7 Price of Fish Caught from Ubonrat Dam, Khon Kaen in 1988

Number	Local Name	Amount (ton)	Price (baht)	Remark
1	<i>kho noi</i>	334.35	3.94	<i>Wallagonia attu</i>
2	<i>kamang</i>	343.92	7.92	—
3	<i>siu kaeo</i>	391.91	2.35	<i>Rasbora</i> spp.
4	<i>sroi kho</i>	303.61	4.43	<i>Cirrhina jullieni</i>
5	<i>sroi nok khao</i>	85.48	1.38	<i>Osteochilus</i> spp.
6	<i>salad</i>	80.36	2.41	<i>Notopterus notopterus</i>
7	<i>bu</i>	32.31	0.94	<i>Oxyeleotris marmoratus</i>
8	<i>krot</i>	18.58	0.73	<i>Mystus nemurus</i>
9	<i>chon</i>	16.98	0.61	<i>Ophicephalus seriatius</i>
10	<i>khayaeng</i>	16.50	0.42	<i>Mystus cavasius</i>
	Total	1,624.0	25.13	

Source: [Thailand, PFO 1995]

2.2 Farmers

The people in the Northeast are mainly members of the Thai-Lao ethnic group. They speak the Thai-Lao language but write in the official Thai alphabet. The customs and ways of life are unique and different from other regions. They have glutinous rice as a staple food for three meals per day. They listen to *mo lam*, a normal folk song and enjoy the *bun bang fai* festival, one of the big events in the country. Many activities were formed and transferred from generation to generation, from father to son, from mother to daughter without any school for teaching. Most of their learning process is only on trial and practice for getting some experiences. Some learn by hearing from mouth to mouth but some only from observing the way of doing. Family seems to be the main place not only for staying but for knowledge transfer. Some three generations live in each family commonly in many villages of the region. Parent, children and grandchildren live together, work in the same fields, and eat the same dishes. The passing of learning is always present. There is no special hour for learning but every moment is important.

Some minor ethnic groups live among these people, especially in the border provinces close to Laos and Cambodia. Sakon Nakhon is the main area of many ethnic groups; Renunakhon district is the home of Phuthai; Mueang district of Yo and Yoi; Akat Amnuai and Kut Bak districts of Kaleng; and So people in Kusuman. Surin province is the city of Suai. These people stay in their villages with their own customs, dialect and traditions, which are going well with many of Thai. Both of them sometimes live in the same village. They all enjoy both the Thai and ethnic tradition in the village and there are no problem between them.

2.2.1 Northeastern Farmer

Kunstadders *et al.* [1978] published a famous book about “Farmers in the Forest” of the Northern provinces of Chiang Mai, Chiang Rai and Mae Hong Son. The farmers in the North work in the forest area on the mountains and in the lowland forest for crop planting. The main population of the farmers is the hill-tribes.

Fig. 4 illustrates the overall view of paddy fields and the farmers. A woman is sitting in her



Fig. 4 Tree, farmer, and paddy field in northeast Thailand, where *Albizia lebbeck* is located in the foreground, *Tamarindus* in the center and *Samanea saman* in the background.

own paddy field in summer with her cattle and son. The cattle are grazing on the new shoot of rice and grass springing up after a small shower. The time might be around noon as the trees on the paddy fields are shading the animals. Her son is intensively taking care of these animals. The village is not far away, just on the margin of the paddy field. This is a typical complexity of paddy, farmers and animals. She could enjoy looking on her paddy fields, animals, trees and her son with happiness. A farmer who cultivates rice in the rainy season for family consumption can share circumstances throughout the year on

the paddy fields. The agricultural calendar of the farmers of Ban Rua, Phu Wiang Khon Kaen is as follows (Table 8).

In the Northeast the proportion of the farming population is rather high. Kongkajan *et al.* [1990] found in their study villages that all people were engaged in rice cultivation (100%). Fukui

Table 8 Agricultural Calendar of the Farmers, Ban Rua, Phu Wiang, Khon Kaen

Number	Events	Time												Remark
		J	F	M	A	M	J	J	A	S	O	N	D	
1	Compost application	----	×	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	once a year
2	Opening ceremony	-----	-----	-----	-----	×	-----	-----	-----	-----	-----	-----	-----	
3	First plowing	-----	-----	-----	-----	×	×	-----	-----	-----	-----	-----	-----	
4	Rice seedling preparation	-----	-----	-----	-----	-----	×	-----	-----	-----	-----	-----	-----	<i>bun khao sat</i>
5	Second plowing	-----	-----	-----	-----	-----	×	×	-----	-----	-----	-----	-----	
6	Raking	-----	-----	-----	-----	-----	×	×	-----	-----	-----	-----	-----	
7	Pulling out rice seedlings	-----	-----	-----	-----	-----	-----	×	-----	-----	-----	-----	-----	
8	Transplanting	-----	-----	-----	-----	-----	-----	×	×	-----	-----	-----	-----	
9	Tending	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	
	9.1 water control	-----	-----	-----	-----	-----	-----	-----	×	×	×	-----	-----	
	9.2 chemical fertilizer	-----	-----	-----	-----	-----	-----	-----	-----	×	-----	-----	-----	
	9.3 crab protection	-----	-----	-----	-----	-----	-----	-----	×	×	×	-----	-----	
10	Rice growth festival	-----	-----	-----	-----	-----	-----	-----	-----	-----	×	-----	-----	
11	Reaping	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	×	×	<i>bun khao chi</i>
12	Rice sheafing	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	×	
13	Rice sheaf transportation	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	×	
14	Rice sheaf piling	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	×	
15	Threshing ceremony	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	×	
16	Threshing	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	×	<i>bun khao chi</i>
17	Rice transportation	×	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	×	
18	Rice harvesting festival	×	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	
19	Rice barn opening	×	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	

× = present; ---- = absence

Table 9 The Crop Calendar of the Farmers in Ban Rua Village, Phu Wiang, Khon Kaen

Number	Crop	Planting Time												Remark
		J	F	M	A	M	J	J	A	S	O	N	D	
1	Chili	-----				×	×	×	×	×	×	-----		Rainy season
2	Egg plant	-----				×	×	×	×	×	×	-----		〃
3	Onion	×	×	×	-----								×	Dry season
4	Garlic	×	×	×	-----								×	〃
5	Tobacco	×	×	×	-----								×	〃
6	Cucumber	×	×	×	-----								×	〃
7	Green leaf vegt.	×	×	×	-----								×	〃
8	Yard long bean	×	×	×	-----								×	〃
9	Melon	-----				×	×	×	×	×	×	-----		Rainy season
10	Corn	×	×	×	×	×	×	×	×	×	×	×	×	
11	Local bean	-----				×	×	×	×	×	×	-----		Rainy season
12	Hairy basil	-----				×	×	×	×	×	×	-----		Rainy season
13	Holy basil	×	×	×	×	×	×	×	×	×	×	×	×	<i>thiang na</i>
14	Kitchen mint	×	×	×	×	×	×	×	×	×	×	×	×	〃
15	Lemon grass	×	×	×	×	×	×	×	×	×	×	×	×	〃
16	Ginger	×	×	×	×	×	×	×	×	×	×	×	×	Home garden
17	Sweet potato	-----				×	×	×	×	×	×	×	×	〃
18	Jam bean	-----				×	×	×	×	×	×	×	×	<i>thiang na</i>

[1993] found like wise. But Prachaiyo [1993] who studied villages of, Phu Wiang, Khon Kaen found 95.57% of the villagers own their paddy field. Nagata [1995] in his database concluded that the number of farming household in the Northeast was 2,412,663 out of the total 2,756,617 or around 87.52%.

The farmers in Ban Rua village, Phu Wiang, according to my observation, have a specific schedule to plant various kinds of vegetables for household consumption. Table 9 shows the crop calendar of these people.

2.2.2 Occupation and Income

Most people in the region conduct crop cultivation as their occupation. Some people grow only rice because of the shortage of land. But mostly rice planting is the first priority and is followed with many kinds of crop. Rice is grown for family consumption as a staple food and many cash crops are planted for subsidizing the family's need for food and cash income. Glutinous rice is the main, but nonglutinous rice is also planted in small amount for Buddhist ceremonies which are performed every month in the village. Table 10 shows the kinds of some cash crops.

Rice and many crops play the first role in supplying the farmers' foods and living necessities, but animals such as buffalo, cattle, pigs, ducks and chickens are also raised. Buffalo are used as the main source of energy in rice cultivation, although recently the energy comes from the engines, and buffalo only serve as a source of meat. Pigs, ducks and chickens are raised in every household as the basic protein food. The number of these animals is shown in Table 11.

Thailand, NSO [1992] reported the types of the monthly income of each region in the country and found that in the Northeast the average family obtains 3,563 baht per month from various sources of income (Table 12). This monthly income seems not enough for the farmers. They spend all of this amount or over. In 1990 for particular, 291 baht was spent more than their income (Table 13).

Table 10 Main Agricultural Crop Production of the Northeast (1993/94)

Number	Crop	Product (ton)	Farm Value (Mil. baht)
1	Second rice	32,323	95
2	Major rice	7,125,324	26,700
3	Maize	838,469	2,356
4	Cassava	11,679,874	6,658
5	Sugarcane	9,381,852	4,597
6	Mungbean	12,450	114
7	Soybean	66,195	534
8	Groundnut	42,618	369
9	Cotton	12,369	150
10	Kenaf	119,502	583
11	Sorghum	3,826	9
	Total	29,314,802	42,165

Source: [Thailand, CFAS 1994]

Table 11 The Amount of Domestic Animal in the Northeast (1993/94)

Number	Animal	Amount
1	Buffalo	3,597,883
2	Cattle	2,097,984
3	Swine	1,177,834
4	Duck	6,420,269
5	Chicken	33,070,113

Source: [Thailand, CFAS 1994]

Table 12 The Average Monthly Income per Household by Different Sources in the Northeast (1990)

Number	Source of Income	Income	
		Baht	%
1	Wage and salary	901	25.3
2	Non-farm profit	371	10.4
3	Profit from farming	766	21.5
4	Property income	21	0.6
5	Current transfer	303	8.5
6	Non money income	812	22.8
7	Other money receipts	54	1.5
8	Rental value of owned home	335	9.4
	Total	3,563	100

Source: [Thailand, NSO 1992]

Table 13 The Average Monthly Expenditure per Household in the Northeast (1990)

Expenditure Group	Amount	
	Baht	%
Consumption	3,578	92.8
Food & beverage	1,542	40.0
Alcoholic beverage	35	0.9
Tobacco	54	1.4
Apparent foot wear	301	7.8
Housing	944	24.5
Medical care	143	3.7
Personal care	96	2.5
Transportation & communication	304	7.9
Recreation & reading	66	1.7
Education	35	0.9
Miscellaneous	58	1.5
Non consumption	276	7.2
Total	3,854	100

Source: [Thailand, NSO 1992]

2.2.3 *Belief and Behavior*

The people in the Northeast pay a lot of attention to the rites during the year. Apart from working, much of their time was spent in the performance of several rites in the villages. There are a total 12 rites (*het sip song*) for all people to participate in throughout the year. Each rite is performed in each month of the year. They believe very much that the conduct of these rites will pave a way for them to have a real happiness and better living than before. The rites held in the village are conducted by the old generation, and the young generations have to learn little by little as the years pass by. Some rites are the responsibility of women, but the family heads are the core people to follow the indigenous way of their ancestor. Table 14 lists the 12 rites of the year.

The rites are practiced basically monthly, which means the rites concern the activities done by farmers in that month. *Bun khao pradap din* in August, for example, is usually performed in August because rice in paddy fields is at the peak of the growing season and about to bear rice grain. The rite is performed for asking the special care to the god of cultivation and enough water from rain. The rite is marked with typical food. One set of food is composed of rice, chili, salted fish, cigarette, chewing materials, wrapped with banana leaf. These sets of food will be presented to the god who takes care of paddy fields by putting them on the drainage outlets of paddy dikes. This is the important part of paddy fields that control the water level in each unit. If the drainage outlet is damaged by animals, especially crabs, the water will be drained out and rice will die because of water deficit. In offering the food to the god, the farmers always talk to the god since they are sure that god is waiting and observing their behavior. Farmers believe that the god will understand their praying and give them some assistance as they request.

The Northeastern people also pay a lot of attention to the *krong sibsi* (a frame of 14 ways of

Table 14 The Twelve Rites in Northeast Thailand

No.	Rite	Time	Purpose
1	<i>bun khao kam</i>	December	listening to Dhamma given by monk
2	<i>bun kum khao yai</i>	January	harvesting ceremony
3	<i>bun khao chi</i>	February	presenting the monks with first rice yield
4	<i>bun prawet</i>	March	merit-making and listening to the Dhamma in 13 chapters
5	<i>songkran</i>	April	traditional Thai new year and family reunion
6	<i>bun bangfai</i>	May	initial stage of cultivation by asking the rain from Dhaen
7	<i>bun ban</i>	June	preparing cattle for new cultivation
8	<i>bun khaophansa</i>	July	start 3 month stay in temple for all monks
9	<i>bun khao pradap din</i>	August	donating food to former ancestors and god of cultivation
10	<i>bun khao sat</i>	September	special presentation of typical belongings to monks
11	<i>bun tai namman</i>	October	present lights to the god to show the gratitude of people
12	<i>bun katin</i>	November	big merit-making of the year to pay respect to monks in temple

Source: [Parinyano 1982]

merit-making for a good living). Practicing the requirements in this frame aims at a fortunate living of all people. Naturally, the farmers are generous people. This might be the results of their practicing *krong sibs*. The details of *krong sibs* for normal people are as follows:

1. The first products of rice, crop, and fruit from farm should be partly offered to the monks before daily consumption.
2. Aware from balance cheating and paying a robbery money but saying and speaking only on polite words.
3. Cooperation for temple fence making as well as private fence, and making the shrines at the 4 corners of the village.
4. Feet must be clean before entering the house.
5. Making a forgiving respect to 3-rock fire place, fire place, ladder main frame, and house doors on every Buddhist days.
6. Feet must be clean before going to bed.
7. Women must pay forgiving respect to their husbands on every Buddhist day and bring flowers and candles to the monks.
8. Merit-making by inviting the monk to the house must be done on the middle of the tenth month of lunar year.
9. In offering rice to the monks during his *pinta bat*, the offeres must remove shoes as well as cap or hat or umbrella and avoid from touching the rice bowl (*bat*).
10. Peasants must present flowers, candles, caterings and utensils to the monks during *bun khao kam* rite on December.
11. Peasants must always be a seated during talk with monks.
12. Don't step on a monk's shadow.

13. Food remaining from wife's eating is forbidden to be offered to the monks or passed to her husband.
14. Love affair is forbidden on Buddhist days, like *khaophansa*, *okphansa* and *songkran*.

I believe that the farmers in Ban Rua village, Phu Wiang, Khon Kaen have been performing some activities since the old days. The details of my observation are shown in Table 15.

2.2.4 Education

Primary education is compulsory. Under the Primary Education Act of 1917, all Thais of both sexes have to go to school at the age between 7-15 years. Village primary school was established later on. Four year class was formerly a common curriculum and extended to be 6 years nowadays. But for secondary school, some fees have to be paid for both the governmental and private schools.

Thai girls learn from their mothers how to be a good wife and keep house in the future. Cooking is priority to be learnt with many steps concerning cooking such as fuel-wood collecting, fresh food preparing, rice cooking for family consumption, vegetable growing and gathering. Weaving is also important for many girls. They have to produce many fabrics for the family from both silk and cotton. They learn how to grow mulberry for silkworms, how to feed them, and the silk threading and sewing of typical *mat mi* for women's costume. Cotton was common in the former days and is still normal now. Its production starts with cotton planting, then cotton picking, threading and weaving a very typical *pha khao ma* (cloth for all season) for male use. Working in paddy field as a rice seedling withdrawer, transplanter, reaper, harvester, thresher is another lesson a girl must learn from both her mother and father.

The phrases *ruean sam* (three homes) and *nam si* (four waters) are among the most customary expressions. *Ruean* (home) *sam* (three) means body, household and kitchen. Girls

Table 15 The Social and Home Compound Events in Ban Rua Village, Phu Wiang, Khon Kaen

Events	Time												Remark
	J	F	M	A	M	J	J	A	S	O	N	D	
Home fence repairing	---		×	×	-----								
Home building/repairing	×	×	×	×	-----								
Temple fence repairing	--	×			-----								before <i>bun pawet</i>
Temple repairing	---		×	×	-----								
Cleaning of shallow well	-----										×	×	
Merit making	×	×	×	×	×	×	×	×	×	×	×	×	See Table 14
<i>bun buek ban</i>	-----					×							village shrine
<i>bun liang ban</i>	-----				×								Cultivation opening ceremony
Community fishing	-----				×	×							
<i>song ku</i>	-----				×								forest shrine
<i>song phra</i>	-----				×								temple water ceremony to the Buddhist images

must be calm, charming, and clean people. Clothes, hair, nails, body smell must be intensively taken care of. Household, the place to stay, must be neat to be a nice place to every family member or guest. Kitchen means the food security. All food must be available at a time of need.

Nam (water) *si* (four) is composed of a generous mind. Women are expected to be unselfish. Drinking water is always full at all times in the water container to serve. Drinking water is comparable to tea or coffee in other countries. Guests will be greeted with a cup of drinking water before starting their talk. Bathing water for family members also has to be prepared in each house.

The boy learns how to work in paddy fields, how to cultivate field crops from his father as well as how to fish and hunt. The tools for these works have to be made by themselves. In the old days, plow, rake, bamboo basket, bamboo string for fastening, fish trap and rope were the big lessons for every Thai boy to learn. After returning from primary school, they directly follow their fathers to work in paddy fields and forests. At the age of 20, all of them have to leave home to become a monk for at least three months during *khaophansa* (middle months of rainy season) at the village temple. After that they will become a good adult and ready for marrying with some good girl. So, before becoming a monk, they must master all works in farm or household. Three months or more in a monkhood will be spent for Dhamma learning to better understand the village community. This way of learning passed on from older generations to younger ones is more important than any school education.

2.3 Forest

2.3.1 Area

The forests in the Northeast have dramatically decreased during the last three decades. The main factor which affected the forest decrease was human interference, by which many forest products and finally the forest land were exploited for people's living and rice planting. Many human activities concerning forest affair were cited elsewhere [Yoda and Sahunalu 1991; Phragtong 1993; Prachaiyo 1983a]. The forest area remaining in the region in 1991 was only 12.91% of the total area (Table 16), and the lowest in the country. This means that the need of land for living and planting in the region is the highest in the country.

Table 16 Forest Area in the Northeast during 1961-91

Year	Whole Kingdom		Northeast	
	km ²	%	km ²	%
1961	273,681	53.34	70,913	41.99
75	221,721	43.21	50,681	30.01
76	198,417	38.67	41,494	24.57
78	175,224	34.50	31,221	18.49
82	156,600	30.52	25,886	15.33
85	150,866	29.40	25,580	15.15
88	143,803	28.03	23,693	14.03
89	143,417	27.95	23,586	13.97
91	136,698	26.64	21,799	12.91

Source: [Thailand, RFD 1992]

2.3.2 Forest Type

There are four sub-types of forest in the region: Dry Evergreen Forest (DEF), Mixed Deciduous Forest (MDF), Dry Dipterocarp Forest (DDF), and Pine Forest (PF). These forests distributed all over the region but mainly on the upper and lower part of the region, becoming sparse at the center (Fig. 5). Table 17 shows the area of each forest type in the region. Each type is different in terms of characteristic species composition and structure.

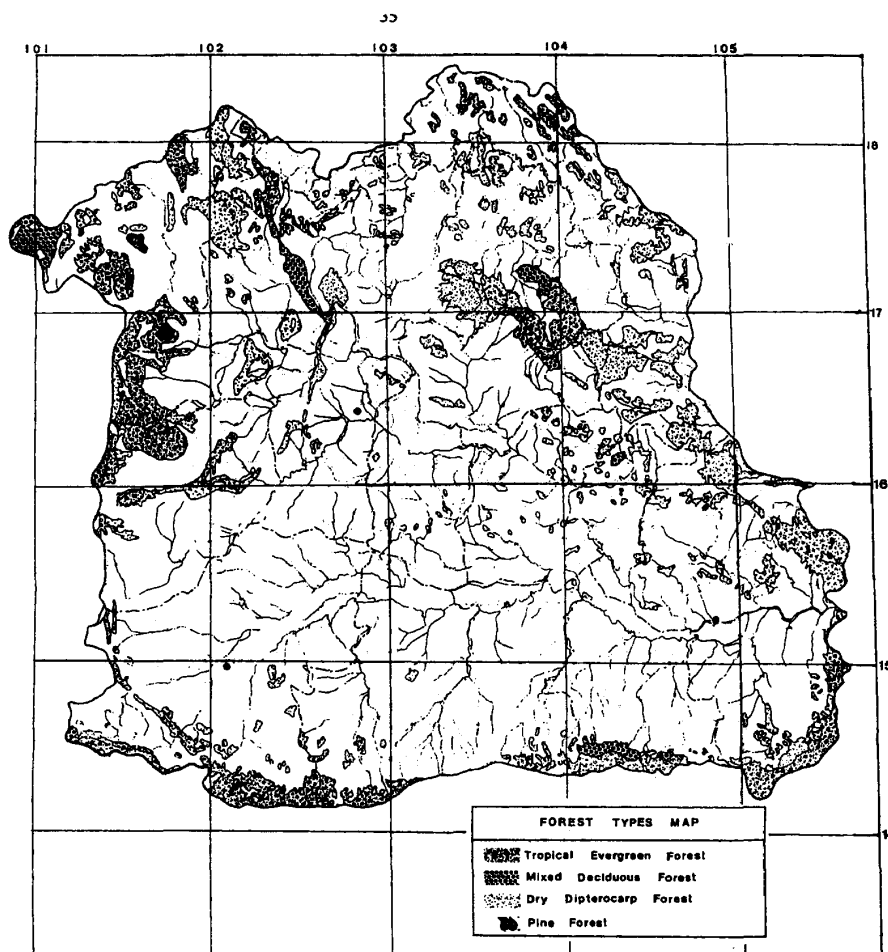


Fig. 5 Forest Type Map of the Northeast Thailand

Source: [Viriyanbancha 1992]

Table 17 Forest Type and Area in Northeast Thailand (1982)

No	Forest Type	Area	
		km ²	%
1	DEF	9,305	35.95
2	MDF	2,618	10.11
3	DDF	13,819	53.38
4	PF	144	0.54

Source: [Thailand, RFD 1992]

1) *Dry Evergreen Forest (DEF)*

This forest was adapted from Tropical Rain Forest (TRF) because of the limitation of especially the annual rainfall, which is 1,000-2,000 mm/year. This forest flourishes only at the altitude of 500 meter above mean sea level [Phongamphai 1976]. The soil is similar to that of TRF, but located on the mountainous areas with rather shallow soils on steep slopes and with plenty of boulders. This forest is most dense in the region. Trees are usually tall, have big stems and round canopies. Leaves appear to attach to the main branches in canopies all year round and become remarkably green among brown and red color of the forest in summer. Many forests in the region are still under the intensive management for wildlife and for amenity purpose. The DEFs in Phu Kradueng, Phu Phan and Phanom Dong Rak mountains are the heads of many rivers in the region.

Sahunalu *et al.* [1979] summarized the quantitative characteristics of this forest at Namphrom Dam; tree density at 1,163 tree/hectare, number of species about 50, basal area at 0.278%, and index of diversity at 5.05. They observed the canopy stratification in this forest to be three layers: the first layer composed of 9 species with height higher than 21.5 meter; 13-21.5 meter for the middle layer with 15 trees species; and 35 tree species with height less than 13 meter in the third layer.

Smittinanda [1977] stratified the forest into three strata. The first stratum is the layer of the big dominant trees with rounded canopies covering the most of the lower layers. The trees are excellent for timber products such as *Anisoptera costata*, *Dipterocarpus alatus*, *Dipterocarpus*

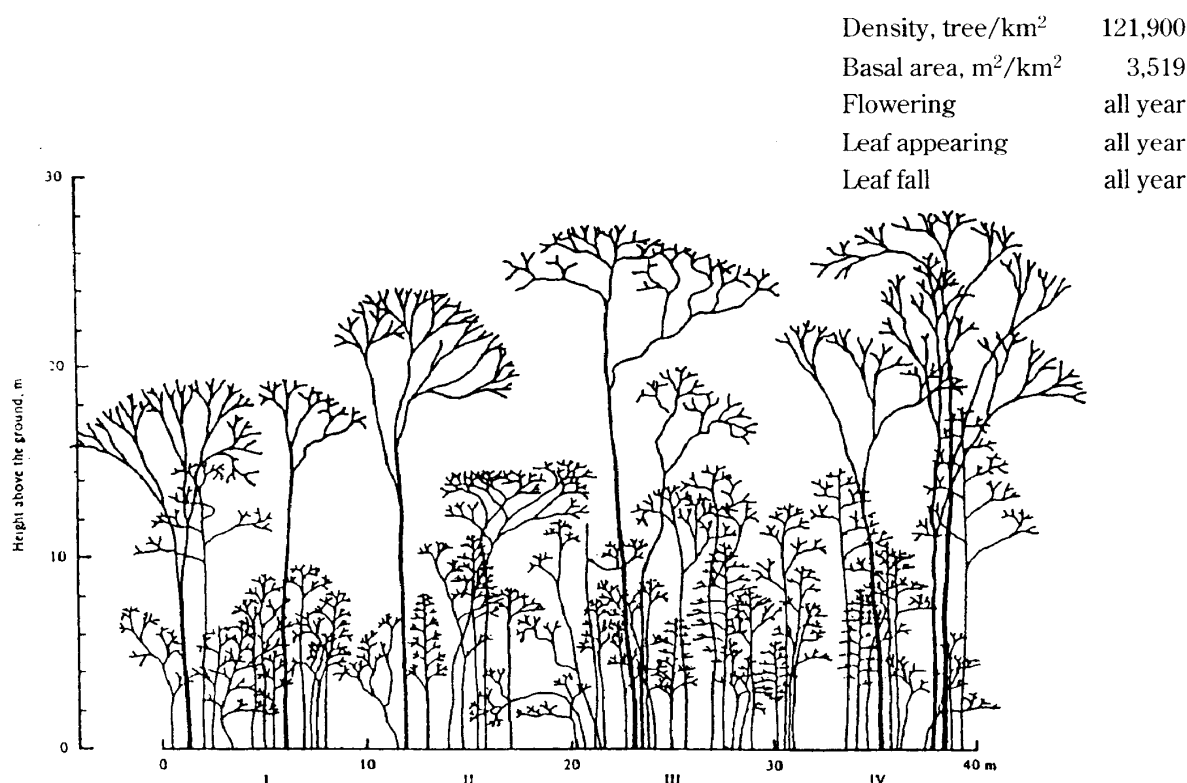


Fig. 6 Profile Diagram of DEF at Nam Phon Dam, Chaiyaphum

Source: [Tsutsumi *et al.* 1981]

turbinatus, *Hopea odorata*, *Hopea ferrea*, *Shorea thorelii*, *Alstonia scholaris*, *Tetrameles nudiflora*, *Azelia xylocarpa*, *Lagerstroemia avaliforia* and so on. The middle stratum trees are both dominant and co-dominant trees of smaller size. The trees are good for both timber and non-timber products such as *Cratoxylum maingayi*, *Castanopsis nephrenoides*, *Lithocarpus harmandii*, *Spondias pinnata*, *Cinnamomum iners*, *Irvingia malayana*, *Peltophorum dasyrachis*. The lower stratum is normally flourishing with many shrubs and small seedlings of trees such as *Memecylon ovatum*, *Memecylon geddesianum*, *Aporosa villosa*, *Apousa aurea*, *Aporosa fioifolia*, *Baccarea sapida*, *Melodorum fruticosum*, *Mitrephora laotica*, *Torennia collinsae*, *Dillenia ovata*, *Dillenia obovata* and *Crateva religiosa*.

The ground cover of this forest consists of herbs, climbers, and shrubs that prefer the moist and shaded circumstance. Many of them serve as medicinal plants, such as *Ardisia helferiana*, *Ardisia siamensis*, *Ardisia vestita*, *Ixora finlaysonianana*, *Zingiber zerumbet* and so on.

Many palms are found in this forest, such as *Calamus* spp., *Areca triandra* as well as many kinds of bamboo such as *Gigantochloa albociliata*, *Bambusa natans*, *Dendrocalamus strictus*. Climbers of several species are common, *Phanera lathyroides*, *Congea tomentosa*, *Ventilago denticulata*, *Tetrastigma cruciatum*, *Sphenodesme involucrata*, *Hymenopyramis brachiata*, *Toddalia asiatica*, *Uraria crinita*, *Pisonia aculeata*, *Derris alborubra*, *Derris scandens*, *Derris dalbergiodes*, *Entada pursaetha* and so on.

Intensive studies in DEF at Nam Phon Dam, Chaiyaphum covered several aspects. Prachaiyo and Tsutsumi [1990] studied the rate of wood litter decomposition of several tree species in this forest and found that the rate of decomposition was dramatically increasing from the second year up to the fourth year during the study period. In a four-year period, the rate of decomposition was as high as 84.5% (Table 18).

Leaf litter is the main agent for forest soil improvement. The decomposition of leaf litter will enhance soil fertility by adding humus and soil nutrients. Takeda *et al.* [1984] found the decomposition rate (k) of leaf litter of seven tree species in this forest to be 0.0422-0.2308 per month. The decomposition process is the main mechanism by which forest soil maintains good properties, because all of the nutrients will be released to soil after the complete decomposition. Prachaiyo and Tsutsumi [1989] made their intensive study in the same forest and their finding is shown in Table 19 where leaf shows the highest concentration of nutrients, decreasing with branch and stem, at the ratio of 100 : 46 : 23.

2) *Mixed Deciduous Forest (MDF)*

This forest is one of the deciduous forests in which most trees are deciduous. But, in the northern region, *sak* (*Tectona grandis*) grows intermixed with other trees. The forest is classified to three categories: moist, upper, and mixed deciduous forests. MDF occurs on the site with elevation of 300-600 meters. Trees grow well on loamy soil derived from granite rock. Dry upper mixed deciduous forest spreads on the ridge at the elevation of 300-500 meter where soil is loamy sand with patchy lateritic soil. The mixed deciduous forest flourishes on the arid area on the lower flat plain with elevation of 50-300 meter, and *sak* is limited to this patch [Smittinanda 1977].

Table 18 The Decomposition of Weight with Time of Wood Litter in DEF, Nam Phon Dam, Chaiphum, Northeast Thailand

Number	Tree Species		Dry Weight (gram)				
			Initial	1	2	3	4 Year
1	<i>Excoecaria bicolor</i>	gm	224	173	125	55	15
		%	100	72	52	22	7
2	<i>Excoecaria bicolor</i>	gm	997	781	500	264	46
		%	100	78	50	26	4
3	<i>Excoecaria bicolor</i>	gm	253	161	116	16	6
		%	100	62	46	7	2
4	<i>Lagerstroemia duperreana</i>	gm	283	189	150	74	48
		%	100	66	53	26	17
5	<i>Paranephelium longifoliatum</i>	gm	197	181	141	121	115
		%	100	92	72	61	61
6	<i>Diospyros castanea</i>	gm	224	113	85	15	5
		%	100	60	38	7	2

Source: [Prachaiyo and Tsutsumi 1990]

Table 19 The Average Concentration of Nutrient Elements for Each Organ of Tree in DEF, Nam Phon Dam, Chaiphum, Northeast Thailand

Tree Organ	Nutrient Content (%)				
	N	P	K	Ca	Mg
Leaf	1.83	0.13	0.91	2.12	0.93
Branch	0.64	0.08	0.34	1.26	0.33
Stem	0.34	0.05	0.16	0.79	0.11

Source: [Prachaiyo and Tsutsumi 1989]

William [1965] classified the MDF at Nam Phong Basin, Khon Kaen as a dry mixed deciduous forest where annual rainfall is about 1, 270 mm/year with all the trees shedding leaves and stagnant growth during long dry period of six months each year. Ground cover and shrubs that were found to be common in the rainy season include: *Zoysia matrella*, *Brachiaria mutica*, *Zingiber* spp., *Dioscorea* spp., *Selaginella* spp., *Jusminum bifarium*, *Jusminum harmandianum*, *Ophiapogon malayanum*, *Ephatorium odoratum* and *Imperata indica*. All of them completely dried in summer. One more important species is *Corypha lecomtei*, which is uniquely scattered in this basin.

Sahunalu *et al.* [1979] reported their findings that trees in this forest form three strata according to their height. The first layer of trees higher than 23.5 meters composed of seven tree species with total basal area of 0.2515%. The dominant tree is *Lagerstroemia calyculata* growing among many big and valuable trees such as *Dalbergia nigrescens*, *Lagerstroemia duperreana*, *Pterocarpus macrocarpus*, *Terminalia tripteroides*, and *Dalbergia cochinchinensis*. The second layer consists of trees with height of 16-23.5 meter. These trees are mostly suppressed by the trees in the first layer. Seven tree species are found and *Lagerstroemia duperreana* is the only

dominant tree, accounting for 59% of the basal area of the layer. The common trees in this layer are *Dalbergia nigrescens*, *Pterocarpus macrocarpus*, *Bauhinia variegata*, *Cassia garrettina* and so on. The third layer consists of the trees with height of less than 16 meter. Nine species of trees are present and all are suppressed by the bigger trees in the upper layers. The common tree is *Dalbergia nigrescens* which collaborated growing along with *Lagerstroemia calyculata*, *Heterophragma adenophyllum*, *Colona flagrocarpa*, *Canarium kerrii* and *Grewia elastostemoides*. Only one bamboo, *Dendrocalamus strictus*, is found.

3) Dry Dipterocarp Forest (DDF)

A deciduous broad leaf forest type which occurs on the relatively dry site and is mainly composed of trees belonging to the family of Dipterocarpaceae. Except in the south, it is widely found in most parts of the country, where the annual rainfall is 1,000 to 1,300 mm/year with the 5-6 month dry period. Soil is shallow and less fertile, unsuitable for any kind of agriculture. It is, however, the reason why the farmers do not invade this forest.

The life forms of plants in this forest are rather unique. Prachaiyo *et al.* [1995] reported the results of their finding in DDF at Phu Phra forest of Kalasin that the mature trees having girth at breast height (GBH) of more than 100 cm consist of many valuable tree species, big in size and reaching the climax stage, such as *Dipterocarpus tuberculatus*, *Dipterocarpus obtusifolius*, *Shorea obtusa*, *Shorea siamensis*, *Xylia xylocarpa* and *Irvingia malayana* among the others. The trees are good for house construction of the farmers. The pole trees with GBH of 30-100 cm are the climax stage, such as *Cartoxylon formosum*, *Careya arborea*, *Vitex pinnata*, *Vitex glabrata*, *Dillenia obovata*. But most of them are the trees of younger stage. Saplings with GBH of smaller than 30 cm, consist of woody climbers and the young generation of the upper life forms such as *Terminalia bellerica*, *Canarium kerrii*, *Terminalia mucronata*, *Sindora siamensis* and so on. These saplings keep growing, but do so slowly since they are obstructed by forest fire in summer, poor soil, and long drought periods. The last form is seedlings and ground cover, which mostly are herbs and seedlings of many tree species. The trees in this life form are good for both food and medicine of the farmers, such as *Spondias pinnata* (f), *Milentha suavis* (f), *Micromelum minutum* (m), *Morinda coreia* (m), *Elaphantopus scaber* (m), *Artocarpus lakoocha* (m), *Salacia chinensis* (f) (f stands for food and m for medicine).

Sukwong [1974] subdivided DDF into four categories: (1) *Shorea-Pentacme* Forest, the most dry DDF spreading over the slopes where outcrops of sandstone, granite, gneise and basalt are common. Soil is mainly conglomerate and laterite. *Shorea obtusa* and *Pentacme suavis* (*Shorea siamensis*) are dominant. The forest floor is covered with *Imperata* grass and *Cycas siamensis* is common scattered. The obvious characteristic of this arid area is the presence of many thorny plants such as *Zizyphus* spp. and *Cratoxylum* spp. (2) *Dipterocarpus tuberculatus*-*Dipterocarpus obtusifolius* Forest, usually grown on the lower flat land with altitude less than 700 meter and on the moist area of the first category. Tree species and density are found to be higher but *Dipterocarpus tuberculatus* and *Dipterocarpus obtusifolius* are dominant. *Dipterocarpus tuberculatus* particularly grows on the lower flatland with sandy soil. The soil is deep and rock

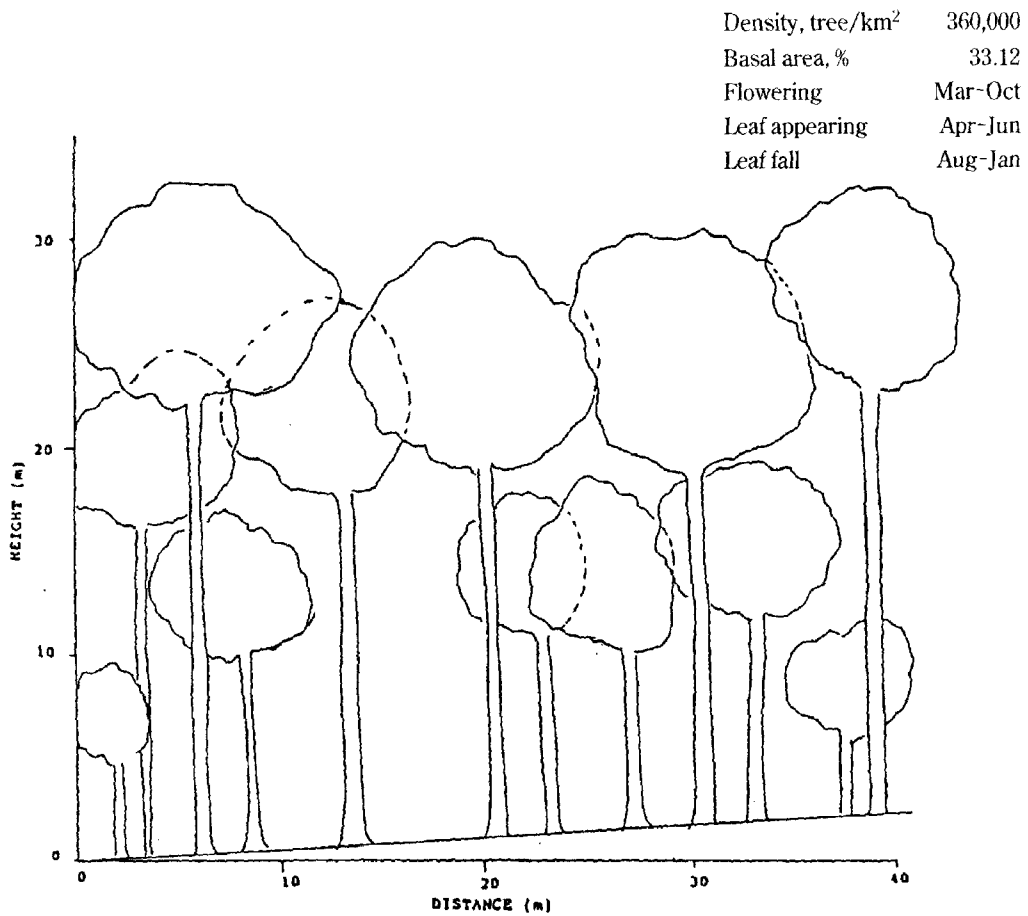


Fig. 7 Profile Diagram of MDF at Nam Phon Dam, Chaiyaphum, Northeast Thailand
Source: [Sahunalu *et al.* 1979]

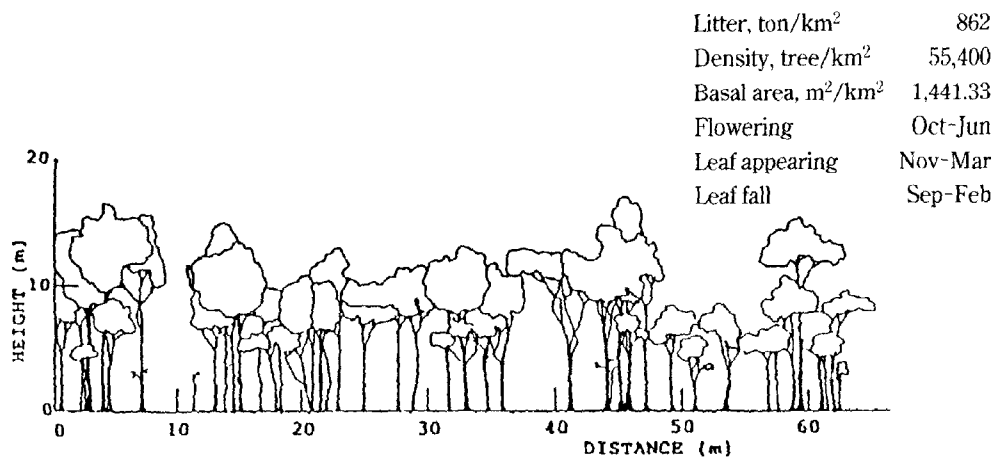


Fig. 8 Profile Diagram of DDF at Sakaerat, Nakhon Ratchasima, Northeast Thailand
Source: [Sahunalu and Dhanmanonda 1995]

outcrops are rare. Some sites have the pure stands of this tree. The proportion between these two species changes with the increase of altitude, with *Dipterocarpus obtusifolius* preferring higher ground. *Phoenix paludosa* is found in some forests. (3) Mixed Dry *Dipterocarp* Forest, appearing with intermingling of *Dipterocarpus tuberculatus*, *Dipterocarpus obtusifolius*, *Shorea obtusa* and *Shorea siamensis*. No dominance is found among these trees. Some deciduous tree species are found among them. Soil is normally sandy clay loam with high moisture content. This forest is frequently found on the eastern slope of valleys. (4) Pine-*Dipterocarp* Forest, uniquely flourishing at higher altitude of 750 meter up to 1,100 meter. *Pinus merkusii* grows among the DDF tree species. But at lower latitude at Ubon Ratchathani and Sri Saket, this forest is growing on the flat land at about 200 meter only.

Wacharakitti *et al.* [1979] reported their final compilation in Nam Phong Basin that DDF on this area is found to be in two distinct types. One is composed of medium and tall trees commonly found along the lower part of Phu Kradueng, Phu Khiao and Phu Wiang mountain at the lower altitude than that of MDF. The dominant trees are *Dipterocarpus tuberculatus*, *Dipterocarpus obtusifolius*, *Shorea obtusa* and *Shorea siamensis*. But *Shorea siamensis* is dominant on the rocky area. Three layers are common. The first layer consists of trees with the height more than 20 meter, which are mainly species of *Dipterocarpaceae* and intermingled with many broad leaf deciduous tree species such as *Irvingia malayana*, *Shorea siamensis*, *Shorea roxburghii*, *Garuga pinnata*, *Pterocarpus macrocarpus* and *Cassia fistula*. The second layer is the layer of trees with height range of 12-20 meter, and consists of many smaller trees such as *Phyllanthus emblica*, *Morinda coreia*, *Meranorrhoea usitata*, *Lagerstroemia macrocarpa*, *Shorea roxburghii*, *Careya arborea*, *Randia tomentosa*, *Terminalia chebula*, *Terminalia tomentosa*, *Xylia xylocarpa* and *Quercus kerrii*. The third layer consists of saplings and seedlings of trees in the upper layers but many shrubs, grasses, herbs and climbers are common such as *Antidesma diandrum*, *Aporosa villosa*, *Bauhinia purpurea*, *Bauhinia variegata* and *Flacaurtia indica*.

The other is dwarf tree type and mainly found along Nam Phong Dam area on the flatland where annual rainfall is quite low. Tree species are the same but smaller in size. Stratification is limited to only two layers. The first layer is 15 meter in height and the second is below. *Shorea obtusa* and *Shorea siamensis* are common.

4) Pine Forest (PF)

A minor forest type in the region is found only on Phu Kradueng mountain at the altitude of about 1,200 meter. *Pinus merkusii* forms a pure stand, while *Pinus khasya* grows naturally among many *Quercus* spp. *Pinus merkusii* is uniquely found at Haui Tha forest in Sri Saket and Pha Taem cliff in Ubon Ratchathani at the lower altitude.

2.3.3 Existing Forest in the Region

Table 17 shows the last forest area in the region in 1982. Fig. 5 illustrates the former distribution of the forest in the region. From the previous paragraphs we realize that DEF and PF are the forests that are scattered in the mountain area, while DDF and MDF are mostly distributed on the

lower flat land.

DEF is mostly found on the mountain ridges at higher altitude, such as Mount Phu Khio, Chaiphum, Mount Phu Wiang in Khon Kaen, Mount Phu Phan in Udon Thani and Nong Khai, Mount Dong Bang in Nakhon Phanom. These mountains are the only existing DEF in the region. These forests are very strictly managed as national parks and wildlife sanctuaries. This is the best way to protect the forests.

MDF is found only in small patches covering part of Petchabun Ridge in Chaiphum, Phanom Dong Rak Ridge in Surin, Mount Phu Phan in Udon Thani and Mount Phu Sing in Nong Khai. Formerly, this forest spread over other parts of the region, but unfortunately, a huge area of the forest was converted to residential areas and paddy fields, as in the case of Dong Mun forest in Kalasin. In the early 1960s this was a typical dense MDF and a good habitat of many wild animals.

DDF, the biggest portion of forest in the region, is found covering a vast area from the lowest slopes to the top ridges of many mountains. It is concentrated on the upper part of the region at Phukoa in Udon Thani, Phu Phan in Sakon Nakhon, Mount Khok Luang in Khon Kaen, Mount Khao Khiao in Nakhon Ratchasima, Mount Pha Taem in Ubon Ratchathani, and Khao Phra Wihan in Sri Saket. Some forests are under the plan for national parks and wildlife establishment. At the borders of all paddy fields there are still some patches of forest and all of them are DDF.

Pine forest is a small forest covering the tableland of Mount Phu Kradueng in Loei in the Fig. 5. Two other small patches of this forest are found at lower altitude at Ubon Ratchathani and Sri Saket. The quantitative data about these forests show the richness of tree species in DEF, the highest among the other 72 species/hectare as well as its density at 1,612 tree/hectare, while the lowest is of DDF with 32 species.

2.3.4 *Phenophase*

Phenophase refers to the alteration of the reproductive organs of trees in the forest. The step of each transformation is seen as the color change in each season. DDF trees, for example, change the leaf color from dark green of rainy season to various colors such as indigo of *Careya arborea*, yellow of *Spondias pinnata* and *Shorea obtusa*, red of *Shorea siamensis*, yellowish brown of the big heart shape leaf of *Dipterocarpus tuberculatus* and *Dipterocarpus obtusifolius*. These leaf colors convey a very sentimental feeling to anyone who prefers the seasonal change of forest. This phenomenon occurs after the end of rainy season. The color makes the forest more lively than other seasons in the same way as the autumn in temperate zone. But the autumn is not clear in Thailand. The coming of dry season or winter stimulate many trees to shed their leaves. This is the falling phenophase of trees in this forest until the last leaf fall, which may happen at the empty canopies of all trees.

The forest at this time of the year, the leafless period, seems to be very silent, dry and hot without any living things. The accumulation of dry leaves on the forest floor poses a dangerous risk of summer fire in most parts of this forest. Fire occurrence each year is very simple. Only a cigarette may cause the huge fire. All litter fall as well as many ground covers are burnt by fire

and leaves the forest floor with the dark gray ashes. This seems to be the worst season of each year. But suddenly the first shower comes, new leaves spring out on the ground and branches of trees. The forest recovers in a very short time after rain. Flowers of many colors from different trees start as soon as the springing of new leaves. The yellow flower of *Shorea* spp. is common in the forest and has a mild, pleasant smell. Fruiting follows within a couple of weeks. This is the one cycle of phenophase of trees in DDF.

The appearance of birds is one of the phenomena of the forest. Many forests are too dry and hot in summer. There is no shelter for animals. There are very few birds or insects in this season. But after the springing of new leaves around March, insects become abundant. Many of them are good for bird feeding. Birds start to move to the forest for food. Some insects, especially cicadas (*Magicidadas* spp.), are typical delicious for farmers' cooking, too.

The phenophase is the time of each tree bearing some reproductive activities such as leaf appearing, flowering, fruiting, and leaf falling. The period of these activities can be discovered only by recording or observation. In Thailand, only some dominant and commercial tree species are recorded of their phenophase. Table 20 summaries the phenophase of 10 tree species in each DEF, MDF and DDF forests. Fig. 9 illustrates the phenological seasonal characteristics of dominant trees in DEF, MDF, and DDF respectively.

From Table 20 we can see that the flowering season of trees in all forests is concentrated in the beginning of summer and succeeded by fruiting in a very short time, less than two months. Leaf appearance and fall are not remarkable in any definite time especially the evergreen trees where new leaf emerges throughout the year. Table 21 shows the intensive phenophase of some dominant trees in DEF, MDF and DDF respectively following Fig. 9 to show the trends of tree phenophase in different forest types.

2.4 Land Utilization

Thai people own a piece of land for living. Most of them have another piece of land for rice cultivation. Lands for living and rice cultivation seem to be basic necessities of their lives. Depending on the capability, some farmers have other lands for more purposes. Field crop planting is normal for many families. But recreative land, fruit plantation and large scale forestation are limited to a few wealthy people. Land use pattern is regionally different in the country. In the North, with mountainous area and cool temperature, the farmers enjoy various vegetable planting. In the South, ore mining and fruit plantation are common. The central plain is concentrated with a lot of rice cultivation. In the Northeast, where soil is dry and poor, rice is planted with many cash crops, e.g., cassava, kenaf and sugarcane. The central plain area has the highest GDP, followed by the South, and the North, and the Northeast has the lowest.

2.4.1 Land Category

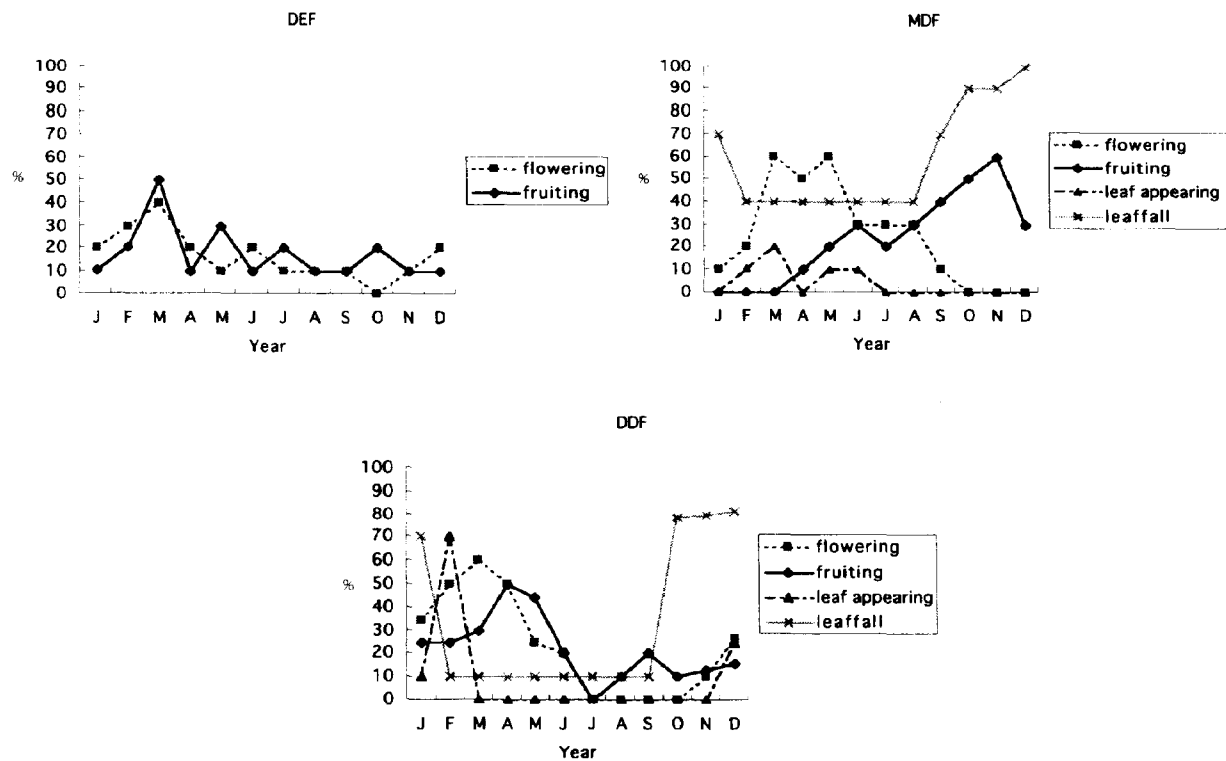
Chuntanaparb and Wood [1986] mentioned that the basis of all land laws in Thailand is that all lands belong to the crown or state. The land certificate given to each land holder defines the lands in different categories.

Table 20 Periodical Phenophase of Trees in Sakaerat Forests, Nakhon Ratchasima in Northeast Thailand

(%)

Forest Type	Phenophase	Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
DEF	Leaf appearance	—	—	—	—	—	—	—	—	—	—	—	—
	Flowering	20	30	50	10	30	10	20	10	10	20	10	20
	Fruiting	20	30	40	20	10	20	10	10	10	—	10	0
	Leaf fall	—	—	—	—	—	—	—	—	—	—	—	—
MDF	Leaf appearance	—	20	20	—	10	10	—	—	—	—	—	—
	Flowering	10	20	60	50	60	30	30	30	10	—	—	—
	Fruiting	—	—	—	10	20	30	20	30	40	50	60	30
	Leaf fall	70	40	40	40	40	40	40	40	70	90	90	100
DDF	Leaf appearance	10	80	—	—	—	—	—	—	—	—	—	30
	Flowering	40	60	70	60	30	20	—	—	—	—	10	30
	Fruiting	30	30	40	60	50	20	—	10	20	10	10	20
	Leaf fall	80	10	10	10	10	10	10	10	10	90	100	100

Source: [Thailand, RFD 1990b]

**Fig. 9** Seasonal Phenophase of Trees in Different Forest Types in Sakaerat Forest, Nakhon Ratchasima, Northeast Thailand

Source: [Thailand, RFD 1990b]

Table 21 Phenophase of Some Dominant Tree Species in Sakaerat Forests, Nakhon Ratchasima in Northeast Thailand

Number	Species	Phenophase			
		Leaf App.	Flowering	Fruiting	Leaf Fall
DEF					
1	<i>Hopea odorata</i>	—	Jan-Mar	Feb-Apr	—
2	<i>Afzelia xylocarpa</i>	—	Feb-Mar	Jan-Aug	—
3	<i>Alstonia scholaris</i>	—	Oct-Dec	Jan	—
4	<i>Tetrameles nudriflora</i>	—	Dec-Jan	Feb-Mar	—
5	<i>Dipterocarpus alatus</i>	—	Mar-May	Apr-Jun	—
6	<i>Lagerstroemia calyculata</i>	—	Jun-Sep	Mar	—
7	<i>Dalbergia cochinchinensis</i>	—	May-Jun	Sep	—
8	<i>Dalbergia oliveri</i>	—	Mar-May	Jun	—
9	<i>Hopea ferrea</i>	—	Jan-Mar	Mar	—
10	<i>Dialium cochinchinense</i>	—	Sep-Oct	Nov-Feb	—
MDF					
1	<i>Terminalia alata</i>	—	Mar-Jun	Sep-Nov	All year
2	<i>Terminalia bellerica</i>	—	Mar-May	Sep-Nov	All year
3	<i>Xylia xylocarpa</i>	Feb	Feb-Mar	Oct-Dec	Sep-Dec
4	<i>Pterocarpus macrocarpus</i>	Feb	Mar-May	Jun-Oct	Oct-Jan
5	<i>Adina cordifolia</i>	May	May-Sep	Aug-Dec	Oct-Jan
6	<i>Millettia leucantha</i>	—	Mar-May	Jun-Aug	All year
7	<i>Albizia lebbeck</i>	Mar	Mar-Apr	May-Jun	Sep-Dec
8	<i>Albizia procera</i>	Mar	Mar-Aug	Oct-Dec	Sep-Dec
9	<i>Peltophorum desyrachis</i>	—	Jun-Mar	Apr-May	All year
10	<i>Careya arborea</i>	Jun	Jul-Aug	Sep-Oct	Dec-Jan
DDF					
1	<i>Dipterocarpus tuberculatus</i>	Dec	Dec-Apr	Jan-May	Oct-Jan
2	<i>Dipterocarpus obtusifolius</i>	Dec	Nov-Jan	Dec-Jan	Oct-Jan
3	<i>Shorea obtusa</i>	Feb	Mar-May	Apr-Jun	Oct-Jan
4	<i>Shorea siamensis</i>	Feb	Jan-Mar	Feb-Apr	Nov-Jan
5	<i>Shorea roxburghii</i>	Feb	Jan-Mar	Mar-Apr	Oct-Dec
6	<i>Canarium kerrii</i>	Feb	Dec-Apr	Jan-May	Oct-Jan
7	<i>Dillenia obovata</i>	Feb	Apr-Jun	Aug-Sep	Oct-Jan
8	<i>Cassia fistula</i>	Feb	Feb-Apr	May-Jun	Oct-Jan
9	<i>Phyllanthus emblica</i>	All year	Feb-Mar	Apr-May	All year
10	<i>Terminalia chebula</i>	Feb	Apr-Jun	Sep-Dec	Oct-Dec

Source: [Thailand, RFD 1990b]

1) Private Land

Most of this land is owned by the farmers in accordance with Land Title Deed and Land Certificate of Development. But there are many pieces of land which are owned by the people without official permission. These are mostly forest lands occupied by farmers. Private land is the main part of land used for house building, paddy fields, field crop, fruit and vegetable orchards. This land is located in the community since a very long time ago with fixed boundary,

and recorded in the registration book of each Land Office. The land is privately owned but still under the government control, and it may be taken over with compensation for certain uses, e.g., road construction. The right of land ownership is transferred by inheritance or sale.

2) *Communal Land*

This land is for communal use in each village or a group of villages. This land consists of public playing grounds, animal feeding grounds, community forests and public reservoirs. The utilization of this land depends on the villagers' needs. The community forest, for example, may be used for collecting fuel wood, non-wood forest products and timber for house construction. The decision for any use comes after the discussion of the committee members. The committee of this communal land is officially designated by the government. This committee takes responsibility for management and utilization of the products from this land.

3) *Governmental Land*

Governmental lands are under the administration of the Ministry of Interior, the Ministry of Agriculture and Cooperation, the Ministry of Finance, the Ministry of Communication and the Ministry of Education, and include forests, dams, roads and lands where government offices are stationed.

2.4.2 *Land Use Pattern*

Table 22 shows the various types of land use and area in the Northeast. The total area of the region is 168,854 km², and paddy fields occupy 60,756 km² on the flood plain, river terrace and upper slopes. The forest area in the region is only 21,799 km² or 12.91% of the total area, the lowest rate in the country and far from the 40% as stipulated by the national forestry plan. This forest mostly covers the mountainous areas of the region where many national parks and wildlife sanctuaries are located. The third biggest segment of land amounts to 21,528 km² as the lands for planting cash crops, of which cassava is the main component. Fruit, vegetable and livestock occupy rather small land, 2,950, 334, and 632 km² respectively. The other land 834 km², is reservoirs, dams, rivers, roads, railways and airports. Lastly, the unclassified land is the land claimed for living and planting without any official ownership. By law, this is still forest land, because the Forest Act (1931) stressed that "land without any official certificate is forest."

2.4.3 *Forest Land Use*

The forest land use was planned in three categories: conservation, economic, and agricultural. The activities scheduled for these lands are different from each other. The borderline is made to identify the type of each forest category.

1) *Conservation Forest (C)*

This is a forest where many efforts are made to preserve the forest for as long as possible. This forest covers all national parks, wildlife sanctuaries, non-hunting areas, and natural study center. All of them are within the National Reserved Forest (NRF). The protection scheme in these

Table 22 Land Use by Province in Northeast Thailand (1991)

Province	(km ²)										
	Total	Forest	Housing	Paddy	Field Crop	Fruit Tree	Vegetable	Live-stock	Idle	Other	Unclassified
Buriram	10,322	536	131	5,102	843	195	8	7	99	59	3,342
Chaiyaphum	12,778	3,135	111	2,537	2,259	222	37	28	174	50	4,225
Kalasin	6,947	599	109	2,522	1,117	90	10	10	60	15	2,415
Khon Kaen	10,886	844	144	4,471	1,730	232	37	57	95	99	3,178
Loei	11,425	2,936	85	943	2,127	232	20	25	161	44	4,854
Maha Sarakham	5,292	38	109	3,217	671	81	15	84	88	35	954
Mukdahan	4,340	1,353	45	652	378	97	6	14	40	8	1,747
Nakhon Phanom	5,513	595	48	1,850	308	111	10	20	59	46	2,467
Nakhon Ratchasima	20,494	2,340	175	6,196	5,501	539	71	38	148	39	5,446
Nong Khai	7,332	492	96	2,279	1,072	120	12	36	266	67	2,892
Roi-et	8,299	195	157	4,552	436	89	7	84	140	46	2,595
Sakon Nakhon	9,606	1,437	102	3,308	427	118	27	39	404	80	3,663
Sri Saket	8,840	747	108	4,124	788	178	40	10	71	19	2,756
Surin	8,124	300	131	4,794	330	98	5	4	52	25	2,387
Ubon Ratchathani	18,906	3,668	211	6,878	856	205	14	85	915	125	5,950
Udon Thani	15,589	2,196	181	5,307	2,195	225	12	60	406	56	4,951
Yasothon	4,162	390	63	2,025	491	119	5	31	131	20	886
Total	168,854	21,799	2,005	60,756	21,528	2,950	334	632	3,310	834	54,706
%	100	12.91	1.19	35.98	12.59	1.75	0.20	0.37	1.96	0.49	32.40

Source: [Thailand, RFD 1992]

forests is intensively done by the foresters to prevent encroachment by people. The aim of this protection is to keep the forest as a recreational place, watershed and shelter for wild animals. The area of these forests in the region totals 19,381 km² or only 35.16% of the forest area in the region.

2) *Economic Forest (E)*

This is forestland in NRF after heavy encroachment, where the land is not suitable for agriculture because of the steep topography. Many farmers left the land for a long time so that the land is covered with weeds. Now this becomes a proper site for making commercial plantation. The government paves the way with the regulation of Forest Plantation Act 1992. Along with this act, any farmers can propose a plantation project in this forest with their investment. All the products from the plantation, including *yang* (*Dipterocarpus alatus*) and *sak* (*Tectona grandis*), which were formerly claimed as government property, belong to the planters.

3) *Agricultural Forest (A)*

This is forest land which, after heavy encroachment, is still suitable for agricultural crop planting. The land is located in a flat valley bottom or on high marsh. To plant agricultural crops, the farmers have to get planting permission from the government. The permission is temporary and non transferrable. Table 23 shows a detail of each forest category in the Northeast.

Table 23 The Forest Land of Each Category in the Northeast (1992)

Province	Conservation Forest		Economic Forest		Agricultural Forest	
	km ²	%	km ²	%	km ²	%
Buriram	618.22	24.11	1,911.25	74.53	35.08	1.37
Chaiyaphum	1,634.01	48.89	1,663.21	49.77	44.72	1.34
Kalasin	777.83	49.06	730.60	46.09	76.88	4.85
Khon Kaen	799.13	28.55	1,465.09	52.35	534.68	19.10
Loei	4,485.54	65.66	2,266.37	33.19	78.76	1.15
Maha Sarakham	–	–	299.21	91.52	27.72	8.48
Mukdahan	1,698.82	65.78	883.63	34.22	–	–
Nakhon Phanom	188.92	26.51	523.63	73.49	–	–
Nakhon Ratchasima	2,259.62	28.96	5,398.00	69.18	145.62	1.87
Nong Khai	442.68	13.12	2,879.91	85.35	51.84	1.54
Roi-et	108.55	13.80	531.43	67.56	146.68	18.65
Sakon Nakhon	798.12	26.85	1,774.23	59.69	400.20	13.46
Sri Saket	649.68	32.86	1,312.17	66.36	15.40	0.78
Surin	262.13	15.01	1,347.30	77.13	137.39	7.56
Ubon Ratchathani	2,923.74	41.29	3,719.17	52.54	437.01	6.17
Udon Thani	1,537.56	20.70	5,061.71	68.15	827.56	11.14
Yasothorn	198.44	16.40	993.05	82.07	18.44	1.52
Total	19,380.98	35.16	32,760.55	59.14	2,917.97	5.40

Source: [Thailand, RFD 1992]

2.5 Paddy Fields

The farmers in the Northeast are always happy if there is enough rice stored in their barns. Only rice paddy makes them happy. They pay a lot of attention to paddy storage. The more paddy stored in the barn, the more happy they are. With this satisfaction, they can afford any participation to the community especially the merit making in Buddhist religion. Paddy is not only food for daily consumption but also their property or treasure which can be converted to another need. Fresh fish, for example, is normally bartered with paddy in a proper rational negotiation among them. Cash is also always easy to obtain by selling paddy. If they have rice, the people do not worry too much about another food. They usually carry lunch box with only rice and salted fish (*pla ra*), or only salt and chili while traveling to the field or into the forest for working. A lot of vegetables in the forest or paddy field are available. Fish, particularly in the rainy season, are easy to catch from any natural reservoirs. Birds and many reptiles are common in paddy fields in all seasons. These animals and vegetables are the farmer's daily food during outside works. Rice is the only thing they have to prepare from the home kitchen.

On the contrary, the shortage of paddy will become a big trouble and discourage the people from enjoying their living. They fall so sad and look like a hopeless people. They travel day and night to obtain some paddy for their families. Some look for any temporary jobs to buy rice for their children. Some carry goods for bartering with paddy. Many people even become beggars to ask for small money from the passers by. These people do not have enough time to spend on the

communities' activities.

Rice is comparable to the farmers' life. They believe that one family should have at least a piece of paddy land to produce rice. This paddy field is customarily shared among the children when the parent is old or passes away. The tiny piece of land they obtain by heritage is not enough to produce rice. So, travel in search of new paddy fields is popular among the people in this century.

2.5.1 *Stage of Paddy Field Development*

During the beginning of the seventeenth century, most of the area of Northeast Thailand was covered with dense forests. Paddy fields were very few and only spread over a small area of flat land in the lower plain. Gradually, with the increase of the population, the paddy fields expanded into the forests. The vast area of paddy fields appeared all over the region. The steps of the transformation from the forest to rice fields are as follows.

1) *Searching Stage*

The farmers start to search for the new paddy land when the yield from old paddy fields can not support the need. They go to the nearby forests and look for the suitable land for paddy fields. The land must be flat or slightly undulating one and located close to the river or main reservoir. Flat land is good for paddy fields because fewer dikes are needed. The nearby river or reservoir is effective not only for supplying water for rice cultivation but also benefits with fishing, bathing, animal feeding and off-season vegetable planting. After finding a site, a notch is made on the trees as a mark of reservation. This notch is done by knife or ax in the shape of "X." Some notches are marked by ". . ." and followed with the rough distance from each corner. The farmer's name is normally hidden because the opening is illegal in the national forest. The farmers know who made the mark, and they never interfere with each other. The search is always done prior to other processes. Sometimes, they reserve land for many years before they start the next process.

2) *Site Clearing Stage*

There are two cases of site clearing, one in a post-logging area and the other in a non-logging area. In the former case, the farmers travel along the logging roads, which allow easy access to the suitable site. The land is already cleared by logging operation. Logging residues like leaves, branches, twigs and broken stems are collected and put on a fire. In the latter case, the farmers cut all trees small enough to be cut by knife. The big trees remain standing on the site. After cutting, the fallen trees are left on the forest floor for a couple of months. The good stems are separated for farm hut (*tiang na*) building, and some for fence making around the new site, and finally the big branches are removed for firewood. The farmers start to burn these trees before rain comes.

3) *Dike Making Stage*

The farmer starts to make dike immediately after the first big shower comes. The shower softens

the soil. The farmer stands firmly on the initial point of the dike. He decides the direction of the dike. Soil of every digging is pitched along the dike line. The first layer of dike is easy to make. Then other pitches of soils are put on the dike up to a suitable height. The soil on each layer is pressed down by treading on and hardened. The width and height of the dike depends very much on his experience. Some part of dike is finished on the first day and he continues dike-making until the cleared site is completely enclosed.

4) *Paddy Floor Preparing Stage*

On the paddy floor, there are still many stumps. The farmers have to remove them before plowing. The small stumps are easily dug out by hoe. But the big ones are hard to dig, so that they build a fire on them. The fire is kept burning for a couple of days until the main part of stump and big root are absolutely burnt. The remaining trees, which are normally large in size and good in quality, will have the buttress roots cut off, and the canopy thinned so as to transmit light to rice underneath. This landscape with standing trees in the rice fields is very specific to the Northeast. Details of the standing trees are given in 4.4.4(Chapter 4).

2.5.2 *Evaluation of Paddy Fields Depending on Remaining Trees*

There are typical relations among the topography of each paddy fields, the soil condition, and the tree species remaining in the rice fields. We believe that most of the paddy fields have been transformed from natural forests and each tree species growing on the site reflects the original forest type before the opening. We accept that tree species are specific to the site or forest type. The forest type is, therefore, assumed from the remaining trees. Because most indigenous species are completely destroyed in the site clearing stage, the remaining trees on the paddy fields will give a clue about the forest type in the former days.

1) The paddy fields on alluvial plain or flat land along the riverbanks have the trees of the tropical rain forest. This forest flourishes over the moist areas especially the river basins. The tree community consists only of the evergreen trees. One of the most popular remnants of this forest is *Dipterocarpus* spp., with big round canopy, great trunk and long clear bole. The soil under this forest is always moist and deep. The paddy fields on this site are assumed to be the oldest of all.

2) The paddy fields on the middle slope show the second stage of paddy field expansion, which followed the first stage. This site is located on the higher land. The soil is still deep but less moist and less fertile than the first one. The forest type is evergreen and deciduous, or so-called MDF. The existing tree species consist of evergreens such as *pradu* (*Pterocarpus macrocarpus*), *mapork* (*Parinarium anamense*) and deciduous species. The paddy fields in this category are younger than the first one. The age is estimated around 50-100 years old.

3) The paddy fields in the high slope seem to be the youngest of all. They show the last process of paddy fields opening. The farmers turn to dry dipterocarp forest, which had been ignored in

the former days. Most of them started from around the 1960 when the demand for rice fields was great. These paddy fields are the poorest of all because of the infertile soil and heavy erosion due to the intensified surface runoff. The site is always susceptible to the draught. The common tree species is *hiang* (*Dipterocarpus obtusifolius*) and some *Shorea* species.

2.5.3 Paddy Field Compound

The typical characteristic of the paddy fields in the northeast Thailand is in the complex and multi-functional land use.

1) Planting Ground

The whole field is divided by dikes into small and proper planting units. The size of each unit is irregular depending on the topography of the field. The main purpose of division into small units is to keep the same level of the water during the cultivating season. Other alignments are small canals, the line of trees on bigger dikes and border dikes. Trees are standing on planting ground, too. Each paddy field might be categorized to be two, a sowing and a transplanting area. Some units are suitable for nursery, where the river close by assures water supply to the seedlings. An important consideration is to make level beds for sowing of rice seeds to prevent them from being washed away by heavy rain after sowing. The planting ground is the rest of the paddy fields, including the nursery where seedlings have been pulled out.

2) Farm-hut (*Tiang Na*)

Tiang na is the temporary building for the farmers to stay during the cultivating season. This season falls on the peak of rainy season with heavy rain every day. The farmers whose paddy fields are a long way from home take all of their belongings, food, clothes, children, and animals with them. They keep all of these things in the *tiang na*, especially the babies, who are protected from the sunshine and heavy rain. *Tiang na* is normally built on the higher lands such as termite mound, soil mound, and on the junction of paddy dike and surrounded by standing trees. These trees are good for both food and other purposes. The *tiang na* is good for animals too to avoid flooding lands. Many farmers spend whole of their planting season in *tiang na* as the second home.

3) Paddy Field Shrine (*Taahaek*)

A miniature shrine is built for the spirit of paddy to live. This shrine is found both on the termite mound or in the same compound with *tiang na*. The farmers believe that during their works in the field this spirit will take care of them as well as the seedlings they planted. They pray to the spirit before the first plowing and after the harvest. Seven or eight rice seedlings are transplanted in the small space in front of the shrine. This is to be the representative of the whole paddy field. Before rice harvesting, the farmers reap these plants at the shrine first. The rice yield from this hill is believed to forecast whole product from the fields.

4) *Threshing Ground*

The farmers leave the reaped sheafs on the paddy floor for about two weeks for drying. During this period the threshing ground is prepared. The ground is normally located at the center of the paddy fields or on *tiang na* compound. The center of paddy field is convenient for transporting rice sheafs. The *tiang na* compound is more safely as there is permanent fence, and will protect rice sheafs from dew at night-time.

The farmer cleans the surface of threshing ground by hoe. The approximate size of the ground is about 10 × 10 meter or 8 × 8 meter, depending on the size of paddy fields. After the ground has been cleaned, the farmer takes fresh cattle dung, mixes it with water at the proportion of around 1 : 0.5, and paves the ground with the dung. After a couple of days for drying in the sunshine, the surface of the ground becomes a hard dung pan. This paved ground will serve for rice threshing. The soil particle does not mix with the rice grain, and the softness of the pan also prevent cracking of rice grain during the threshing.

The farmer carries the rice sheafs to the ground with a bamboo rod, a 3-4 meter bamboo stem with sharpened ends easy to tip on the rice sheafs. They put 6-8 rice sheafs on each end of this rod, and carry on their shoulders to the threshing ground.

The farmer piles up the rice sheafs after most of the sheafs were transported to the ground. After the rice sheafs dry, all family members and neighbors come together and they start the threshing.

5) *Straw Keeping Areas*

Straw is used not only as cattle feed but also as material for *tiang na*'s roof, and mulching material for vegetables. The farmer has three different ways for keeping the straw: putting it on the canopies of trees standing on the fields or *tiang na*; putting it on the *tiang na*; and piling it up on some particular spot, a higher place, to save from flood in rainy season and summer fire. To make a straw pile, the farmer pitches a bamboo pole or other hardwood on the site as the core of the piling. The straw is piled up layer by layer around the core up to 2-3 meter high. A couple of piles are common on the bigger paddy fields.

6) *Marginal Forest*

During the site clearing stage, the farmer keeps some patch of forest in its primary condition. This forest patch is located on the higher part of the paddy fields and now becomes the good forest close to the field. The forest provides many products like firewood, mushroom culture, vegetable and small timber for temporary constructions. The forest distributes some nutrients to the paddy fields through the litter fall. Most of this forest is in the area of the old paddy fields, but rather less in the recently opened ones because of the lack of the land and natural forest.

2.5.4 *Paddy Field as a Source of Food*

The main product of paddy field is rice. Furthermore, the paddy field is important place that assures anchorage basis for the farmers to stay in the circumstance. Paddy field provides them

with several kinds of fish, animals, vegetables and so on. With this support, farmers have maintained their main living style up to now.

1) *Vegetables*

The farmers obtain two kinds of vegetables from their paddy fields, the natural and the planted ones. The former refers to various kinds of edible herbs and grasses, which naturally flourish on the paddy floor. The abundance of these vegetables is most beneficial in the rainy season when the farmers are busy with farming jobs and have less time to look for other vegetables. These vegetables are not only good for the farmers but also for their poultry, cattle and pigs, which they raise at home for protein food. The common natural vegetable consists of *kayaengna* (*Limophila aromatica*), *tumlung* (*Coccinia grandis*), *phakbung* (*Impomoea reptans*), *phakvaen* (*Masilia polycarpa*), *phakkanjong* (*Monochria hastata*) and so on.

After the rice harvest, vegetables are planted to meet the family need for vegetable consumption. The vegetable is also kept for all year round consumption up to the next annual planting. These vegetables include chili, garlic, onion, cucumber, egg-plant, cabbage, leafy vegetable, tobacco, beans and so on.

2) *Animals*

The animals in the paddy fields are fish, insect, and others. Fish is the favorite product among the farmers. The coming of the rainy season means the beginning of the good season for obtaining fish in the shallow rivers, canals, and water tanks. The fish start growing after the coming of rain. Immediately after the first shower, most of the fish are in the juvenile stage, and gradually grow up later on. At the end of the rainy season, many water bodies are crowded with mature fish. Many farmers can earn a lot of money from these fish. The common fish found in the fields are *tapien* (*Rasbora* spp.), *chon* (*Ophicephalus striatus*), *mo* (*Anabus testudeneus*), *siew* (*Rasbora* spp.), *lod* (*Macrogynatus aculeatus*), *duk* (*Clarias macrocephalus*), and so on. Besides the natural fish, the farmers raise many varieties of fish in ponds close to their *tiang na*. The favorite fish is *nin* (*Tilapia nilotica*).

Insects are common in the paddy fields in the rainy season, including water insects such as *maengdana* (*Lethocerus indicus*), *maengkachon* (*Gryllotalpa africana*), *jingreed* (*Gryllus bimaculatus*) and summer insect, *kudji* (*Onitis* spp.), *maengginun* (*Lepidiota bimaculata*) and *moddaeng* egg (*Oecophylla smaragdina*).

All of these insects, combined with other foods are a “must” for the farmers, combined with another food at each meal. Other animals like frogs, small toads, crabs and prawns are common. Even snake is eaten by some ethnic groups. Rats and birds are one of the protein foods of the farmers.

3) *Food from Paddy Trees*

Many trees standing on the paddy fields produce some specific fruit, leaf, flower or shoot of use to the farmers. They consume these products as vegetable or medicine. The fruit of *samoethai*

(*Terminalia chebula*) is good for medicine, while the fruit of *makham* (*Tamarindus indica*), and *makirm* (*Canarium kerrii*) are good for cooking. Fresh leaves from many trees are good for food such as *sadao* (*Azadirachta indica*), *khilek ban* (*Cassia siamea*), and *makok* (*Spondias pinnata*). The flower of *sadao* is commonly eaten after boiling to remove the bitter taste.

2.5.5 *Self-improvement of Paddy Fields*

The remaining trees on paddy fields play an important role as the supplier of organic matter and plant nutrients (details are given in 4.4.7) to the paddy soil. These trees produce some amount of litter annually. The litter contains plant nutrients. The decomposition process is the main path of nutrient return to paddy soil. These nutrients are nitrogen, phosphorus and potassium, which are necessary to rice growth. The soil physical property will be improved through the debris of litter after decomposition in the form of humus or organic matter.

Recently, timber and non-wood forest products obtained from trees in paddy fields are the top topic that has attracted many people's attention. These products have been familiar to the farmers since a long time ago. The farmers have tried to keep the balance between the agricultural use and forestry use of the land. More details about the Northeast are given in Appendix 1.

Chapter 3

Farmers' Use of Forest and Encroachment into the Forests

Many activities of people cause the alteration of forest. The disappearance of the forest is mostly caused by people. They have lived on the forest since a very long time ago, gathering wood and non-wood forest products. Since then, people and forest have been closely related. Formerly, the people's use of the forest was well balanced with its preservation. But, later on the land itself became what they most needed for living. This is the main reason for the huge loss of natural forests. The final result of forest encroachment, timber harvesting and infrastructure construction is now revealed as the decrease of forest area in the whole country, and there is only 12.91% of forest area in the Northeast region.

3.1 Wood Products

The farmers have depended a lot on the forest products. Forests provide not only wood and timber but also several kinds of non-wood forest products. The latter seem to be more essential to the people's living than the former. According to laws, some forest products are forbidden to be gathered freely without official permission. But, these laws allow farmers to collect traditionally permitted commodities in proper time and amount. These commodities meet the farmers' need, especially for food. They may be troubled if the products are exhausted. Now most of the forest has been heavily destroyed.

Forests in the Northeast have produced timber as the main forest products since the beginning of this century after the establishment of Royal Forest Department (RFD) in 1896. RFD was founded by the government to control the log harvesting of the country where firstly only teak in the North was put under the control; non-teak was taken under the control later on. Trees which could be logged must be under the examination of the foresters. The logging had been done continuously until 1989, when it was halted all over the country. The amount of logs harvested from forest in the country during 1976 to 1991 is totally 1,999,362 m³ [Thailand, RFD 1992]. In addition, the farmers logged an unrecorded amount trees for house building.

The need of farmers for timber for house construction has never decreased, because population has continued to grow. Mungkorndin [1981] stated that "the wooden house is prevalent in rural areas and still traditional for urban dwelling; even modern house have relatively high wood compound." The wooden house is the tradition of the rural people's living style even today.

The study made by Chinthaganan *et al.* [1990] revealed that many people left their old village in Dong Mun forest after selling the old house built around 1970, and then encroached into the same forest to build new houses only for sale. With the money they moved to the new sites in Nongkhai and Sakonakon province.

In Phu Wiang forest of Khon Kaen, where the forest type is mainly DEF, and in Dong Bang Li

forest of Roi-et, where the forest type is MDF, for example, trees had been logged since 1950, and the products from these forests during 1977 to 1987 amounted to 95,474 trees with the total volume of 189,486 m³ in the former, and 35,110 trees with the total volume of 106,006 m³ respectively (Table 24). In 1985, several tree species were harvested: a total of 33 tree species were cut with 9,355 stems, and 27 tree species with 3,371 stems in these two forests respectively (Table 25).

Fuel-wood consumption is large in the region. All of it is gathered from the forest. The farmers have used this fuel-wood since the old days and never change to other fuel, especially in the rural areas of the region. The official data about fuel-wood is difficult to compile but it is recognized by many people. Hoameaungkaew *et al.*[1994] tried to calculate the amount of fuel-wood that is consumed around Pha Taem forest in Ubon Ratchathani and found that each family needs 15.84 m³ of fuel-wood per year, worth about 792 baht.

Forests are the single source of wood for agricultural tools. Thai farmers use many kinds of wood to make various types of tools for rice cultivation. Plows made from hardwood were widely used in the country until the 1990s. The buffalo is the main source of energy in rice cultivation for both plowing and raking. The accessories for plowing include rope made from the fiber of some tree and a yoke made from the hardwood tree species. Table 26 lists some of the wooden agricultural tools that farmers in Ban Rua, Phu Wiang of Khon Kaen are using nowadays in rice cultivation. The data is compiled from my field observation in the village.

Table 24 Number and Volume of Trees Harvested from Phu Wiang Forest of Khon Kaen and Dong Bang Li Forest of Roi-et during 1977-87

Year	Phu Wiang Forest		Dong Bang Li Forest	
	Tree Number	Volume (m ³)	Tree Number	Volume (m ³)
1977	5,416	19,175	3,333	19,158
78	13,364	25,728	3,947	16,767
79	13,394	31,309	3,947	9,198
80	13,463	31,490	2,004	12,429
81	4,652	5,272	4,492	15,806
82	4,626	3,878	4,492	10,460
83	4,592	2,839	4,492	5,974
84	10,828	24,952	2,801	7,778
85	10,829	25,118	2,801	3,958
86	10,449	11,192	2,801	4,538
87	3,861	8,532	—	—
Total	95,474	189,486	35,110	106,006

Source: [Thailand, RFD, Khon Kaen 1990]

Table 25 Tree Species, Number of Trees, Logs and Volume Harvested from
Phu Wiang Forest Khon Kaen and Dong Bang Li Forest Roi-et in 1985

Number	Local Name	Scientific Name	Phu Wiang Forest			Dong Bang Li Forest		
			Number	Log	Volume(m ³)	Number	Log	Volume(m ³)
1	takhian hin	<i>Hopea ferrea</i>	3,287	3,357	7,763.71	—	—	—
2	wa	<i>Eugenia cumini</i>	1,354	1,381	2,777.27	—	—	—
3	tabaek yai	<i>Lagerstroemia calyculata</i>	949	1,006	2,051.20	404	441	866.70
4	phawa	<i>Garcinia speciosa</i>	814	862	1,163.14	5	5	9.73
5	sathip	<i>Phoebe paniculata</i>	734	752	920.74	—	—	—
6	yang	<i>Dipterocarpus</i> spp.	646	1,276	5,531.60	29	56	428.60
7	kabok	<i>Irvingia malayana</i>	392	420	1,277.55	155	155	500.22
8	makha tae	<i>Sindora siamensis</i>	389	414	845.27	37	37	96.67
9	tiu	<i>Cratoxylum</i> spp.	155	164	202.20	4	4	6.52
10	khleung	<i>Dialium cochinchinense</i>	118	132	284.44	129	130	344.76
11	samo phiphek	<i>Terminalia bellerica</i>	61	74	192.23	—	—	—
12	kabak	<i>Anisoptera costata</i>	59	105	649.89	70	93	549.55
13	tin pet	<i>Alstonia scholaris</i>	45	45	81.08	—	—	—
14	mok man	<i>Wrightia tomentosa</i>	47	61	189.03	—	—	—
15	ko	<i>Castanopsis</i> spp.	42	42	134.30	—	—	—
16	som phong	<i>Tetrameles nudiflora</i>	36	42	134.30	—	—	—
17	nonsi	<i>Peltophorum inerme</i>	34	37	36.29	26	27	53.47
18	ngiu	<i>Bombax kerrii</i>	36	37	112.11	—	—	—
19	tin nok	<i>Vitex pinnata</i>	17	17	13.70	—	—	—
20	yom hin	<i>Chukrasia velutina</i>	29	36	71.33	—	—	—
21	maklam ton	<i>Adenanthera pavonina</i>	21	24	72.92	—	—	—
22	takhian thong	<i>Hopea odorata</i>	41	81	482.11	1	1	4.48
23	mamuang pa	<i>Mangifera caloneura</i>	17	21	92.4	10	10	41.90
24	pu chao	<i>Terminalia nigrovenulosa</i>	4	5	10.52	13	13	19.40
25	teng dong	<i>Shorea thorelii</i>	—	—	—	1,469	1,845	6,979.76
26	teng	<i>Shorea obtusa</i>	—	—	—	2	2	2.25
27	khwao	<i>Adina cordifolia</i>	—	—	—	29	30	81.54
28	rang	<i>Shorea siamensis</i>	—	—	—	18	18	16.04
29	saton	<i>Millettia leucantha</i>	—	—	—	14	14	18.40
30	tabaek lueat	<i>Terminalia mucronata</i>	—	—	—	9	9	12.88
31	rok fa	<i>Terminalia tomentosa</i>	—	—	—	4	4	5.46
32	phayom	<i>Shorea roxburghii</i>	7	8	13.17	695	817	6,116.88
33	makha mong	<i>Azelia xylocarpa</i>	6	11	16.95	86	131	249.86
34	khamun pa	<i>Artocarpus lanceifolius</i>	2	3	17.63	4	5	23.86
35	pradu	<i>Pterocarpus macrocarpus</i>	6	11	24.17	26	29	81.50
36	takhian nu	<i>Anogeissus acuminata</i>	1	1	1.12	—	—	—
37	takhram	<i>Garuga pinnata</i>	1	1	1.12	—	—	—
38	som kop	<i>Hymenodictyon excelsum</i>	1	1	0.88	—	—	—
39	daeng	<i>Xylia xylocarpa</i>	2	2	2.64	126	126	236.61
40	phayung	<i>Dalbergia cochinchinensis</i>	2	2	1.69	—	—	—
41	khae foi	<i>Dolichandrone crispa</i>	—	—	—	4	4	7.49
42	man pla	<i>Fagraea fragrans</i>	—	—	—	2	2	11.86
43	phan sat	<i>Erythrophleum succirubrum</i>	—	—	—	1	1	4.84
Total			9,355	10,432	25,118	3,371	3,978	16,766.55

Source: [Thailand, RFD, Khon Kaen 1986]

3.2 Non-wood Forest Products

The non-wood forest products refer to the products that people obtain from forest in other forms than wood. The most common are food, medicinal plant, fodder for animals and ornamental plants. Prachaiyo [1984] commented on the management of DDF for non-wood forest products that this forest must be managed in two majors lines; for fuel-wood production for the rural people, and for range land for the rural cattle, particularly in the rainy season when most paddy fields are covered with rice. Another finding by Prachaiyo [1993] concentrated on the use of DDF by rural people whose villages lie around the Phu Phra Forest in Dong Mun, Kalasin. These people used the forest as their recreational ground, animal grazing ground, and collecting ground for mushrooms and non-wood forest product. The benefit from this use reaches 1.8 million baht per year or an average of 17 million baht per km² per year (Table 27).

Table 26 Some Agricultural Tools Made from Wood Used in Ban Rua Village, Phu Wiang, Northeast Thailand

Number	Name	Tree's Wood	Pattern of Use
1	Plow	Bamboo, <i>Xylia xylocarpa</i> , <i>Lagerstroemia calyculata</i> , <i>Pterocarpus macrocarpus</i>	plowing
2	Rake	Bamboo, <i>Xylia xylocarpa</i> , <i>Pterocarpus macrocarpus</i>	raking
3	Yoke	<i>Xylia xylocarpa</i> , <i>Pterocarpus macrocarpus</i>	cattle's neck control
4	Yoke rope	<i>Terminalia tomentosa</i>	cattle's neck control
5	Cattle rope	<i>Hibiscus</i> spp.	cattle tether
6	Bamboo string	<i>Bambusa</i> spp.	rice seedling binding, rice sheaf trussing basket making etc.
7	Bamboo fan	<i>Bambusa</i> spp.	winnowing
8	Barn	Bamboo/hardwood	rice storage
9	Rice box	<i>Bambusa</i> spp.	glutinous rice container
10	Hoe handle	Bamboo, <i>Lagerstroemia calyculata</i> , <i>Xylia xylocarpa</i>	general digging
11	Knife handle	Bamboo/ hardwood	general cutting

Table 27 The Values from Forest Utilization in DDF, Phu Phra, Dong Mun Forest, Kalasin

Number	Type of Using	Value (baht)	Remark
1	Recreation	139,500	
2	Animal grazing	112,500	
3	Mushroom collection	750,000	
4	Another non-wood forest products	750,000	<i>phak wan</i> , honey, tuber, vegetables

Source: [Prachaiyo 1993]

3.2.1 Foods from Trees

Various parts of many trees are used as the farmers' daily food. Some fresh leaves are eaten raw, such as *tiu* (*Cratoxylum* spp.) and *kradon* (*Careya arborea*). Some trees produce fruit/nut/pod for the farmers consumption such as *ko* (*Castanopsis* spp.), *mafai* (*Baccaurea sapida*), *kabok* (*Irvingia*

Table 28 Food from Various Forest Plants in and around Ban Rua Village, Phu Wiang, Khon Kaen, Northeast Thailand

Plant	Number	Local Name	Scientific Name	Part of Plant	Way of Consumption
Tree	1	<i>chamuang</i>	<i>Garcinia cowa</i>	young leaf	soup in local style
	2	<i>daeng</i>	<i>Xylia xylocarpa</i>	young seed inner bark	fruit cooking with bird meat in local lab
	3	<i>khanun</i>	<i>Artocarpus heterophyllus</i>	ripen fruit young fruit	fruit local curry
	4	<i>ko</i>	<i>Castanopsis</i> spp.	nut	roast
	5	<i>kradon</i>	<i>Careya arborea</i>	young leaf	vegetable
	6	<i>kumbok</i>	<i>Crativa microphylla</i>	young leaf	fermented leaf
	7	<i>mafai</i>	<i>Baccaurea sapida</i>	ripen fruit	fruit
	8	<i>makham pom</i>	<i>Phyllanthus emblica</i>	fruit	fruit
	9	<i>makok</i>	<i>Spondias pinnata</i>	young leaf	fresh vegetable
	10	<i>phak wan</i>	<i>Melientha suavis</i>	young leaf	local curry
	11	<i>phe ka</i>	<i>Oroxylum indicum</i>	pod	vegetable after cook
	12	<i>tako na</i>	<i>Diospyros rhodocalyx</i>	ripen fruit	fruit
	13	<i>tiu</i>	<i>Cratoxylum</i> spp.	young leaf	fresh vegetable, local soup gredient
	14	<i>makoem</i>	<i>Canarium kerrii</i>	fruit	salted
	15	<i>khilek ban</i>	<i>Cassia siamea</i>	leaf & flower	local curry
Climber	1	<i>phak sap</i>	<i>Adenia viridiflora</i>	leaf & flower	vegetable after boil
	2	<i>som lom</i>	<i>Ecdysanthera rosea</i>	leaf & flower	local soup ingredient
	3	<i>khiaang</i>	<i>Euphorbia</i> spp.	leaf	fresh vegetable
	4	<i>yanang</i>	<i>Tiliacola triandra</i>	leaf	ingredient for local bamboo and khilekbaan curry
	5	<i>man nok</i>	<i>Dioscorea bulbifera</i>	tuber	staple food
	6	<i>wai</i> (rattan)	<i>Calamus</i> spp.	young shoot	local curry
	7	<i>hua kloi</i>	<i>Discorea hispida</i>	tuber	staple food
	8	<i>man seau</i>	<i>Discorea alata</i>	tuber	staple food
	9	<i>tin tang</i>	<i>Anomianthus dulcis</i>	ripen fruit	fruit
	10	<i>phak kha</i>	<i>Myriopterion extensum</i>	young leaf	local curry
	11	<i>som poi</i>	<i>Acacia rugata</i>	young leaf	ingredient for local curry
Herb	1	<i>buk</i>	<i>Amorphophallus</i> spp.	stem	local curry
	2	<i>chaplu</i>	<i>Piper sarmentosam</i>	leaf	fresh vegetable
	3	<i>phak pu ya</i>	<i>Caesalpinia mimosoides</i>	young leas/stem	fresh vegetable
	4	<i>krachai</i>	<i>Boesenbergia pandurata</i>	rhizome	cook vegetable
	5	<i>kut hin</i>	<i>Nephrolepis falcata</i>	young leaf	fresh vegetable
	6	<i>phueak</i> (taro)	<i>Colocasia esculenta</i>	tuber	staple food
	7	<i>krachiao</i>	<i>Curcuma parviflora</i>	stem & flower	cook vegetable
	8	<i>i lok</i>	<i>Thomsonia sumawongii</i>	stem	local curry

malayana) and so on. *Sadao* (*Azadirachta indica* var. *siamensis*) supplies root and bark as medicine, leaf and flower for food, fruit for insecticide, and wood for timber. Herbs and climbers also play a big role for this purpose. Table 28 compiles the results from my long experience about food from trees in and around Ban Rua village area of Khon Kaen.

3.2.2 Mushrooms

The forest floor with annual accumulation of litter is the main source of mushrooms. The decomposition of litter offers habitats for many kinds of mushrooms. In the beginning and middle of the rainy season, plenty of mushrooms are found in the forest. The farmers gather them every day in this season. Most of them are gathered for domestic food, but some farmers make commercial gathering with a huge amount of various mushrooms. Some common mushrooms found in the region are shown in Table 29.

3.2.3 Medicinal Plants from Forest

Thai people are very keen on the use of medicinal plants. The oldest recorded use of medicinal plants dates to the Sukhothai period about 700 years ago as seen in the stone inscription with the name of betel nut palm (*Areca catechu*). The fruit of this tree is still used for many kinds of local medicinal purpose. Wat Pho was the first Thai Medicinal School with many formulas of medicine. Other temples in the region also have played a big role in the Thai medicinal supply to the people. The monks in each temple gained the knowledge during their travel into the forest. Some temples, in Khon Kaen in particular, are the office of Thai Classical Medicinal Plant Association that distributes the knowledge, display of dangerous species, the imported medicinal plant, the effect of each plant and so on. Many Thai medicines are formulated from various trees for specific use. The formulation is mixing of many parts of various plants; for curing a bronchodilator, the heartwood of *fang daeng* (*Caesalpinia sappan*), *samae san* (*Cassia garetting*), climber of *thaowan priang* (*Derris scandens*), leaf of *makham kai*, and tuber of *ya haeu mu* (*Cyperus rotundus*), are

Table 29 The Common Mushroom that the Farmers in Phon Thong, Roi-et, Collect from Forests

Number	Local Name	Scientific Name	Way of Consumption
1	<i>het na kho</i>	<i>Lentinus</i> spp.	local curry
2	<i>het na daeng</i>	<i>Lentinus</i> spp.	local curry
3	<i>het na lae</i>	<i>Russula violeipis</i>	local curry
4	<i>het na ua</i>	<i>Russula heterophylla</i>	local curry
5	<i>het phueng</i>	<i>Favolus alveolaris</i>	local curry
6	<i>het kradang</i>	<i>Lentinus praeriquidus</i>	local curry
7	<i>het la ngok</i>	<i>Amanita vaginata</i>	local curry
8	<i>het cha kai</i>	<i>Russula delica</i>	local curry
9	<i>het pho</i>	<i>Astreous hygrometricu</i>	local curry
10	<i>het pluak</i>	<i>Termitomycea fuliginosu</i>	local curry

Source: [Prachaiyo *et al.* 1993]

Table 30 Some Forest Trees Used as Medicinal Plants

Number	Local Name	Scientific Name	Tree Organ	Effectiveness
1	<i>som poi</i>	<i>Acacia rugata</i>	pod	post partum resting, bathing
2	<i>ma tum</i>	<i>Aegle marmelos</i>	young fruit	antidiarrheal
			mature fruit	laxative, digestion
			bark	antimalaria
3	<i>thon</i>	<i>Albizia procera</i>	bark	antiasthmatic
			seed	antiflatulent
			wood	tonic
4	<i>tin pet</i>	<i>Alstonia scholaris</i>	bark	antidysenteric
5	<i>sadao</i>	<i>Azadirachta indica</i>	bark	antimalaria
			seed	insecticide
			flower	stomachic
			petiole	antipyretic
6	<i>khun</i>	<i>Cassia fistula</i>	fruit	laxative
			flower	antipyretic
			wood	anthelmintic for roundworm
7	<i>fang</i>	<i>Caesalpinia sappan</i>	wood	blood tonic, pulmonary, expectorant, emmenagogue
8	<i>ma kluea</i>	<i>Diospyros mollis</i>	fruit	anthelmintic for hookworm
9	<i>wa</i>	<i>Eugenia cumini</i>	bark/fruit/seed	antidiarrheal
			leaf	antidysenteric
10	<i>man pla</i>	<i>Fagraea fragrans</i>	leaf	antimalaria, stomachic, antiasthmatic
11	<i>po pit</i>	<i>Helicteres isora</i>	bark/root	stomachic
			fruit	expectorant
12	<i>mok yai</i>	<i>Holarrhena antidysenterica</i>	bark	antidysenteric
13	<i>som kop</i>	<i>Hymenodictyon excelsum</i>	root/wood/bark	antipyretic
14	<i>pip</i>	<i>Millingtonia hortensis</i>	flower	bronchodilator
			root	lung tonic
15	<i>marum</i>	<i>Moringa oleifera</i>	bark	carminative
16	<i>phe ka</i>	<i>Oroxylum indicum</i>	root	stomachic, antidiarrheal
17	<i>makham pom</i>	<i>Phyllanthus indica</i>	fruit	expectorant, antipyretic, diuretic, antiscurvy
18	<i>phayom</i>	<i>Shorea roxburghii</i>	bark	astringent, food preservation
19	<i>samo phiphek</i>	<i>Terminalia bellerica</i>	young fruit	laxative
			ripen fruit	astringent
20	<i>samo thai</i>	<i>Terminalia chebula</i>	young fruit	laxative, expectorant, antidysenteric, antipyretic
21	<i>mok man</i>	<i>Wrightia tomentosa</i>	bark	stomachic
			wood	oxytocic
			latex	antidysenteric
22	<i>kum bok</i>	<i>Cratogeomys microphylla</i>	bark/flower	stomachic, expectorant, diuretic
			leaf/fruit	antiflatulent
23	<i>sakae na</i>	<i>Combretum quandrangulare</i>	root	venereal disease
			seed	anthelmintic for earthworm
			leaf	relief of muscular pain

Source: [Faculty of Pharmaceutical Sciences, Mahidol University 1992]

boiled in hot water about 10 minutes. This infusion is then used as drinking water by the patients, who will continue drinking until recovery [Samunphraichaoban 1984]. Table 30 lists the name of trees with typical uses.

3.2.4 Protein Food from Forest

Animals from the forest are one of the farmers' main sources of protein. Nearly all kinds of animals in the Northeast are their favorite food. Normally the protein food is very rare in the region, especially in the summer when most of the water tanks are dry. Fish are scarce and difficult to find in this season. Many people go into the nearby forests and look for any animals, birds, insects, reptiles and amphibians for their food. The farmers are very keen on shooting, trapping of birds, wild hare and rat. Many simple instruments are made from bamboo for catching these animals. But the hunting of big animals, deer, barking deer, boar, and red bunting is very seldom done these days because of the strict protection by the official staff. Only some typical small animals are caught by the farmers, as detailed in Table 31.

Table 31 Animals from Forests as the Farmer's Food in the Northeast

Type	Number	Local Name	Scientific Name	Remark
Animal	1	<i>krachong</i>	<i>Tragulus</i> spp.	
	2	<i>fan</i>	<i>Muntiacus muntjak</i>	barking deer
	3	<i>kratai pa</i>	<i>Lepus siamensis</i>	hare
Bird	1	<i>nok kata yai</i>	<i>Ardea sumatran</i>	
	2	<i>nok kata tung</i>	<i>Francolinus pirtadeanus</i>	
	3	<i>kai pa</i>	<i>Gallus gallus</i>	
	4	<i>nok pet nam</i>	<i>Anatidea</i> spp.	
	5	<i>nok plau</i>	<i>Treron curvirosta</i>	
	6	<i>nok khao</i>	<i>Mocropygia ruficeps</i>	dove
	7	<i>nok kachok</i>	<i>Passor mantanus</i>	
Insect	1	<i>maeng chi nun</i>	<i>Lepidiota bimaculata</i>	
	2	<i>kutchi</i>	<i>Onitits virens</i>	
	3	<i>chakachan</i>	<i>Dundubia manniferra</i>	
	4	<i>maeng thap</i>	<i>Chrysobolthis smaragdiana</i>	
	5	<i>ching rit</i>	<i>Gryltus bimarculatus</i>	cricket
	6	<i>takataen</i>	<i>Cyntacanthacris tatarica</i>	grasshopper
Reptile	1	<i>ngu sing</i>	<i>Phyas</i> spp.	
	2	<i>ngu lueam</i>	<i>Python python</i>	python
	3	<i>ngu ngao</i>	<i>Zamenis mucrosus</i>	cobra
	4	<i>yae</i>	<i>Leiolepis bellianna</i>	ground lizard
	5	<i>kapom</i>	<i>Leiolepis</i> spp.	tree lizard
	6	<i>laen</i>	<i>Varanus nebulosus</i>	
Amphibian	1	<i>tao dam</i>	<i>Siebenrochiella crassicollis</i>	turtle
	2	<i>tao nam</i>	<i>Gyomeda grandis</i>	turtle

Source: [Mungkorndin 1981]

3.2.5 Fodder

The farmers herds are grazed in the forest during the rainy season when the paddy fields are covered with rice. The forest is the only place for these animals in this wet period to feed on grasses, herbs, or tree leaves and fruits. Many farmers whose villages are located far away from forests have trouble in finding suitable places for these animals. Many animals feed only on the young shoots of *ya pek* (*Pulsila aruninaria*), which is an indicator of DDF and puts out young leaves during the rainy season. The new shoots spring out immediately after being grazed by animals and are ready for other animals in couple of days. Some herbs are eaten by these animals such as *kachiau* (*Curcuma parviflora*), *kha pa* (*Zingiber* spp.). Many climbers are also a good source of fodder, e.g., *khiang* (*Euphorbia* spp.), *saitau* (*Beaumontia murtonii*). Many tree leaves are good for these animals such as *pradu* (*Pterocarpus macrocarpus*), *phayom* (*Shorea roxburghii*), *wa* (*Eugenia cumini*), *makok* (*Spondias pinnata*), *makham pom* (*Phyllanthus emblica*) and so on.

3.2.6 Ornamental Plants

Wild orchids are planted for decoration in many Thai houses. Forests are the main source of various kinds of orchids. The common orchids that grow in the Northeast are: *kulap pa* (*Aerides falcata*), *kulap khorat* (*Aerides houlletiana*), *pet nam* (*Aerides multiflora*), *malaeng po* (*Arachis maingayi*), *bia mai* (*Bulbophyllum hymenthum*), *kip ma yai* (*Bulbophyllum rufinum*), *khao phae* (*Cleisostoma arietinum*), *ueang tian* (*Cleisostoma filiforme*), *cho mamuang* (*Cleisostoma racemiferum*), *ueang mak* (*Coelogyne trinervis*), *ueang sam dok* (*Coelogyne viscosa*), *kratae tai mai* (*Cymbidium pubescens*), *kare karon* (*Cymbidium simulans*), *phisuea* (*Cymbidium traceyanum*), *ueang kham* (*Dendrobium chrysotoxum*), *ueang kham noi* (*Dendrobium fimbriatum*), *tau sian mai* (*Dendrobium indivisum*), *ueang takhap* (*Dendrobium ochreatum*), *ueang kham tak wai* (*Dendrobium pulchellum*), *tin nok* (*Dendrobium tortile*), *takhap khao* (*Eria stricta*), *ueang phrao* (*Eulophia burkei*), *hua khao tom* (*Eulophia graminea*), *wan hua khru* (*Eulophia nuda*), *nang tai noi* (*Habenaria columbae*), *nang ua noi* (*Habenaria dentata*), *wan khao phae* (*Peristylus goodyeroides*), *ueang khao kae* (*Rhynchostylis coeleotis*), *chang kra* (*Rhynchostylis gigantea*), *aiyaret* (*Rhynchostylis retusa*), *kulap saraburi* (*Seidenfadenia mitrata*), *kulap dong* (*Smitinandia micrantha*), *ueang sampoi phae* (*Vanda bensoni*), *fa mui* (*Vanda brunnea*), *fa mui noi* (*Vanda coerulescens*), *khao kae* (*Vanda concolor*), *sampoi dong* (*Vanda denisoniana*), *ueang mok* (*Vanda hookeriana*), *khem khao* (*Vanda lilacina*), *ueang sampoi* (*Vanda tessellata*), *suea khrong* (*Vanda vipani*) and *thao ngu khiao* (*Vanilla aphylla*).

The trees with beautiful flowers are the favorite plants of many people. These trees flower longer time than normal. Some trees are usually dug out with roots and moved from forest to people's home. Table 32 lists some forest trees with some special flowers from my long experience of field observation in the Northeast.

3.2.7 Litter Production and Nutrient Content in Natural Forests

Litter-fall has a typical meaning in forest ecology. Tsai [1974] defined litter as the small leaves, twigs, branches, flowers, fruit, bract scales and small particles of plant as well as dead insects

Table 32 Trees with Some Flowers from Northeast Forest

Number	Local Name	Scientific Name	Color of Flower	Flowering Season
1	<i>pradu</i>	<i>Pterocarpus macrocarpus</i>	yellow	Nov
2	<i>nonsi</i>	<i>Pteltophorum dasyrachis</i>	yellow	Feb-Mar
3	<i>inthanin nam</i>	<i>Lagerstroemia speciosa</i>	reddish pink	Jul-Aug
4	<i>salao</i>	<i>Lagerstroemia tomentosa</i>	purple	Jul-Aug
5	<i>khun</i>	<i>Cassia fistula</i>	yellow	Apr
6	<i>chan</i>	<i>Butea monosperma</i>	red	Mar
7	<i>chang nao</i>	<i>Ochna integerrima</i>	reddish yellow	Mar
8	<i>tabaek</i>	<i>Lagerstroemia</i> spp.	purple	Jul-Aug
9	<i>mok man</i>	<i>Wrightia tomentosa</i>	white	May
10	<i>phayom</i>	<i>Shorea roxburghii</i>	yellowish brown	Mar-Apr
11	<i>inthanin bok</i>	<i>Lagerstroemia macrocarpa</i>	purple	Jul
12	<i>tabaek na</i>	<i>Lagerstroemia floribunda</i>	purple	Jul
13	<i>salao bai yai</i>	<i>Lagerstroemia lounii</i>	purple	Jul
14	<i>nguang sum</i>	<i>Congea siamensis</i>	reddish white	Mar
15	<i>kruea on</i>	<i>Congea tomentosa</i>	pink	Mar-Apr
16	<i>pradu ban</i>	<i>Pterocarpus indicus</i>	yellow	Nov
17	<i>kan phai</i>	<i>A. mahidole</i>	violet	Feb-Mar
18	<i>thao paep chang</i>	<i>A. sericea</i>	violet	Feb-Mar
19	<i>fang</i>	<i>Caesalpinia sappan</i>	yellow	Jul
20	<i>fai kham</i>	<i>Crateva religiosa</i>	yellow	Nov-Dec

attached to these parts of plants that fall to the forest floor.

Many parts of trees detached from the main stem fall to the forest floor as litter. This litter is only the main path of nutrient transportation, and after decomposition the nutrients are released to forest soil and become the only one way to improve the soil quality. Forest soil is always fertile because of the enrichment of plant nutrients in this closed cycle, which also makes the soil structure stable by organic matter. Many of us want to keep this process going on to ensure the fertility of soil in the agro-ecological system. The disappearance of forest trees means the loss of plant nutrients supplied to the system, which is now in a critical stage in all tropical countries.

Litter production in forests is different from each other. Bray and Gorham [1964] found the main limiting agents to the amount of the litter are tree species, climatic conditions, topography, and management practices. Table 33 shows the amount of litter production and nutrient from some forests in Thailand.

In the Northeast, where most of the forest is DDF, one sub-type, the *Dipterocarpus tuberculatus* sub-community, plays an important role to benefit the farmers with many products as well as litter. Prachaiyo [1983b] made an intensive study on litter production in this forest in Kalasin, Northeast Thailand, and found that the total amount of the litter was about 8.62 ton/ha, of which 4.79 ton is leaf litter, 0.53 ton/ha branch litter, and 3.29 ton/ha others (Table 34).

The same study also found that the leaf litter produced from the five main tree species were quite different. *Phluang* (*Dipterocarpus tuberculatus*), the dominant tree species produced 55.25% or 2.65 ton/ha/year of litters, followed by *daeng*, *rak*, *teng* and *meaud* in decreasing amount (Table 35).

Phluang is the dominant tree species in this forest and provides the great amount of leaf litter. This means that this tree supplies a lot of nutrient to the forest system each year. The chemical study in laboratory made by Adulprasertsuk [1993] confirmed this hypothesis. She found the nutrient content in the leaf litter of *phluang* tree to be 0.92, 0.059, 0.213, 0.68 and 0.233% for N, P, K, Ca and Mg respectively. From this finding, the leaf litter of *phluang* in Lam Pao, Kalasin can produce a total amount of nutrient of 47.82 kg/ha/year (Table 36).

Table 33 Litter and Nutrient Production in Several Forests of Thailand

Forest Type	Litter ton/ha	Nutrient kg/ha				
		N	P	K	Ca	Mg
Dry evergreen forest	7.4	84.8	7.5	58.3	169	20.3
Mixed deciduous forest	7.9	56.2	7.1	49.1	154	16.6
Dry dipterocarp forest	4.7	120	7.5	69.1	91.0	23.8
Pine forest	11.3	62.4	5.7	47.6	28.4	12.5

Source: [Tsutsumi *et al.* 1983; Taiutsa *et al.* 1978]

Table 34 Litter Production in DDF, Lam Pao, Kalasin, Northeast Thailand

No.	Part of Tree	Total	Litter Production (gm/m ²)												
			J	F	M	A	M	J	J	A	S	O	N	D	%
1	Leaf	479.13	55.76	135.28	172.35	19.16	1.85	3.33	4.46	3.04	12.95	16.49	22.53	31.93	55.5
2	Branch	53.38	7.82	10.14	13.47	6.99	1.00	0.33	0.39	0.50	1.93	4.88	2.61	3.47	6.2
3	Other	328.93	8.54	8.89	3.81	141.72	148.27	3.54	2.14	2.49	4.94	1.92	1.40	2.27	38.27
	Total	862.6	72.12	154.31	189.63	167.87	151.12	7.20	6.99	6.03	19.87	23.29	26.54	37.6	100.00

Source: [Prachaiyo 1983b]

Table 35 The Leaf Litter from Main Tree Species in DDF with *Phluang* (*Dipterocarpus tuberculatus*), Lam Pao, Kalasin

Number	Tree Species	Litter		Remark
		%	ton/ha/year	
1	<i>Dipterocarpus tuberculatus</i>	55.25	2.65	<i>phluang</i>
2	<i>Melanorrhoea usitata</i>	10.73	0.51	<i>rak</i>
3	<i>Xylia xylocarpa</i>	12.14	0.58	<i>daeng</i>
4	<i>Shorea obtusa</i>	4.43	0.21	<i>teng</i>
5	<i>Sympocos</i> spp.	4.37	0.21	<i>meaud</i>
6	Others	12.48	0.60	

Source: [Prachaiyo 1989]

Table 36 Annual Plant Nutrient Produced from Leaf Litter of *Phluang* Tree in Lam Pao, Kalasin

Number	Plant Nutrient	Amount (kg/ha)
1	N	16.43
2	P	1.56
3	K	5.64
4	Ca	18.02
5	Mg	6.17
Total		47.82

Source: adapted from Prachaiyo [1989] and Adulprasertsuk [1993]

Table 37 The Decrease of Forest Area in the Northeast during 1961-91

Year	Forest Cover		Forest Decrease km ² /year
	km ²	%	
1961	70,912	41.99	—
74	50,672	30.01	15,569
76	41,494	24.57	45,890
78	31,221	18.49	51,365
82	25,886	15.33	13,338
85	25,580	15.15	102
89	23,586	13.97	500
91	21,799	12.91	894
Total			16,371

Source: [Thailand, RFD 1992]

3.3 Forest Degradation

The decrease of forest area in the Northeast is remarkable. Many forests, for example, Dong Pha Ya Yen forest in Nakon Ratchasima, Dong Mun forest in Kalasin, Dong Lan forest in Khon Kaen and Nam Som forest in Udon Thani, underwent terrible change within 20 to 30 years, from a dense forest to the residential area, paddy field, and field crop area. Most of all old forests in the region faced similar change as a result of "*ha na di*" (land pioneering), one of the main reasons for people's migration. *Ha na di* literally means seeking good paddy land, which was done by opening the forest.

This seeking process is a typical reason for cutting many forests in the region. Forest cover in the Northeast during 1961-91 decreased at the rate of 16,371 km² per year (Table 37). The loss of forest cover is forest degradation from the viewpoint of forest ecology.

3.3.1 Initial Issue

There are three important factors leading to the degradation of forest in the Northeast.

1) *Road Construction*

The main factor resulting in the degradation of forest is human activities. The wilderness of the forest in the old days prevented the normal people from traveling into the forest. People preferred to stay far away from the forest except when accompanying with a big group gathering seasonal forest product. The first railway was constructed in 1867 into the Dong Pha Ya Yen (the extremely cool jungle) forest in Saraburi and Nakhon Ratchasima which was before named Dong Pha Ya Fai (the extremely hot jungle). Because of malaria many of railway construction workers died during their work. To change the name to Dong Pha Ya Yen was only for mental assistance. It took several years for completion and offered the first access through the terrible forest. Gradually, alteration of the forest along the railway took place, and the field crop areas were formed by clearing the old forest year by year. Radius of the encroachment became wider and wider and each railway station seemed to be the nucleus. From around 1950, Dong Pha Ya Yen become famous among the elite of Bangkok, who wanted to make a short visit and finally owned a piece of land for weekend farming. The huge encroachment to this forest was seen after the construction of Mitrapap (friendship) road between Saraburi and Nakhon Ratchasima in 1957. This caused the complete disappearance of most of this forest.

In Dong Mun forest at Kalasin, a dense forest and a habitat of many wildlife and full of valuable trees, the same event occurred after 1970. The forest company in the province obtained a logging concession in this forest. Annual cutting needed the logging roads. The roads were constructed into the forest for convenient log transportation. This road became a possible access to the forest for many farmers to find cassava planting area. At first, only a few people conducted this planting, but many followed as the years passed by. The activities of communists in Thailand during that time were also the big factor to accelerate a complete clearing of the forest for house and field crop planting in 1985. In only 15 years the big change happened and turned the forest into the big community seen today. Coincidentally with logging roads the highway passed through this forest in 1975. Both of them accelerated the degradation of these forests.

2) *Migration*

In Dong Mun forest migration has been quite common during the last three to five decades. Yongwanit and Homnetara [1991] compiled the details of migration of the people to Dong Mun Forest during 1807-1993 as follows.

1807-57. The people from Laos settled down at Kanthara Wichai, Maha Sarakham province in Nam Chi river basin. Some of the migrants moved back to their home town but the majority traveled northward and settled at the southern rim of Dong Mun forest.

1858-1926. After the settlement of the first Lao people group at Dong Mun forest, many local Thai people from neighboring areas migrated to the same site and established many villages.

1927-52. The extensive log harvesting was carried out in the forest by the sawmill owners from the surrounding districts. Many logging roads were constructed. Many people followed these roads to find out suitable sites in the north part of the forest. Some people got a job as a temporary workers in log harvesting.

1953-66. The Tha Kantho District Office was established at the northern rim of the forest. The base of Communist Party of Thailand was located in the forest. The Lampao Irrigation Dam was constructed in 1965 and many farmers suffering from flooding migrated to the eastern rim of the forest.

1967-76. Dong Mun forest was officially managed as the National Reserved Forest (NRF), and Nong Kungsi District Office was established on the western part of this forest. There was frequent severe fighting between the government officers and members of the Communist Party of Thailand, but there was no affection on the local settlers who lived in the outer rim of the forest. These people gradually penetrated to the interior of the forest to look for the cassava planting sites. Many immigrants from Buriram, Nakhon Ratchasima, who suffered from drought settled at the inner most part of the forest.

1977-83. The political conflict declined and many people moved to the forest. The asphalt-paved road was constructed through the forest for easier access. The governmental forest restoration projects were implemented such as Forest Development Project, Land Allotted Project, and Agricultural Land Reform Project.

1984-93. The government-subsidized projects were introduced to many villages in the forest such as village road construction, water reservoir improvement, electricity supply, and public health care. Some settlers still cut illegally the remaining trees for house building and sale.

The same process occurred in the forests in this region wherever the farmers carried with them the process of seeking new paddy lands. This was a very popular activities at that time and many of the national forests were converted from land for wood and non-wood products to be the land for housing and crop planting.

3) *Logging*

Official logging is criticized by many people as the main cause of the forest degradation. I want to make clear about this point. Logging itself is not a harmful agent to destroy any forest. Each logging system¹⁾ is done under the logging procedure²⁾ and supervision of many forestry staffs.

1) Logging system : (1) Small-scale logging: Some small amount of trees were permitted to be cut for both private and commercial use. One who wants to cut trees must apply at the Distinct Forest Office, the Serif or governor will provide them permission. (Invalid now.) (2) Large-scale logging: The permission for cutting trees in one-year period in any projected forest which is divided into 10 compartments and 3 cutting units in each compartment. One unit for one year permission. The cutter, always the saw mill owner, will apply for cutting at the Provincial Forest Office. The Minister of Agriculture and cooperative takes responsibility for permission. The cutting of trees follows the regulation of the Selection Cutting System. (SCS; invalid now.) (3) Concessional logging: The government gives a concession for tree cutting to the Provincial Logging Company in each province all over the country to conduct logging in the concessional forest. Logging due to 30 years for the first rotation and one cutting unit for one year logging. The cutting follows with the SCS. (Terminated in 1991.)

2) Logging procedure is composed of three main steps. (1) Tree marking: All 65% of non-*yang* (*Dipterocarpus* spp.) trees and 35% of *yang* trees which fall into the girth limit of each tree species in each annual cutting unit will be marked by a forester from Regional Forest Office with the running number of ✎

The selective cutting system³⁾ was introduced to each logging forest.⁴⁾ If logging is done according to law, many trees in the second layer still remain for the next cutting rotation which is scheduled in the next 30 years. There are many checking steps both from the Regional Forest Office and the Provincial Office in each region. The concessionaire⁵⁾ has the regulation to follow. If there is any misdoing in logging, the concession will be canceled after the intensive inspection by many officers from the headquarter. The logger is not able to do any cutting without being regulated by law. The term of concession is 30 years. They can continue their logging up to the schedule time. If we look through the logging process only, every step is checked for the logging procedure. But the trouble is the logging road constructed for convenient access and for log hauling and transportation. Through these roads many farmers who are looking for good paddy fields come to these logging areas. This is a typical first step of forest degradation.

1) trees/or cutting, the cutting year, cutting mark, and personal mark of the marker. An index map and name list of marked trees is then made. (2) Cutting: All trees marked for cutting in each year were cut down by the harvester along with the number and species in the marking list. Trees without marking cannot be cut. Each felled tree is bucked into a proper length for transportation. (3) Hauling and transportation : Forester from Regional Forest Office makes an intensive check of all bucking logs by measuring the length and girth and tree species by stamping another mark for hauling and transportation on each log. A list of these logs is prepared. (4) Royalty payment: All bucking logs are transported to hauling ground for the last checking for royalty payment. The forester from District Office or Provincial Office takes responsibility for this duty. The logs, after this step, will be the concessionaire's to make into lumber.

3) Selection Cutting System: Trees are cut based on the girth limit of each tree species. Trees with girth less than the limit are not allowed to be cut. *Yang na* (*Dipterocarpus alatus*), for example, has a girth limits of 250 cm at breast height. The number of trees to be cut is prescribed by two selection cutting regulations: (1) *Yang* (*Dipterocarpus*) trees may be cut at 35% of total mature trees above the girth limit, and (2) Non-*yang* trees may be cut at 65% of total number. In addition, the single trees, trees standing within 20 meter of a river bank, and mother trees should not be cut.

4) Logging forest: Each concessional forest is divided to be 10 compartments. Each compartment contains 3 cutting units. The annual logging will be done in each cutting unit. The tree marking will be done every three years on each compartment for logging in three-year period. The details of cutting units and compartments can be seen in Fig. 10.

5) Concessionaire : The one who get the logging concession from the government. The government issues the logging concession to the Provincial Forestry Company (PFC) in each province all over the country to harvest the trees in the logging forest. The company is made up of shareholders of the Forest Industry Office (FIO), sawmill owners in the province, and local people in the ratio of 40, 40 and 20% respectively. The main duty of the company is log harvesting, but the forest protection and reforestation are for the main jobs after harvesting. The sawmill owners make up the main body of the company and take most of the responsibility for logging. The concession is valid for 30 years for the first rotation and another 30 years for the following rotations.

The distribution of concessions is officially regulated by law such that the government should give the logging concession to each local PFC to log the trees in the local logging forests. The PFC pays a royalty to the government and bears all expenditures related to logging and other works assigned by the concession rules. The local people who share 20% of the total benefit also have the right to use 20% of the number of logging trees for their own use, but normally they sell these to the PFC and get cash instead of timber.

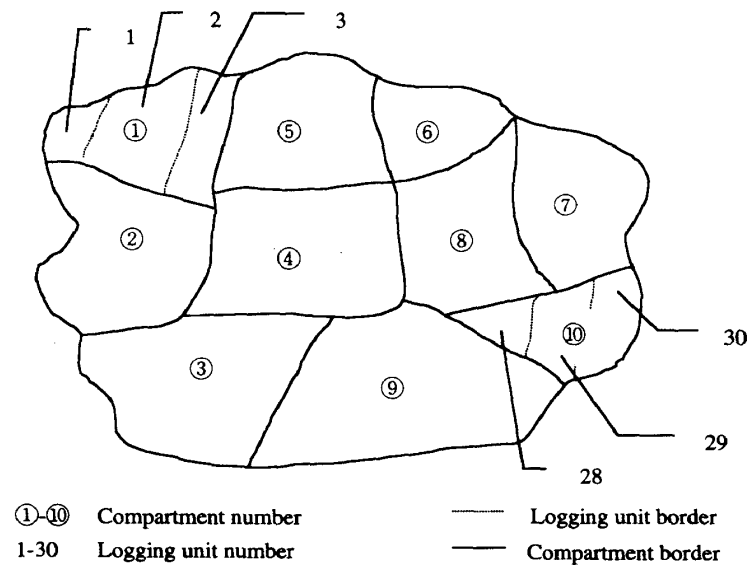


Fig. 10 Concessional Forest, Compartment and Logging Unit

3.3.2 Stage of Forest Degradation

Forest degradation starts with the disappearance of first trees from the forest and ends with land without trees or with only a very small number of undesirable trees. Process required 15 years in the case of Dong Mun forest, Kalasin and longer in the case of Dong Pha Ya Yen forest. Technology is the main factor in forest alteration. At the beginning of this century, the cutting of trees was done only with knives, axes or hand-saws, but during the 1970s chain-saws became popular among the tree harvesters and normal farmers. If we look through the rate of forest decrease (Table 37), the peak of the rate occurred during 1978 to 81 at 82,184 km²/year. This is the final result of this integrated process.

Road construction is one of the main factors to accelerate the degradation of forest. Fig. 11 shows the increasing of accessible roads in Dong Mun forest during 1953-93. The following processes are what happened in Dong Mun forest.

1) Site Acquisition

The first step of forest degradation occurred after the approach to the site by farmers along the logging roads. After logging, many broken stems, small branches as well as leaves of logging trees remained on the site as logging residue under sparsely scattered trees. The farmers collected these residues and burn them. They spent some days on this work to clear the site. The first sites were limited to the logged sites because the rest of the forest was still dense. Crops such as chili, corn and pumpkin were planted and raised without any tending. These crops were harvested after a couple of months (Table 38).

Table 38 Schedule for Crop Planting on the First Site in Dong Mun Forest, Kalasin

Time	Activities	Remark
April	the end of timber harvesting season logging residue burning	before raining
May	crop seed sowing	after raining
October	harvesting	

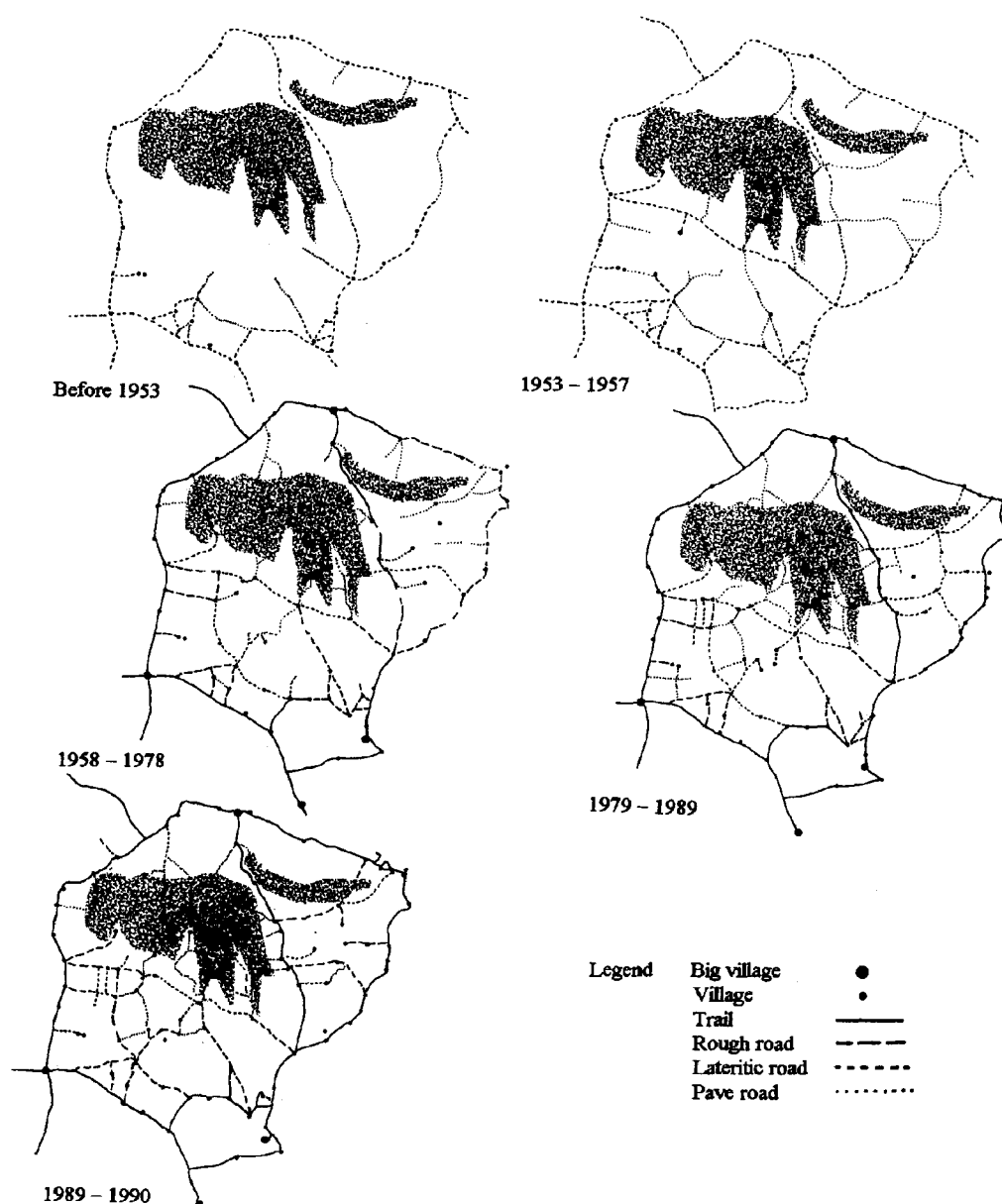


Fig. 11 Road Construction and Settlement in Dong Mun Forest, Kalasin, 1953-90
Source: [Yongwanit *et al.* 1991]

2) *Site Expansion*

In the first year, the amount of land was limited in size, and the number of farmers engaged in this work was also very few. Only those who are in trouble with the maintaining of their old paddy fields lived around the forest. The land was extended in the following years as many other farmers came to the site for the same purpose. The expansion of land was done by clearing bush and cutting all trees that could be cut by knife and then burning them. The burned area depended very much on the energy input. Only a small area was extended each year, and this was repeated year after year. In many case the family husband was working alone in the forest. They hoped very much to have a large piece of land to support their families. The children were too young to cooperate in this work.

During this time, the farmers temporarily visited to the site, working for some hours a day in some essential jobs, and then staying in their permanent house in the old villages. Only a small rough hut was built on the site for day-time use. Some crops were planted after each clearing.

3) *Field Crop Planting*

The big trees remaining on each site were the reserved trees on the marking process of annual logging. These trees were scheduled for cutting in the second rotation 30 years ahead. But, actually the concession started in the region around 1970, and when cutting stopped in 1991 no forest had a second cutting. Where had the trees gone? The expansion step is the single main factor for the disappearance of these trees. After bushes and small trees were cut in the following years, some remaining trees were cut down to produce timber for house construction and many of them were left to burning. After burning, all trees fell down and kept burning until the last piece was completely burnt. Some unbelievable activities were done by making charcoal from these valuable trees. Chuntanaparb and Wood [1986] stated that "very often trees of great value have been turned into simple fuel sold for a few baht (Thai currency) by farmers clearing forest land." Planted crops included kenaf, cassava, and sugar cane.

Kenaf

People have three ways of using kenaf. They plant this crop in a small amount as a raw material for rope making. Fiber selling is the second purpose. The whole stem of kenaf is soaked in a nearby reservoir for a couple of weeks to facilitate fiber peeling. They clean and dry these fibers and sell to the market. Thirdly, the farmers sell all parts of kenaf to the pulp factory.

Cassava

The farmers cut stems with one to two bud, and plant them into any soil with or without plowing or by making a small hole with a wooden stick. The new shoots appear within a couple of weeks and keep on growing even though the soil moisture is minimum, and with a less tending tuber harvesting is done within 10 to 12 months after planting. Tuber is only the part that benefits the farmers for selling. Cassava was first introduced to the region via Nakhon Ratchasima after the highway between the Northeast and the East was completed. It spread quickly with the farmers' migration all over the region especially the new encroachment areas where most of them earned

their income from this plant. The established tapioca powder factories became the market where cassava products were sold. Middlemen who owned small stores for buying cassava products also accelerated the forest destruction because many of them offered the loan to the cassava planters with a terribly high interest rate. The farmers in many cases obtained nothing after selling their cassava. The cash from selling went back to the store owners as principal repayment and interest. This terrible cycle has continued for many years since the forest clearing stage.

Sugar cane

The sugar cane then appeared. It was introduced into the region around 1970 after the first sugar refining factory was constructed at Kumphawapi, Udon Thani, since then factories have been built around the region. Sugar cane planting areas were zoned in the provinces, e.g., Chaiyaphum, Khon Kaen, Udon Thani, Kalasin and so on. The big sugar cane plantations usually appear after the forest is cleared away, and in worse situations these encroach into NRFs, leaving many trees standing dead amid the plantations because of the farmers' girdling.

4) *Paddy Field Formation*

The big increment of the population is not only causing the big amount of timber consumption but also stimulating the expansion of planted areas especially for rice. The main purpose of forest encroachment is to get new land for rice planting. In the first step, some cash crops were planted only for temporary consumption not a staple food. Rice was planted on the lower part of the area where water was available. This rice planting area was extended in the following year even on the upper part where water was not so plenty. The suitability of the site for rice cultivation was not so much considered, and the expansion of wide area was the main motivation of these farmers. The sequence of paddy formation is described in detail elsewhere in this paper (chapter 2 : 2. 5. 2).

The crop plantings are the farmers' main source of cash income. They earn most of their money each year from them. In rice cultivation, the yield is mainly for domestic consumption, and few farmers have a surplus of rice to sell for cash. The farmers seek land for these crop plantings. The increase of these planted areas directly caused the decrease of the forest land. There are many people, not only farmers, who conducted the same activities and caused the clearing of forest for planting site. Chuntanaparb and Wood [1986] raised this point very clearly:

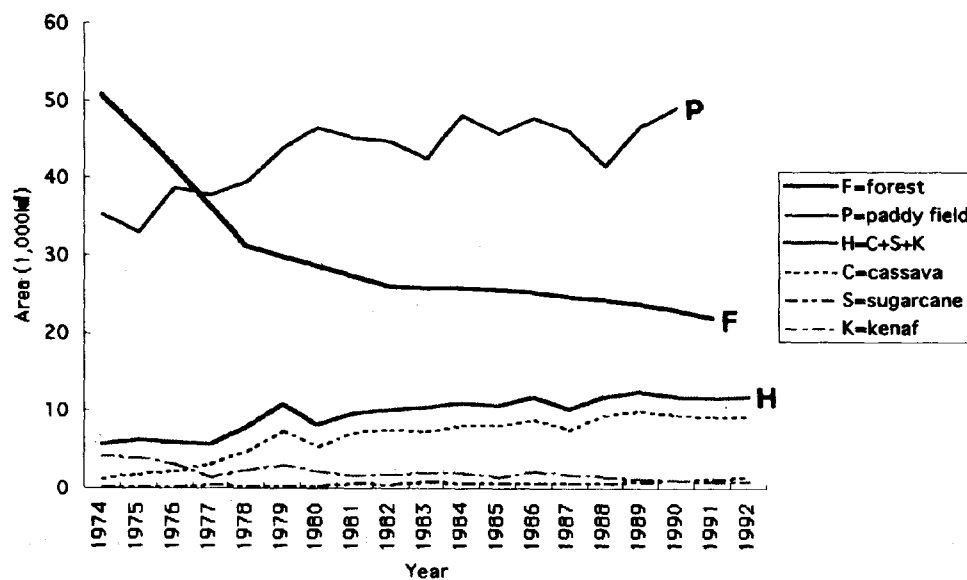
... in many cases the original destruction of forest was carried out by people of middle to high socio-economic position who live far from the forest, either through direct cutting or through the instigation of the farmers in the areas to clear the land. ... In the case of the instigators being agro-industry owners, the farmers are then encouraged to plant the crops e.g., cassava, to supply the industries ...

Forest disappearance and the growth of crop-planting areas are controversial phenomena in the country. The increase of planted area is the reverse ratio of the forest decrease. Table 39 and Fig. 12 show relevant data. From 1974 to 1992, forest decreased by 17,982 km²/year while the planted areas of main cash crops, cassava, sugar cane, kenaf and maize, increased by 421, 78, 174 and 81 km²/year respectively, while paddy land in the region expanded sharply as much as 812 km²/year.

Table 39 Planted Area of Main Cash Crops in the Northeast during 1974-92

Year	Forest Area	Planted Area				
		Cassava	Sugar Cane	Kenaf	Maize	Paddy Field
1974	50,672	1,306	144	4,226	2,458	35,422
75		1,896	227	3,978	2,998	33,016
76	41,488	2,356	274	3,211	3,429	38,986
77		3,387	504	1,637	4,139	37,976
78	31,216	4,834	442	2,536	2,976	39,594
79		7,277	462	3,139	3,277	44,032
80		5,434	482	2,242	3,899	46,538
81		7,256	790	1,688	3,627	45,158
82	25,888	7,581	672	1,866	4,870	44,800
83		7,262	1,035	2,171	5,011	42,571
84		8,126	811	2,130	4,530	48,197
85	25,584	8,166	789	1,606	4,619	45,709
86		8,851	782	2,250	5,216	47,730
87		7,581	755	1,926	5,254	46,006
88		9,482	851	1,538	4,421	41,520
89	23,696	10,055	986	1,332	4,448	46,699
90		9,515	1,069	1,203	4,971	49,227
91	21,799	9,324	1,295	947	4,979	
92		9,320	1,635	915	4,002	
Total (km ² /year)	17,982	421	78	174	81	812

Source: [Thailand, CFAS 1993]

**Fig. 12** The Trend of Forest Covering and Crop Area in Thailand during 1974-92

Source: [Thailand, CFAS 1993]

Prachaiyo *et al.* [1993] studied the diversification of vegetation of Phu Phra forest, Dong Mun, Kalasin and found three stages of degradation of the forest.

(1) Climax forest, 1930-50. The forest was dense enough to be called a jungle. DEF was the major one, MDF was the second, and the lastly was DDF. There was no migration of the farmers, no human interference at the core of this forest. The forest biomass was expected to be one hundred percent of the original. No logging was done by the government. Most people did not dare to enter to the inner part of the forest for hunting or gathering. The forest seemed to be in the climax stage.

(2) Open forest, 1950-70. There was large-scale logging in the forest with the selection cutting system. The official record tells that 3,462 trees were cut in 1964, 1965 and 1966; 1,098, 1,374 and 990 trees respectively [Thailand, RFD, Khon Kaen 1990]. Most of the trees in the upper layer were cut, and the remaining trees in the second layer were left for the harvest in the next rotation. The trees in lower and middle layer were still in the original condition. After logging roads were constructed for log transportation, the small migration of the farmers followed seeking a place for temporary crop planting. They stayed in wooden huts. The biomass of trees in the whole forest fell to 75%.

Table 40 Degradation of Phu Phra Forest, Kalasin, Northeast Thailand

Time Event	1930-50	1950-70	1970-90
Forest composition	Climax DEF, MDF, DDF forest multi storey high density	Open forest 1st storey removed lower storey primary species	Degraded forest 1st storey scattered lower storey primary species secondary species moderate soil erosion
Human activities causing degradation	Low minimal interference	High selective commercial logging of 3,462 trees *	High selective commercial logging with 22,387 trees * fuel-wood NWFT gathering
Management strategies	Custodial protection	Technical exploitation RFD supervised	Technical exploitation RFD supervised
Silvicultural	Limited extraction	Limited extraction basis	Extraction on concessional

Source: [Prachaiyo *et al.* 1993]

* Official logging record [Thailand, RFD, Khon Kaen 1990]

(3) Degradation stage, 1970-90. The logging was operated by a concessional procedure and 22,897 trees were cut by the Kalasin PFC [*ibid.*], with frequent intervention between the government and the Communist Party. A great number of trees were cut by the concessionaries and by the local farmers who were forced to cut by the Communist Party. The Communist Party cut all the remaining trees and then burnt the ground cover for clearing the land to crop planting. From 1975 to 1990, the forest completely changed to the residential area and planting area. Table 40 illustrates the sequence of degradation in this forest.

Chapter 4

Man and Forest Interaction

4.1 *Fuel-wood*

There are two different types of fuel-wood, firewood and charcoal. The former is the more primitive and popular among the farmers. The latter is the adapted form of fuel-wood for more convenient use and transportation. Sturgeon [1979] described firewood as a renewable energy resource. Compared to other energy sources, firewood is easy to collect everywhere and normally cheaper. The process of firewood use is not so complicated. Firewood is not only a non-polluting energy source but also generates light for illumination. The ash might be used as an inorganic fertilizer in the home garden. Prachaiyo [1983a] claimed that the application of ash from the bark of *Terminalia tomentosa* was the main source of potassium returning to soil in a tamarind plantation, a key nutrient to control the sweet taste of this fruit.

4.1.1 *Uses of Fuel-wood*

1) *Cooking*

The farmers in the Northeast follow a humble life style. They live close to nature in their farms and at home. Often they cook on a simple three-rock fireplace, called a *roti* stove, or tripod on the ground under the high floor. They just set the three rocks in a triangle and put the pot or pan for cooking on the rocks. Firewood is put under the cooking pot and burnt. In the paddy fields, where rocks are scarce, they make an earth furnace on the ground. Every house in the region has a separate small kitchen which is attached to the house. In the kitchen, the fireplace is prepared by placing a wooden frame measuring about one meter square and about 20 to 25 centimeter high on the kitchen floor. Soil is put inside this frame to prevent heat damage to the wooden floor. Three rocks are set on this fireplace and support the cooking pan. For fish smoking, a tripod is more suitable. Three bamboo sticks are tied together at one end and another end is adjusted so as to make a triangle. The open ground is more common to prevent house or any belongings from damage. The shelf made from bamboo is put on the tripod for smoking fish. Lots of firewood is needed to smoke fish and beef. To eat something re-warmed afterwards is a common practice among these farmers. With most of these styles of cooking, a huge amount of firewood is needed.

2) *Productive and Non-productive Uses*

Subhadhira *et al.* [1988] distinguished two main categories of fuel-wood utilization, productive and non-productive.

(1) *Uses for production consist of many activities, as follows:*

Cooking

The main type of fuel-wood utilization. Farmers cook at least twice a day every day all year round. They cook at home, in the fields, and even in the forest, especially in bamboo shoot and mushroom collecting period. For all kinds of mushrooms, boiling and steaming are necessary to extract any poison. Rice needs cooking before eating. Cooking twice a day is popular.

Silk production

Homemade silk production is the task of women. The extraction of silk thread requires hot water at constant temperature. For this reason, firewood rather than charcoal is used because the sticks of firewood can be withdrawn and re-inserted to maintain a constant level of heating. In contrast, the use of charcoal tends to result in thick and uneven thread.

Charcoal production

Charcoal is easily made from firewood in many ways. The farmers produce charcoal for their own use, particularly in the planting season, when the frequent rain makes it hard to find firewood for cooking. Hard work in the paddy fields prevents them from collecting firewood. Charcoal, on the other hand, is easy to transport from home to farm and *thiang na*. Commercial charcoal production is the part-time job for farmers to get more cash income.

Salt production

Some areas produce salt crusts on the ground surface. The farmers produce salts from these crusts. They collect the soil and put it in a wooden trough with water. The water percolating from the trough is brine, which is boiled in a big pan placed on the three-rock fireplace or any *roti* stove. A huge amount of firewood is needed for salt-making. This salt is mainly used for making salted fish.

Blacksmithing

Knives and iron tools are sometimes produced in the village. The farmers prefer them to the ones sold in the market. Charcoal used by blacksmiths comes from the market or is homemade.

(2) *Non-productive Uses:*

Warming animals

The farmers make a night fire for their animals and cattle. This is done both when the animals are at home and in the fields during transplanting period. This fire is against the insects, which are extremely abundant in the rainy season, and also to reduce the dampness and chill. Farmers also claim that animal fires around the household compound help providing security, especially in the cool season when the risk of buffalo theft is higher. The warmth of fire keeps the dogs nearby and their reaction to unusual disturbances will warn the household of intruders.

Domestic warming

The old farmers always get up early in the morning especially in the cool season. They make a fire in front of the rice barn, poultry house, or under the fruit trees in the home garden. The fire not only provides warmth for them but is also a way of household compound cleaning. They bring along many residues from trees to the fire. They spend some hours around the fire chatting. They put eggs directly to fire and cook them.

Post-partum resting

To lie by the fire is a traditional rite observed by woman right after giving birth. Women in rural areas follow this practice more than women in the cities. A temporary fireplace is made in the house and a bed is placed beside it for a woman to stay for seven or nine days. A fire from firewood is kept going continuously under a big pot filled with water and traditional medicinal herbs. She drinks and bathes with this hot water during her resting time. It is believed that the heat from the fire and hot water quicken post-partum recover and protect against certain illnesses. Several baths and drinks are given each day. Besides physical recovery, this rite plays an important role for mental state of the couple. The woman is too weak to do anything or even move by herself. The husband takes this important role as to assist his wife by doing all jobs in the resting compound and in the household as well. The husband, in night time, pays extra attention to her and does everything she requests.

Cremation

The farmers burn corpses of relatives and family members in the cremation forests with firewood cut from surrounding trees. The trees in these forests are only used for this traditional purpose. To bring the trees for personal use is rare and disliked by many people. In case of the firewood shortage, firewood is often donated to the family.

Merit-making

According to *het sip song* Thai communities conducts at least 12 Buddhist ceremonies each year. A big amount of food is prepared for each ceremony for both donation to the monks and as feast food for guests. A huge amount of firewood and some charcoal are used in the cooking.

Most of the fuel-wood is used for household cooking [Prachaiyo 1983a; Kongkajan *et al.* 1990]. The percentage and amount of fuel-wood consumption found in these two studies show a remarkable similarity. The average percentage and amount of fuel-wood used in each category are detailed in Table 41.

4.1.2 *Type of Fuel-wood*

Kongkajan *et al.* [1990] divided fuel-wood into two types, the traditional fuel and the modern fuel. The former refers to the fuel which the farmers produce for their own use, such as firewood, charcoal, rice husk, coconut leaf, coconut shell, cassava stump, straw, maize pith, kenaf stem and agricultural waste. The latter is most of the fuel which is bought at a high price and used with

Table 41 Summary of Fuel-wood Use in Each Category

Category of Use	Percentage ¹⁾	Amount, kg/hs/yr ²⁾	Remark
Cooking	69.89	2,049	
Human fire	12.89	57	
Animal fire	1.02	5	
Others	16.52	59	silk production, pottery making, blacksmithing

Sources: 1) [Prachaiyo 1983a] 2) [Kongkajan *et al.* 1990]

Table 42 Use of Traditional Fuel-wood in Cooking,
Ban Nong Bon Village, Maha Sarakham

Fuel-wood	Percentage
Firewood and charcoal	57.76
Firewood	26.72
Gas	1.72
Cassava/kenaf/coconut leaf	13.79

Source: [Kongkajan *et al.* 1990]

some complicated instruments. They further divide the traditional fuel to the main and subordinate fuel. The main fuel is the one that farmers use all the time in cooking such as firewood and charcoal, and the rest is the subordinate ones. Table 42 shows the rate of fuel in each type.

4.1.3 Consumption

The study made by Prachaiyo [1983a] in several villages at Phu Wiang of Khon Kaen found the characteristics of the fuel-wood consumption for cooking.

Ways of using

Firewood and charcoal are the main fuel of the people in these villages: 30.56% use only firewood, 26.31% use only charcoal, and 43.26% use both fuel. Poor families use only firewood and the well-off use only charcoal. The mixed use of charcoal and firewood is mostly found in rice cultivating season.

Gathering

There are three ways of gathering fuel-wood. Collection by family members is usual, but the housewife is more responsible. This is the biggest part of the gathering system or about 83.86%. Buying is not popular, only 14.65% of the investigated families. Bartering rice, fruit or fish for charcoal is popular too.

Time of gathering

Gathering at irregular intervals of one, three, or four months accounts for 81.88%, while 4.07% gather on a daily basis, collecting fallen branches of trees in their paddy fields every evening. The remaining 14.05% gather every week, carrying a firewood sack or basket to the nearby forests and collecting some fallen sticks.

Source of firewood

Firewood is found nearly every place in the region. Paddy fields seem to be the biggest source of firewood, supplying 84.65% of the demand; the community forest of their village 12.93% and the community forests of other villages 5.89%. Some 9.87% of people gather firewood from the lands of their relatives, and only 7.95% buy trees for making their firewood. Charcoal is mainly obtained by buying: 77.78% of the charcoal users buy from the normal market and 22.22% buy from within the village.

4.1.4 *Trees for Fuel-wood*

Farmers look only for dry stems or fallen branches of any tree species. But some people still choose particular tree species. The trees in DDF seem to be the favorite ones, particularly *teng* (*Shorea obtusa*), *rang* (*Shorea siamensis*), and *daeng* (*Xylia xylocarpa*) [Kongkajan *et al.* 1990; Prachaiyo 1986b].

Table 43 The Calorific Value of Some Tree Species in the Forests in Northeast Thailand

Number	Local Name	Scientific Name	Calorific Value cal/gm	
			Firewood	Charcoal
1	<i>kathin phiman</i>	<i>Acacia siamensis</i>	4,792	-
2	<i>krabak</i>	<i>Anisoptera costata</i>	5,101	-
3	<i>krabao klak</i>	<i>Hydnocarpus ilicifolius</i>	4,641	-
4	<i>khwao</i>	<i>Adina cordifolia</i>	5,030	7,936
5	<i>khainao</i>	<i>Vitex glabrata</i>	4,530	7,771
6	<i>khilek</i>	<i>Cassia siamea</i>	4,441	7,036
7	<i>khleung</i>	<i>Dialium cochinchinense</i>	4,371	-
8	<i>khae sai</i>	<i>Sterospermum chelonoides</i>	4,504	-
9	<i>takhian thong</i>	<i>Hopea odorata</i>	4,913	-
10	<i>takhian hin</i>	<i>Hopea ferrea</i>	5,001	-
11	<i>takhian nu</i>	<i>Anogeissus acuminata</i>	5,027	-
12	<i>tabaek</i>	<i>Lagerstroemia</i> spp.	4,556	7,524
13	<i>teng</i>	<i>Shorea obtusa</i>	4,960	7,390
14	<i>tiu</i>	<i>Cratoxylum formosum</i>	4,178	7,836
15	<i>pradu</i>	<i>Pterocarpus macrocarpus</i>	5,022	7,539
16	<i>phayom</i>	<i>Shorea roxburghii</i>	5,339	-
17	<i>wa</i>	<i>Eugenia cumini</i>	4,794	-
18	<i>phayung</i>	<i>Dalbergia cochinchinensis</i>	5,112	7,352
19	<i>maklam ton</i>	<i>Adenanthura pavonina</i>	5,191	-
20	<i>phluang</i>	<i>Dipterocarpus tuberculatus</i>	4,859	7,392
21	<i>maklua</i>	<i>Diospyros mollis</i>	5,205	-
22	<i>mahat</i>	<i>Artocarpus lakoocha</i>	5,206	-
23	<i>makha mong</i>	<i>Azalia xylocarpa</i>	4,716	-
24	<i>makaem</i>	<i>Canarium kerrii</i>	4,434	-
25	<i>yang na</i>	<i>Dipterocarpus alatus</i>	4,810	6,261
26	<i>yo pa</i>	<i>Morinda coreia</i>	4,509	7,843
27	<i>rok fa</i>	<i>Terminalia tomentosa</i>	4,063	6,714
28	<i>rang</i>	<i>Shorea siamensis</i>	4,677	6,934
29	<i>sakae na</i>	<i>Combretum quadrangulare</i>	4,937	7,412
30	<i>sadao</i>	<i>Azadirachta indica</i> var. <i>siamensis</i>	5,046	-
31	<i>sathip</i>	<i>Phoebe paniculata</i>	5,346	-
32	<i>samae san</i>	<i>Cassia garetina</i>	4,418	6,477
33	<i>hiang</i>	<i>Dipterocarpus obtusifolius</i>	4,768	7,503
34	<i>daeng</i>	<i>Xylia xylocarpa</i>	7,384	-
35	<i>takhro</i>	<i>Schleichera oleosa</i>	7,765	-
36	<i>makha tae</i>	<i>Sindora siamensis</i>	7,347	-
37	<i>makham pom</i>	<i>Phyllanthus emblica</i>	8,080	-
38	<i>salao</i>	<i>Lagerstroemia tomentosa</i>	7,185	-
39	<i>kabok</i>	<i>Irvingia malayana</i>	7,016	-

Source: [Chomcharn 1983]

Table 44 Trees Forbidden to Be Used for Fuel-wood

Tree Species	Negative Connotation
<i>Irvingia malayana</i>	loss of fortune
<i>Eugenia cumini</i>	epidemics
<i>Randia tomentosa</i>	eye disease in chicken
<i>Phyllanthus emblica</i>	shorten thinking
<i>Hopea odorata</i>	spirit inhabitant
<i>Ficus religiosa</i>	Buddhist tree
<i>Pterocarpus macrocarpus</i>	eye disease in human

Source: [Subhadhira *et al.* 1988]

Calorific values of firewood and charcoal of each tree species are quite different. Charcoal of the same species seems to have a higher value than firewood (Table 43).

The farmers do not use some specific tree species as fuel. Some trees, including the tree belonging to the King Buddha, *Ficus religiosa*, are forbidden to be used as firewood or for construction. Table 44 shows forbidden trees.

4.1.5 Fuel-wood Production

Firewood and charcoal are among the non timber-forest products assigned by the Forest Act 1941. These are classified as dead twigs, branches, and fallen stems of any trees in the national forests. But those in national reserved forests, national parks and wildlife sanctuaries are beyond the umbrella of this law. The farmers can pick up them for their domestic use. To make a charcoal for commercial use, according to the law, official permission is needed for installing the kiln for charcoal making and the source of wood must be identified.

1) Firewood

The law gives room for farmers to gather fuel-wood for domestic consumption, but not commercial use. They are free to collect any amount of firewood from the forests, but to cut down the trees for fuel-wood is prohibited by law. They can find enough dead wood as their firewood, but since 1980s the search for firewood has become difficult. Most forests changed to paddy fields or residential areas. Farmers have to travel farther and spend longer to find enough firewood for household consumption. The early 1990s was the first chapter of fuel-wood shortage in the region. Subhadhira *et al.* [1988] found four stages of fuel-wood availability in their study.

Abundance

People gathered only hardwood tree species as their fuel from the forests nearby their residences. Some stored a large amount of fuel-wood under their houses.

Scarcity

After forest areas were converted to other forms of land use, fuel-wood became limited to some areas such as the communal ground of the village. The size of fuel-wood became smaller. Charcoal made for domestic use and the use of cooking gas became common.

Serious shortage

Most forests were converted to agricultural lands and only some big trees remained on the paddy fields. People traveled further to the NRFs, NPs, and WSs to collect fuel-wood and face the risk of arrest for illegal gathering. They began planting some fast-growing trees as fuel.

Recovery

After 30 years of such severe shortage, people started to grow trees on their paddy dikes for private fuel supply.

2) *Charcoal*

The farmers have two simple but effective methods to make a charcoal.

Rice husk covering

The small pieces of wood of less than one meter in length are piled up on the ground near the house compound. Fire is set to the pile, and once the wood starts burning, it is covered with rice husks. The fire burns for about two days. Thin blue smoke indicates the complete burning and the end of charcoal-making. The rice husks are then removed from the pile after dousing the fire with water. Charcoal is left to cool, then stored in a suitable place under a rice barn or house.

Soil covering

Larger pieces of wood are piled up on the similar ground but in a bigger amount. Soil is pitched by hoe onto the wood pile to a thickness of about 10-20 cm. Aeration holes for smoke are made at four to five points around the mound. One ignition hole is also prepared for setting fire to the wood. After the wood starts burning well the ignition holes are closed. After a couple of days, the wood becomes charcoal. The aeration holes are closed and the kiln left for weeks to cool.

4.1.6 *Problems after Fuel-wood Shortage*

Several phenomena arising from the shortage of fuel-wood have presented farmers with problems recently.

1) *The Change of Farmers' Behavior*

As mentioned earlier, the decrease of forest lands and transformation of forest into the housing areas is one of the main factors affecting the available amount of fuel-wood. Some phenomena distinguish the stage of fuel-wood shortage:

Price increase

The price of charcoal is an indicator of this stage, particularly in the Northeast, where the price of one 30 kg sack of charcoal jumped from 30 baht in 1980 to 120 baht in 1993 [Prachaiyo *et al.* 1995]. This price increase reflects the diminishing supply of charcoal.

Low quality

Farmers prefer fuel-wood from hardwood trees. They choose any tree that produces a high grade of charcoal or firewood. But this is very difficult for them now. They have no choice but to collect the debris of any tree species found.

Table 45 The Farmers' Opinion on Fuel-wood Shortage in Phu Wiang District, Northeast Thailand

Topic	Opinion	Ratio
Future need	Hope to use the same fuel-wood	76.47
	Reluctance	23.53
Stage of collection	Severe	70.59
	Normal	24.41
Fuel-wood plantation	Participate	26.47
	No ideas	73.53

Source: [Prachaiyo 1985]

Difficulty of gathering

Fallen stems and dry branches in forests are now scarce. Farmers have to travel farther to find enough fuel-wood. They face many troubles in entering the forests which are now protected by law. Those who buy fuel-wood are also experiencing greater difficulty in finding sellers than in previous years.

2) Attitudes of Farmers to Fuel-wood Use

The farmers are still interested in using fuel-wood. To change the fuel source is hard. The economic condition in the household level prevents them from trying to use other fuel, gas or electricity. The use of firewood means they pay nothing for expensive fuel. Kitchen utensils, which use gas or electricity do not match their economic condition. The most important one is the food taste; food cooked by fuel-wood is more delicious than that cooked by other fuel. The farmers' opinion on the fuel-wood shortage is now at the stage of alarm, but few are eager to plant trees for fuel-wood supply. Table 45 summarizes the final opinion of the farmers about the issue.

3) Socio-economic Conditions

The shortage of the fuel-wood is directly concerned with the fluctuation of the family's income. The disappearance of forests and trees forces the farmers to travel farther to find fuel-wood, and this separates them from participation in community activities with their neighbors. To cut more young trees might cause further soil erosion, as the surface soil would become exposed to runoff water. Table 46 compiles some of the effects caused by fuel-wood shortage.

4.2 Community Forest

Since forest is a renewable natural resource, it can be fostered if managed properly, and also degraded if managed improperly. Normally forest is under a management program for timber production. Forest increment is gained year by year by the growth of trees. This seems to be similar to the commercial bank's interest. The annual increment is the interest and the growing stock is the deposit. The wise use or logging will not create any harm to the forest. Most of the timber harvesting from natural forests in the world is based on this idea. On the other hand,

Table 46 Negative Effects due to Fuel-wood Shortage in Phu Wiang District, Northeast Thailand

Topic	Cause	Effect
Agriculture	Agricultural waste used as fuel-wood	Low soil organic matter
	Cattle dung used as fuel-wood	Low soil fertility
	Green manure used as fuel-wood	Low yield production
	Straw used as fuel-wood	Shortage of grazing material for cattle
Environment	Heavy cut of young trees for fuel	Alteration of forest stratification and structure
	Bush for fuel	Soil erosion
	Forest transformation	Shortage of wildlife habitat
	Increasing surface runoff	Water storage in watershed
Social	Illegal gathering	Living security
	Low income	Family instability
	Labor shortage	Community unpleasant
	Lessening in forest and trees number	Migration
Economic	Spend more money for fuel-wood	Low income
		Scantiness of other necessities
		No saving for future
		No income job hiring

Source: [Prachaiyo 1985]

forest plays a big role as a recreational spots for the weekends of many people because of their various phenomena such as waterfalls, cliffs, caves and colorful tree leaves. Water supply to downstream communities and paddy fields might have a continuous flow all year long if forest still flourishes.

The above-mentioned refers to the natural forests which support the need of the society economically. This is true in the mangrove forest in the South, but in the Northeast the logging was halted since 1989 after most of the regional forests changed to planting and residential areas. But there is one traditional forest close to many villages that still flourishes in its original state and plays a big role for both mental and physical support of the farmers. These forests are natural ones that have a very close interrelationship with the people in each community. Most of their livelihoods depend to some degree on these forests, especially the rural poor farmers who spend much of their time seeking products, food, shelter, medicine from these forests in the same way that many people had done in the natural forest in the old days. All of these typical forests are under the management of the community, which sets the goal for any activities done for a particular purpose relating closely to the community need. Some villagers or a village committee take responsibility for achievement of this goal.

4.2.1 *Social Forestry*

Social forestry is an interdisciplinary study concerning the forest and people, and comprises

natural sciences such as biology, botany, silviculture, hydrology and soil science and some subjects of the humanities, sociology, and anthropology. One who studies these subjects will get more understanding on the interrelation between forest and people. Major problems addressed concern people's way of life and environmental aspects. We have to change our viewpoint from the conventional forest management, which ignores the people's participation. It is urgent to create a new management method, which is open to participation by inhabitants.

Many people agree that local people should take some role in forest management because they seem to be the first people who realize about the alteration and the ways of improvement of forest close to their community. Some local people have oral records about the forest from their ancestors and are ready to convey this to the staff, who take care of the whole process.

Many people in the country discuss a lot about social forestry, but we are still far from a good solution for the main scheme. Most people still look at the forests only as the source for their necessities, but take a little role for improving them for the future. The lack of sincerity in forest management for the community is one of the big obstacles of the moment.

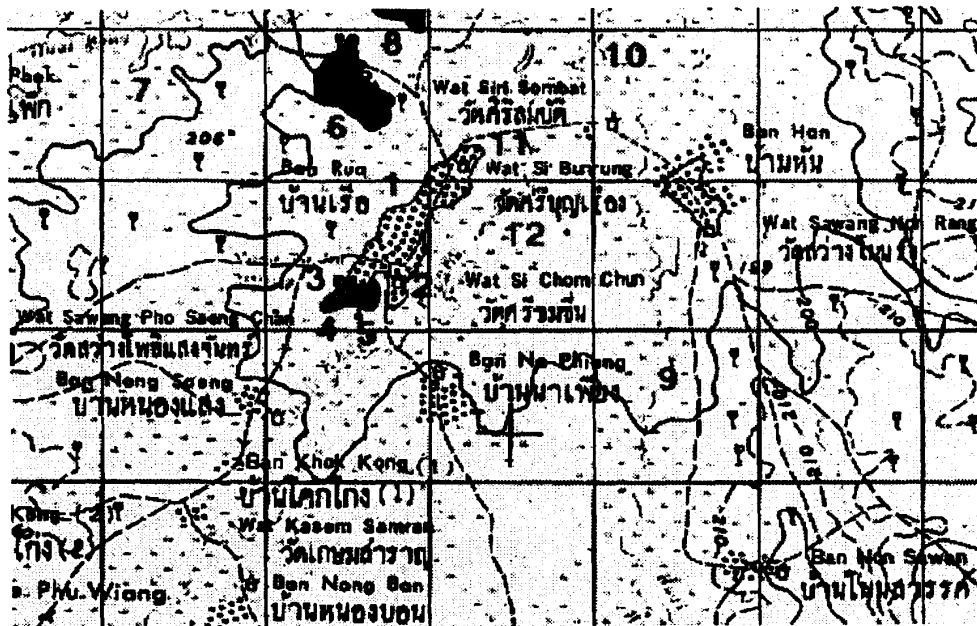
4.2.2 *Community Forest*

Prachaiyo *et al.* [1992] stated in their report that the village settlement involved three main components. Firstly, a site for village building. The site is commonly located on high ground to avoid damage from flooding in the peak of rainy season, and avoid the interference of wild animals. Secondly, fertile land for rice cultivation is important. Rice is grown on the flat land lower than the land for living. A river provides not only water supplement in rice cultivation but a main source of fish, the typical food of the farmers. Lastly, a patch of forest within a convenient distance for producing wood for construction and gathering non-wood forest products. The community forest is the forest where the village people obtain direct benefits. They manage the forest as they desire.

Because of the severe decrease of natural forest, Thai government has paid more attention to community forest since the implementation of the fifth National Economic and Social Development Plan (NESDP) during 1982-86. In 1982, the forest of the country was about 30.52%, and this decreased remarkably to only 28.52% in 1988. This sharp decrease of forest area is one of the main results from the expansion of planting and housing area of the migrants. They never consider leaving patches of the forest for common use as was traditionally done in the former days. Fuel-wood, food, timber are hard to get while flood, drought, strong wind frequently take place. Officials then started to solve these problems by setting up a National Forest Policy in 1985 to introduce a community forest to villages all over the country.

4.2.3 *Type of Community Forest*

Fig. 13 shows the location of Ban Rua village, Phu Wiang district, Khon Kaen, where the community forests are clearly seen. Ban Rua village is an old settlement dating from the beginning of the Bangkok dynasty about 200 years ago. The village is located on a big mound of approximately 0.16 km² with 245 households and 1,071 population comprising 668 males and 409



1= village, 2= temple, 3= pond, 4= school, 5= sacred forest, 6= cremation forest, 7= communal land, 8=ku forest, 9= natural forest, 10= river, 11= bamboo windbreak, 12= paddy fields

Fig. 13 Ban Rua Village and Community Forests, Phu Wiang, Northeast Thailand

females [Ban Rua 1995]. The village area is surrounded by *phai ban* (*Bambusa blumeana*) as a natural fence and wind-breaker. This is the main source for the village community to obtain bamboo shoots and many utensils from bamboo stems. The paddy fields are located on the lower slope than the village compound. Huayyaang on the east is the main river that provides both water and some aquatic animals to the villagers. Most farmers cultivate rice on these paddy fields but some of them have their paddy fields far from the villages on the upper slope, which are not so fertile and younger than the ones close to the village.

There are five community forests close to the village that have served the villagers' needs for a century and still provide many forest and non-forest products to the villagers.

1) Communal Land (7)

Located on the west of the village, the area of this forest in 1995 was only 0.45 km². This forest plays an important role in the village as the source of many forest and non-forest products. It is DDF where soil is poor and lateritic. Animal hunting is popular in rainy season. Fuel-wood, mushrooms, and many insects are normally collected from this forest. The heavy fuel-wood consumption led to enrichment planting in the forest in 1989 with about 3,000 seedling of fast-growing tree species.

2) *Natural Forest (9)*

On the east next of the river is the natural forest, of which only 0.05 km² remained in 1995. The main problem is encroachment by nearby farmers needing paddy land during last three decades. The forest is a good place to produce various kinds of mushrooms in the rainy season and also a grazing ground for cattle. The forest is DDF with good soil suitable for rice planting.

3) *Cremation Forest (6)*

This forest used to be one piece with the communal land in the old days. The forest is about 0.01 km² and many small trees of DDF species are flourishing. The forest is used only for cremation.

4) *Ancient Prang (Ku) Forest (8)*

A DDF forest with an area of 0.01 km² isolated to the north of the village. The location of the foundation of a group of ancient *prang* made from laterite in the 13th century of the Pimai period. The *prang* are holy places to the people of the neighboring villages. They perform the water ceremony at these *prang* in April during the Songkran festival. The original trees are under intensive protection and no one may cut them for any use.

5) *Village Sacred Forest (5)*

Big *yang na* trees are remaining as the covering canopy over the miniature house of the village spirit and close to the village community pond.

Many activities are carried out for community forest events as seen in Table 47, which is compiled from my own observation over a long period.

Sukwong [1984] classified the community forest in the country into many categories. (1) Agroforestry in a farming system by planting trees or bamboo as a fence, planting trees in paddy fields, planting trees in multi-storey plantations, and retaining trees in paddy fields. (2) Tree farming by planting fast-growing tree species for firewood used in pottery factories, trees of mangrove forest for charcoal making. (3) Village wood-lot forest by making a tree plantation for village fuel-wood supply. (4) Management of natural forest for multiple purposes, non-wood forest product and food/fuel-wood gathering. (5) Volunteer forest tree planting program by people cooperating in planting seedlings prepared by the government on communal ground of the villages. (6) Integrated forest management in the watershed area in the mountainous area of the north with land-use planning. Forest rehabilitation for expansion of conservative farming system and improvement of the socio-economic condition of the hill-tribe people who live in the watershed.

Phragtong [1991] classified the community forest into indigenous and developed types. The former refers to all kinds of forests managed by local people, such as sacred forest, water supply forest, the forgiving zone forest, cremation forest, temple forest and family forest. The latter is concentrated in the man-made forest of the village wood-lot, school forest, and the sub-district council forest. A brief explanation of each forest follows.

Sacred forest

Also called spirit forest, god forest, shrine forest and *pa don pu ta*. This forest plays a big role in

Table 47 Calendar for Community Forest Events of the Farmers in Ban Rua Village, Phu Wiang, Northeast Thailand

Number	Events	Time												Remark
		J	F	M	A	M	J	J	A	S	O	N	D	
1	School tree planting	-----	×	×	-----	-----	-----	-----	-----	-----	-----	-----	-----	
2	Road tree planting	-----	×	×	-----	-----	-----	-----	-----	-----	-----	-----	-----	
3	Temple tree planting	-----	×	×	-----	-----	-----	-----	-----	-----	-----	-----	-----	
4	Community pond tree planting	-----	×	×	-----	-----	-----	-----	-----	-----	-----	-----	-----	
	fishing	-----	×	×	-----	-----	-----	-----	-----	-----	-----	-----	-----	
5	Communal land tree planting	-----	×	×	-----	-----	-----	-----	-----	×	-----	-----	-----	1989
	repairing planting	-----	×	×	-----	-----	×	×	-----	-----	-----	-----	-----	1990
	fire protection	-----	×	×	-----	-----	-----	-----	-----	-----	-----	-----	-----	
6	Natural forest collection													
	fuel-wood	×	×	×	×	×	-----	-----	-----	-----	-----	-----	-----	
	mushroom	-----	-----	-----	-----	×	×	-----	-----	-----	-----	-----	-----	
	cattle raising	-----	-----	×	×	×	×	×	×	-----	-----	-----	-----	
	cicada hunting	-----	-----	×	×	-----	-----	-----	-----	-----	-----	-----	-----	
	vegetable	-----	-----	×	×	×	×	×	×	×	×	×	×	
7	Bamboo windbreaker													
	bamboo shoot	-----	-----	-----	-----	×	×	×	-----	-----	-----	-----	-----	
	stem utilising	×	×	×	×	×	×	×	×	×	×	×	×	
	bamboo sheath	-----	-----	-----	-----	×	×	-----	-----	-----	-----	-----	-----	rice seed storage
8	<i>song ku</i>	-----	-----	×	-----	-----	-----	-----	-----	-----	-----	-----	-----	ancient <i>prang</i>
9	<i>song that</i>	-----	-----	×	-----	-----	-----	-----	-----	-----	-----	-----	-----	shrine forest

villagers' spiritual life with the deep belief on the first settlement. The immigrants had no governmental institution to take responsibility for their security. Most of them believe that in the place covered by trees, some spirits of their ancestors live. They want the spirits to give them some protection. So, miniature house is built under biggest trees in their community forest or under the trees close to their villages. The rite is performed several times a year to celebrate the spirits and for protection. The place is holy and the trees are strictly protected, and become one of the impressive forests in the region.

Water supply forest

This forest is protected for water supply to the village. The spirit who controls the water supply is believed to stay at the head of the forest. To satisfy the spirit, the forest is strictly protected. To give respect to the spirit many rites are performed on the fixed days of the year. The village that observes this belief still enjoys plenty of water, but villages that abandon it face water shortage every year.

Forgiving zone (temple forest)

The abundant trees of this zone offer the safe habitat to many animals such as lizards, sparrows, squirrels, rats, hares, and so on. These animals have been poached by the villagers for food. But in the temple area, any poaching is banned. The Thai sign "forgiving zone" is placed around the

temple fence and keeps the people from disturbing these animals.

Cremation forest

A patch of forest is kept some distance from the village and only used for cremation and burying the ash. For each cremation the villagers will cooperate in cutting some trees from the forest. They cut the firewood to the size ca.1.5-2 meter, and piled it to the size of $1.5 \times 1.0 \times 2.0$ meter. The coffin is then put on this pile. After the final religious ceremony the pile is set on fire. Trees of this forest are not used for house building.

Forest of wat pa

The *wat pa* (forest temple) is established within the forest under the canopies of big and small trees. These trees are not only the shelter for monks but also for many animals. The forest is among the good places for Buddhists to spend their time in meditation. The wilderness of *wat pa* keeps the people to concentrate their mind for self-learning. The trees are rarely cut and many people are reluctant to cut them.

Family forest

Artocarpus is planted for younger generations. The plantation is always made in the nearby forest or on the small hill with many *Artocarpus* trees. Only kin members can harvest the fruit from their plantations.

Village wood lot

This was sponsored by the USAID during 1981-85 under the responsibility of RFD to plant some seedlings on the communal lands in some villages where firewood is in short supply. They are distributed in seven provinces in the Northeast: Khon Kaen, Mahasarakham, Roi-et, Kalasin, Buriram, Surin and Srisaket. The RFD produced a lot of seedlings of various tree species including both local economic tree species and exotic fast-growing tree species. The transplantation was conducted collaboratively with the villagers who were members of the communal lands. They also took responsibility for tending the seedlings. The priority use of the planted trees is only for firewood.

Sub-district forest plantation

The royal "Forest loves water" projects were implemented in many communal areas during the 60th anniversary of His Royal Majesty the King's birthday on December 5th, 1987. The project stimulated the people in each sub-district to make the forest plantation on their communal lands. The seedling production and transplanting are similar to those in village wood-lot program. The trees after planting belong to the sub-district. The harvesting will be done under the sub-district council consideration. It is also possible to keep the plantation as forest conservation.

4.2.4 *The Establishment of Community Forest*

Community forest has played a big role for farmers in rural areas of the region since the old days. They tried every means to create a patch of forest for their communal use. This way of thinking has been passed on to the younger generations from a very long time ago. Living close to nature is the main idea of this practice. They can look at the forest with satisfaction and obtain forest and non-wood forest products as a direct benefit. This interrelation seems to have been more popular

in the early period of the century when forest was plenty and population was small. On the other hand, people nowadays pay little attention to this type of forest. They have, however, to need larger land to support the families' need as individualism spread. The establishment of community forest is divided into two categories, the farmers' and the government's methods.

1) *The Farmers' Ways of Community Forest Establishment*

The establishment of community forest by the farmers depends very much on their belief, religion, and behavior.

(1) According to their religious belief, many good spirits live among them in invisible form. These spirits include some of their ancestors, gods and goddesses. Many of them have some supernatural power and can assist their living. To obtain assistance from them, the farmers have to perform several rites for pleasing them. A house for them to stay is the first priority to consider. The spirits normally travel from place to place. To invite them to stay close to the farmers, a spirit house has to be built. Firstly the miniature house is built under the big canopy of the forest close to the village as the residence of the spirits. Many rites are performed periodically throughout the year for obtaining some several good things, such as water for rice cultivation, frequent rains, health of cattle as well as men. The spirits on many occasions respond to these requests. The trees that shelter the spirit house are never cut for any use. This patch of forest still remains in its original condition.

(2) Buddhistic motivation. As Buddhists, they see monks as moderators. They always listen to the monks' teaching and believe what they learn from them. This is a typical way of living. The monks stay in the temples built everywhere. A *wat ban* is common in each village, while a *wat pa* is located in the forest close to the village or on the mountain. The role of the monks is important in the farmer's way of life. Many ceremonies, at least 12 along with *het sipsong*, are performed in the village and some special rites in farmers' homes, such as weddings, funerals and new house ceremonies. The monks are the key persons to perform each of these ceremonies. The temple is not only the community institute but one of the main organs that keep the stability of the farmer's society. The temple compound has trees of different kinds. These trees are neither the monk's treasure nor the farmer's but the community's.

(3) Traditional behavior. The Northeast farmers have a sense of open mindedness. They always care for common property and pay much attention to the sustainability of their communities. They set up the forest as a common place for gathering many products. This way of thinking is the main idea for establishment of community forest.

2) *The Official Establishment of Community Forest*

By the official method, community forest is established in two ways. The first one is assigned by the government. Most of the work is done by RFD in collaboration with other government departments.

(1) Seedling distribution is set up by the village nurseries. The RFD people will take responsibility in supervising the farmers in seedling preparation, tending and transplanting. The

village committee takes care of the project activities. The budget for the nurseries is governmental. The farmers transplant the seedling on their communal grounds. Table 48 lists the tree species in the village nurseries in the Northeast.

(2) Restoration of the community forest. To plant new trees on the harvested lots is the main idea of the project. The RFD staff propose a plan to the department for budget support. The number of restoration projects is limited depending on the government budget. The budget is mainly spent for seedling production, and transplanting is done by the communities.

Table 48 Tree Species of the Seedlings in Village Nurseries in Northeast Thailand (1994)

Number	Local Name	Scientific Name	Number	Ratio %
1	yukalip	<i>Eucalyptus camadulensis</i>	4,758,921	37.80
2	krathin the pha	<i>Acacia mangium</i>	876,920	6.97
3	pradu	<i>Pterocarpus macrocarpus</i>	722,295	5.74
4	sadao	<i>Azadirachta indica</i> var. <i>siamensis</i>	649,432	5.16
5	khilek ban	<i>Cassia siamea</i>	484,161	3.85
6	makham	<i>Tamarindus indica</i>	469,526	3.73
7	sisiat kaen	<i>Terminalia catechu</i>	385,000	3.06
8	phai	<i>Bambusa</i> spp.	329,367	2.62
9	hang nok yung	<i>Delonix regia</i>	271,297	2.16
10	khanun	<i>Artocarpus heterophyllus</i>	228,835	1.82
11	krathin narong	<i>Acacia auriculaeformis</i>	226,751	1.80
12	phai ruak	<i>Thyrsostachys siamensis</i>	212,296	1.69
13	makha mong	<i>Azelia xylocarpa</i>	196,626	1.56
14	kratin yak	<i>Leucaena leucocephala</i>	191,327	1.52
15	phayung	<i>Dalbergia cochinchinensis</i>	182,480	1.45
16	son thale	<i>Casuarina equisetifolia</i>	174,000	1.38
17	khun	<i>Cassia fistula</i>	172,765	1.37
18	inthanin nam	<i>Lagerstroemia speciosa</i>	163,934	1.30
19	khae ban	<i>Sesbania grandiflora</i>	146,863	1.17
20	malako	<i>Carica papaya</i>	111,349	0.88
21	noi na	<i>Annona squamosa</i>	104,600	0.83
22	mamuang himaphan	<i>Anacadium occidentale</i>	100,552	0.80
23	pradu ban	<i>Pterocarpus indicus</i>	86,467	0.69
24	ngiu	<i>Bombax</i> spp.	86,179	0.68
25	nonsi	<i>Peltophorum</i> spp.	84,968	0.67
26	krathin ban	<i>Leucaena glauca</i>	80,200	0.64
27	ton	<i>Albizia lebbeck</i>	79,900	0.63
28	song badan	<i>Cassia surattensis</i>	71,760	0.57
29	masang	<i>Feroniella lucida</i>	68,000	0.54
30	thong urai	<i>Tecoma stans</i>	59,000	0.47
31	tabaek na	<i>Lagerstroemia floribunda</i>	46,000	0.37
32	marum	<i>Moringa oleifera</i>	42,412	0.34
33	mayom	<i>Phyllanthus acidus</i>	37,000	0.29
34	phai sang	<i>Dendrocalamus membranaceus</i>	29,940	0.24
35	salao	<i>Lagersatroemis tomentosa</i>	24,000	0.19
36	rang	<i>Shorea siamensis</i>	23,500	0.19
37	yang na	<i>Dipterocarpus alatus</i>	22,000	0.17

Table 48-Continued

Number	Local Name	Scientific Name	Number	Ratio %
38	<i>khilek america</i>	<i>Cassia floribunda</i>	21,000	0.17
39	<i>siau yai</i>	<i>Bauhinia malabarica</i>	19,406	0.15
40	<i>rat cha preuk</i>	<i>Cassia javanica</i>	18,186	0.14
41	<i>daeng</i>	<i>Xylia xylocarpa</i>	18,000	0.14
42	<i>phikun</i>	<i>Mimosops elengi</i>	18,000	0.14
43	<i>sak</i>	<i>Tectona grandis</i>	18,000	0.14
44	<i>makha tae</i>	<i>Sindora siamensis</i>	14,372	0.11
45	<i>hu kwang</i>	<i>Terminalia catappa</i>	13,000	0.10
46	<i>phang daeng</i>	<i>Caesalpinia sappan</i>	13,000	0.10
47	<i>chan</i>	<i>Butea monosperma</i>	12,500	0.10
48	<i>takhiang thon</i>	<i>Hopea odorata</i>	12,500	0.10
49	<i>mahogani</i>	<i>Swietenia macrophylla</i>	11,500	0.09
50	<i>phai pa</i>	<i>Bambusa arundinacea</i>	9,100	0.07
51	<i>phe ka</i>	<i>Oroxylum indicum</i>	8,000	0.06
52	<i>phai bong yai</i>	<i>Dendrocalamus brandisii</i>	7,950	0.06
53	<i>makham thet</i>	<i>Pithecellobium dulce</i>	5,470	0.04
54	<i>phayom</i>	<i>Shorea roxburghii</i>	5,000	0.04
55	<i>pip</i>	<i>Millingtonia hortensis</i>	5,000	0.04
56	<i>cham churi</i>	<i>Samanea saman</i>	3,000	0.02
57	<i>ma ka bu cha</i>	<i>Tabebuia rosea</i>	2,000	0.02
58	<i>teng</i>	<i>Shorea obtusa</i>	1,000	0.01
59	Others		351,993	2.80
Total			12,588,600	100

Source: [Thailand, RFD 1994a]

(3) Another approach to the official establishment is the project proposal submitted to the government by the farmers. They can propose a project to the government via the District Forest Office, Provincial Forest Office, Regional Forest Office and RFD.

The community forest program in Thailand as reported by Phragtong [1992] started in 1941, when the first tree planting program was scheduled for the National Day, and this was followed by many tree planting programs in later years. Table 49 shows community forest programs practiced in the country.

4.2.5 Organizations Related to Community Forest

There are five acts concerning forest management in the country: Forest Act 1940, National Reserved Forest Act 1963, Wildlife Conservation and Protection Act 1964, National Park Act 1968 and Forest Plantation Act 1992. All of these acts are implemented by RFD. The community forest is not directly under the supervision of any acts and the act for this particular program is not established yet. Any activities related to community forest are based on the regulations of these five acts. RFD is the main organization in dealing with this program. Many rules and regulations are concerned with the trees. The community forest, however, is not only related with forests but also a human concern. These forests are controlled by some special organs.

Table 49 Community Forest Programs of Thailand

Year	Activities	Purpose
1941	National day tree planting	Planting a tree in school, temple and government office
1952	Tree planting on national arbor day (June, 24)	Planting a tree in school, temple and government office
1956	Tree planting in resettlement land for communal forest	Planting a tree on 20% of land remaining
1970	Tree planting in village supply forest	Manage the nearby forests for household consumption by planting a tree
1976	Tree planting in village forest	Planting tree for rehabilitational purpose
1977	Voluntary tree planting	Planting a tree in temple, school, government office, roadside, and village feeding ground areas
1980	Village wood-lot	Planting a tree for fuel-wood in 7 provinces in the Northeast
1984	National community wood supply	Planting a tree in a wood-shortage village program for rural development
1985	Communal tree planting in the central plain	Planting a tree on communal grazing land
1987	National land-use policy	Reallocate forest land less than 1 km ² for community forest
1988	Forest extension program	To demonstrate the forest extension program including tree plantation to the farmers

Source: [Phragtong 1992]

1) *Villagers*

In many villages with community forests, the villagers attempt to keep these traditional forests in the original condition as much as possible. In this case, they take their own responsibility to reconstruct depending on their traditions.

2) *Village Committee*

The committee consists of the village headman as a chairman and several members from the village. The main duty of the committee is to carry out all government projects as well as the build up of community forest. The committee supervised by the District Forest Officer takes care of activities of the community forest project such as seedling distribution to each family that needs them.

3) *Sub-District Committee*

This is a bigger organization headed by the sub-district headman and one village primary school teacher as a general secretary of the committee. The other members are government officers, and sub-district public welfare officers. The village headman from each village under the sub-district serves as a member of the committee. The responsibilities of the committee are similar to those of the village committee but larger in both number and size.

4) *Community Forest Committee*

A specific group of villagers is formed to carry out a particular project. The community forest project is mostly concerned with the transplanting program. This activity needs people to work for it. Villagers always participate in the project during tree planting. This committee takes care of the tending process, weeding, fire protection and animal trespass. It also decides how to divide the harvest.

5) *Temples and Monks*

Many temple forests existing and flourishing in the region are initiated by temple monks and abbots. The abbots play another role as forest conservationists. The temple is the strongest organization in running the community forests at the moment.

6) *Working Groups, Youth Groups, and Conservative Groups*

These are temporary groups formed for a particular work dealing with the government projects.

7) The family is the smallest group, which takes care of the forest that belongs to it.

4.2.6 *Rules and Regulations*

The rules for each forest are established by the members of the group or committee who are concerned with the forest. They hold meetings to set the final rules after many discussions among them. The governmental staff, especially RFD people, may have an advisory role in this process, but all of the work is done by the members. Some rules for typical forests are as follow:

1) The rules for Tham Hang Ma community forest at Phu Hang village and Huai Hin Lat village, Kalasin.

- (1) It is forbidden to cultivate any crop in this forest.
- (2) It is forbidden to cut the trees in the forest for firewood, charcoal, or timber for construction without the permission of the village committee.
- (3) The forest is the common ground for the cattle grazing.
- (4) The tree planting will be done by the villagers under the leadership of the village committee to rehabilitate the forest.
- (5) Punitive measures against anyone who breaks a rule will be as follows:
-remedy

- fine of less than 1,000 baht
- arrest for official punishment.

2) The rules for conservation of Dong Chang Han forest, Roi-et.

- (1) Every member must stand up at 8 am and 6 pm every day wherever they may be to pay respect to the national flag.
- (2) Every member must keep their animals under control so that they do not intrude onto or damage other people's property.
- (3) Every member must refrain from infringing other people's rights and from steal any assets from their farms, gardens, or homes.
- (4) Every member must refrain from any disputes and nuisance which will generate instability in the village.
- (5) Every member must refrain from harassment of other people.
- (6) Every member must refrain from catching any aquatic animals in any reservoirs in the village.
- (7) Forest tree cutting and latex extraction by fire in the hole of *yang na* tree (*Dipterocarpus alatus*) are forbidden.
- (8) Violators will be taken to be punished under the village committee's prosecutor, who has the final decision.

3) The rules were formulated under the specific conditions of each forest by the decision making of the community members. The rules aim at maintaining the community stability of each village or sub-district. After the rules were formulated, most villagers obeyed the rules and the committee as well to protect their forests. The rules for the village community forest are specific and cover the real need of the villagers, while the official acts provide a more general regulation. The processes for establishing rules on community forests are exemplified for the case of The Suan Mon sub-district, Khon Kaen.

(1) Council members:

-Sub-district headmen	Chairman
-Village headmen from 14 villages	Committee
-Learned men from 14 villages	„
-Sub-district Agricultural Officer	Consultant
-Sub-district Community Development Officer	„
-Sub-district Public Welfare Officer	„
-District Educational Officer	„
-District Forest Officer	„

(2) Meeting: the agenda covered harvesting, selling of the harvested trees and expenditure.

(3) Results of meeting:

- The tending operation upon the forest plantation (community forest) must be done by all villagers of 14 villages by the village committee of each village.
- The selling of harvested trees in 1987 and 1989 will be done under the auction system.
- The income will be handled by the Monetary Board of the community forest and the cash will be deposited at the commercial bank.
- Monetary administration will be responsible for the following items with the advice of the main committee.
- Soft loan with 0.5% monthly interest up to 1,000 baht will be available to each household for welfare improvement.
- Donate some money to the district office.
- Keep some money for tending operation to maintain the growth of the planted trees.
- Expansion of the community forest area for two important purposes, commercial and environmental.

The final conclusion of the meeting was recognized by the members and the committee as the rules for management of this forest. The forest is one of the "Tree Loves Water" project, which was implemented in 1987 with transplanting of many seedling including *Eucalyptus*. Five years after planting, a meeting was held to determine harvesting to meet the villagers' need. All the works were carried out by the sub-district committee with many meetings and discussions. An active sub-district headman is one of the key issues to make this project fruitful.

4.3 *Forest Conservation by the Farmers*

Forest conservation is becoming a new topic among Thai people. Formerly, forest management meant timber production to most people. The abundance of forests and trees drove from their minds considerations of other benefits. The forest decrease in Thailand, however, came to the public awareness during the late 1980s. Many government programs were actively done by RFD to lead the people to an understanding of the endangered forests. The school students also participated in tree planting and open seminars. This was the beginning of the campaigns for forest conservation in the country. Normally, the RFD people had paid attention only to the care of trees and forests. They were obliged to change their view from protection to the forest extension to deal with seminars and dissemination of information to the public. Thailand changed her forest management a lot during the 1980s because of the massive alteration of the national forests. The forest area disappeared at the rate of 4,800 km² per year during that time. The decrease of the national forests brought many severe problems to the farmers, both directly and indirectly. The former is the scarcity of wood, timber and fuel-wood, and the latter is the lack of many foods, fodder and some medicinal plants. Also, the frequent occurrence of natural disasters damaged areas especially in the abandoned mountainous areas. The people as well as the government sectors took more notice of the topic, and the first National Forest Policy was formulated in 1985 to tackle with this problem, and forest conservation is one of its main themes.

4.3.1 *Forest Conservation in Thailand*

RFD plays a big role in taking many actions according to the National Forest Policy. One of the main troubles is related to the staff themselves. Since the foundation of the department in 1896, they have worked as forest wardens to protect the national forests. Their duty was away from the community people. They did not expect cooperation from the villagers in fulfilling the assignment. On the other hand, the farmers looked at RFD people as being not their friends but a hostile power. After the declaration of the National Forest Policy, it became clear that the forest protection alone needed the villagers' cooperation.

This was the hard work for the staff who were trained for dealing only with standing trees, not with people. The department started the staff training on this topic through many particular courses. The Faculty of Forestry, the only Forestry Institute in the country, emphasized the curriculum on Community Forestry for undergraduate students in 1988. Ford Foundation gave a grant to the governmental university staff to conduct research on Social Forestry. FAO/UNDP supported the department to carry out some integrated program for improvement of the villagers' living standard without dependence on the forest products. JICA assisted the department to demonstrate the community forest program in the Northeast by establishing a large-scale nursery center to support the farmers' need of seedlings for planting on their home compounds and communal grounds under the community forest plantations.

The RFD, conducted many activities even before the establishment of the National Forest Policy. Many acts concerning forest conservation were formulated. Following these acts, many national parks, wildlife sanctuaries, and national reserved forests were launched as described earlier. This is the full-scale protection of the forests still remaining in a good condition. RFD staff concentrated very much to work in line with the rules in each act to protect the forests. The present problem is that housing and planting areas are scattered all over the country's national forests.

Some activities, however, have been carried out for the purpose of forest conservation as explained below.

Training

Training is conducted to give rural people a better understanding of the role of forests to their communities. Many courses were programmed for forest protection and forest plantation. The government services of several sectors also participate in some specific training which emphasize the broadening of their view on forestry and the means for better cooperation with RFD staff to protect the forests. The program is normally held for people who work closely with the forests.

Special seminars

The department staffs all over the country give special seminars to all students on such occasions as National Arbor Day and special school courses for forest conservation programs. This type of lecture started in 1981 and seems to be an attractive program for the students to participate in many tree planting programs. Some RFD unit visit villages in the evening to talk with villagers about the merit of trees and forests.

Exhibition

Once a year a forestry exhibition is regularly held in every Regional Forest Office, Provincial Forest office, District Forest Office, and at schools and some governmental offices. Beside displaying information, seedlings are also distributed to anybody who need them.

During 1994, the department ran on several activities to stimulate the forest conservation program. The summary of the activities is shown in Table 50.

The idea of forest conservation is not only to protect the trees but also to demonstrate the wise use of their products. To cope up with this discipline, the department spends time and money to find out what might be the proper ways to assure that local people can obtain the proper amount of forest products. The papers and results from many studies are technical tools to support implementation work to demonstrate the hazardous effects of the deterioration of national forests.

4.3.2 Farmers' Ways of Forest Conservation in the Northeast

In 1995, there are about ten million people from one million households living in the national forests in the country without any right or land license. These people pay no attention to forest conservation. One reason for their ignorance is that they are living illegally in the forests. But the rest of the population, the younger generation, in particular, make efforts to assist the RFD staff and cooperate with activities to promote the forest conservation programs of the country. Many farmers' forest conservation programs are now actively carried out in the region. There are three types of forest conservation by the farmers: the conservation group, the community forest protection, and the conservation of non-wood forest products.

Table 50 Forestry Extension Programs of Thailand (1994)

Number	Item	Frequency
1	Forestry exhibition	1,170
2	Publishing	
	booklet	34,000
	leaflet	456,000
	brochure	33,700
	poster	76,000
	paper board	26
3	Radio broadcasting program	1,592
4	Video tape production	5
5	Multi-vision slide	2
6	Article for newspaper	1,722
7	Press conference	11
8	Mobile forest extension program	864

Source: [Thailand, RFD 1995]

1) *The Conservation Group*

The group consists of the village members to protect the patch of forest or mountain close to the village. The members are selected from among the villagers, and the village headman becomes the chairman of the group. The active work of the group is to protect the old forests and to create new forest plantations for communal use. The following description is the case of Phu Phek.

Phu Phek is a small mountain in Dong Mun forest, Kalasin. The surrounding forests which used to be dense 20 years ago was completely cleared by farmers during 1970–80. Only on Phu Phek mountain and some small scattered mountains do trees still flourish. The group formulated the idea to protect Phu Phek forest as meditation area for monks and a recreational area for the general public. Chintaganan *et al.* [1993] stated three main objectives: realization about the disappearance of trees and forests, preservation of the remaining forests for future generations, and the maintenance of the spiritual relationship between the forest and the old people in the village who used to live with forest in the old days.

The 16 members of the group made specific rules for the group and other villagers to work with. Table 51 gives the details about the members and their qualifications.

The group meets twice a month to evaluate the activities done and develop new plans. One of the group activities is the enrichment planting on the Phu Phek area. About 3,000 seedlings were transplanted voluntarily by the villagers for the rehabilitation site. A fine of 500 baht will be imposed on those who cut the trees, burn the fallen or standing trees, or engage in illegal poaching of wild animals. The overall guidelines of the group are as follows:

Table 51 Members of Phu Phek Conservation Group, Dong Mun Forest, Kalasin

Number	Name	Age	Group Post	Village Post
1	Mr. Tongsin Vongchalee	43	Chairman	Village committee
2	Mr. Virote Srisakulthon	29	Vice-chairman	Normal villager
3	Mr. Bunlert Phraphoovong	48	Treasurer	Village committee
4	Mr. Tum Khankaew	61	Member	“
5	Mr. Saman Sittichan	53	“	“
6	Mr. Khai Vorabut	68	“	“
7	Mr. Prasit Nantasing	33	“	“
8	Mrs. Bunkong Viangnanda	48	“	“
9	Mr. Buntom Sridachuay	33	“	“
10	Mr. Kamsri Chuenbunchoo	46	“	“
11	Mr. Tongphun Kongtong	41	“	Learned man
12	Mr. Sawan Unjit	35	“	Public health volunteer
13	Mr. Prasit Chan pho	38	“	Normal villager
14	Mr. Sompong Srisaard	49	“	Village headman
15	Mr. Sokuan Vongchalee	51	“	Normal villager
16	Mr. Amphorn Kamnuan	49	“	“

Source: [Chintaganan *et al.* 1993]

- 1 To protect trees and surroundings.
- 2 To stabilize the condition of the Phu Phek mountain.
- 3 To respond to any punitive measures.
- 4 To manage a place for meditation of the monks.
- 5 To manage a place for recreational purpose.

2) *Community Forest*

Some forests are under good protection and management by the local people, institutes and groups in the region. They manage the forests for the communities' particular needs. The group member and all villagers pay attention to sustain the existing forests for their future use. The main idea of this traditional management is directed to obtaining the forest products, to environmental preservation as well as the spiritual assistance to all the members. The success of the project is more clear than that of most official projects, which are blurred and diminishing to a minimum amount. The following cases show good examples from the temple forest, *pa don pu ta*, and cremation forest.

(1) *Wat Pa Phrom Pa Than Temple, Phon Thong, Roi-et*

The temple area is about 0.67 km², which in 1977 was abandoned land with 1.12 km². The land had been used as common land by the farmers from eight villages (Table 52) to plant cassava as their subsidizing crop, and in 1962 all trees were lost. The cassava yield decreased in 1977 because of repeated planting. The farmers stopped planting and left the land. The area was then covered with *ya kha* (*Imperata cylindrica*).

The present abbot made a pilgrimage to the site in 1982. He was a monk from the famous Nong Pa Pong temple in Ubon Ratchatani. He said that the area was only a grassland of *ya kha* and weeds, and some part of the land was the cremation place. He was one of the reverent monks. He stayed on the site within his *krot* (umbrella). Firstly, the villagers were astonished that he was in this area. During his stay he taught the people about the Dhamma and the role of trees and forests. Villagers were reluctant to follow his teaching but gradually understood what he taught. Within a couple of years, many villagers followed his teaching on the Dhamma, environment and forestry. The trees in the whole area started to sprout from their old stumps, to regenerate from the buried seeds, and the wind brought in some seeds as well. After 1990 the place was covered with trees of several sizes and species, and became an attractive place for meditation and listening to the Dhamma speech given by the abbot.

The forest in this temple consists of DDF trees in the upper canopy and MDF trees in the lower canopy. The main tree species are *ko* (*Quercus kerrii*), *teng* (*Shorea obtusa*), *makoem* (*Canarium kerrii*), *rang* (*Shorea siamensis*), *pradu* (*Pterocarpus macrocarpus*), *krabak* (*Anisoptera costata*), *hiang* (*Dipterocarpus obtusifolius*), *kabok* (*Irvingia malayana*) and *phayom* (*Shorea roxburghii*). The massive natural sprouting from the old stumps quickly occurred during the abbot's stay.

In 1992, Prachaiyo and his colleagues made an inventory survey in this temple forest and found to their astonishment that the forest condition was nearly equal to natural secondary forest

Table 52 The Villages around Phrom Pa Than Temple, Phon Thong, Roi-et

Number	Village	Population			Household
		Male	Female	Total	
1	Khok So Bun	313	220	633	106
2	Nam Kham	219	248	567	137
3	Nong Khi Ma	309	248	557	120
4	Ngiu Tai	396	408	804	140
5	Wan	285	279	564	161
6	Kham Som Sri	445	433	987	178
7	Ngiu Niau	359	345	704	131
8	Sai Fon	479	433	912	110
	Total	2,805	2,614	5,419	1,088

Source: [Prachaiyo *et al.* 1993b]**Table 53** Characteristics of Forest in Phrom Pa Than Temple, Phon Thong, Roi-et

No.	Life Form	Density trees/km ²	Basal Area m ² /km ²	Species	Volume m ³ /km ²	RD	RO	RDo	IVI
1	Mature	74,250	77,031	18	482,231	101.38	102.74	99.92	304.04
2	Sapling	23,200	—	48	—	—	—	—	—
3	Seedling	21,141,000	—	19	—	—	—	—	—

Source: [Prachaiyo *et al.* 1993b]

among the best ones in the region. Table 53 shows the results of their studies.

The conservation of this forest is typically led by the abbot. He is the main coordinator for every work done for this purpose. The villagers respect him deeply and follow his teaching, which is specially done every Buddhist day of each month and on the night before the beginning of meditation practice. His teaching is concentrated on good deeds, living, speaking and thinking. The villagers learn from his teaching about the disappearance of the trees and how to restore them. The teaching is effective since a good example exists as the same as they saw several decades ago. After the recovery of the forest they found many direct and indirect products obtainable from the new forest. The particular non-wood forest products are medicinal plants. The abbot is very keen in using the medicinal plants for therapy. The gathered non-wood products are shown in Table 54.

One of the main reasons for the quick recovery of the forest is the recognition of the value of the forest. This is a result of the good cooperation among the monks and villagers. But it is obvious that the initial stimulation comes from the abbot. The villagers' view of the protective use of this forest is summarized in Table 55.

Table 54 The Percentage of Non-wood Forest Products Gathered from Phrom Pa Than Temple Forest, Phon Thong, Roi-et

Products	Amount %
Mushroom	44.09
Vegetable	21.82
Medicinal plant	6.82
Bamboo	9.55
Fuel-wood	17.73

Source: [Prachaiyo *et al.* 1993b]

Table 55 The Villagers' View of the Role of Forest in Phrom Pa Than Temple, Phon Thong, Roi-et

Item	Percentage
Food	14.89
Medicinal plant	12.77
Timber	8.64
Rain initiator	12.52
Shelter for animals	11.26
Flood protection	7.38
Soil protection	6.63
Soil improvement	7.63
Windbreak	7.63
Amenity	10.64

Source: [Prachaiyo *et al.* 1993b]

(2) *Pa Don Pu Ta (Ancestor's Forest), Ban Khok Kruea Village, Kalasin*

Pa don pu ta is a sacred forest or shrine forest or spirit forest. A miniature hut is built under the canopy of the nearby forest in each village. The hut is believed to be a habitat of the spirits who look after the villagers and animals and protect them from undesirable events. The forest is a small patch located close to the village since the beginning of the settlement for the villagers' spiritual well-being. Cutting of trees is prohibited for any use except for a small amount for communal construction such as the temple, or village meeting room.

At Ban Khok Kruea village, the forest covers an area of 0.01 km². All the trees are deciduous, and the most common one is *teng* (*Shorea obtusa*) which forms a separate group on the upper part of the slope, while *phluang* (*Dipterocarpus tuberculatus*) forms a smaller group on the lower part close to the paddy field. The forest was formerly a part of the dense and wild Dong Mun forest. The latter is now absolutely changed to the residential and planting areas of several villages. But this *pa don pu ta* is still flourishing with many big trees. An investigation in 1994 by Prachaiyo and his colleagues found that the total amount of trees growing in this forest was 4,786 trees of 51 species. The five main common tree species are *teng* (*Shorea obtusa*), *phluang*

(*Dipterocarpus tuberculatus*), *daeng* (*Xylia xylocarpa*), *mueat* (*Sympocos* spp.), *makoem* (*Canarium kerrii*) with total basal area of 122.14 m² and merchantable volume of 563.40 m³. The present value of the timber is about 983,682 baht. The ground cover consists of many seedlings, herbs and coppices of 2,124 individuals in 66 species [Prachaiyo *et al.* 1995]. Table 56 presents the statistical data of this forest and the value of the forest is presented in Table 57.

Table 56 The Summation of Forest Characteristics in *Pa Don Pu Ta*, Ban Khok Kruea Village, Kalasin

Number	Item	Unit	Statistical Data
1	Density	tree/km ²	98,875
2	Species	species/1,600m ²	15
3	Basal area	m ² /km ²	1,789.63
4	Volume	m ³ /km ²	11,312.94
5	Total height(H)	m	10.23
6	First living branch(Hb)	m	6.25
7	Girth at breast height(GBH)	cm	44.33
8	Index of diversity		1.761

Source: [Prachaiyo *et al.* 1995]

Table 57 Species, Frequency, Dominant, Density, and Importance Value Index of *Pa Don Pu Ta*, Ban Khok Kruea Village, Kalasin

Species	Density	Volume tree/km ²	BA m ² /km ²	RF m ² /km ²	RD %	RDo %	IVI %	Remark
<i>Shorea obtusa</i>	63,375	8,556.81	1,247.06	27.12	66.45	69.68	163.5702	<i>teng</i>
<i>Ochna wallichii</i>	1,250	36.81	11.88	3.39	1.29	0.66	5.3436	<i>chang nao</i>
<i>Dipterocarpus tuberculatus</i>	7,500	1,009.31	191.31	13.56	7.74	10.06	31.9913	<i>phluang</i>
<i>Xylia xylocarpa</i>	4,375	520.31	79.56	10.17	4.52	4.45	19.1314	<i>daeng</i>
<i>Sympocos</i> spp.	5,265	266.56	56.00	10.17	5.81	3.13	19.1051	<i>mueat</i>
<i>Darbergia foliacea</i>	1,875	48.00	8.63	5.08	1.94	0.48	7.5021	<i>kraphi</i>
<i>Strychnos nuxvomica</i>	1,250	35.63	5.81	3.39	1.29	0.32	5.0049	<i>tumka</i>
<i>Canarium kerrii</i>	6,250	424.00	150.63	15.25	6.45	8.42	30.1224	<i>makoem</i>
<i>Dipterocarpus obtusifolious</i>	625	36.63	7.31	1.69	0.65	0.41	2.7577	<i>hiang</i>
<i>Diospyros enretioides</i>	625	217.56	18.13	1.69	0.65	1.01	3.3619	<i>lin kwang</i>
<i>Randia tomentosa</i>	625	2.88	1.44	1.69	0.65	0.08	2.4294	<i>nam thaeng</i>
<i>Adina cordifolia</i>	625	9.94	2.44	1.69	0.65	0.14	2.4853	<i>khwao</i>
<i>Morinda coreia</i>	625	0.94	0.63	1.69	0.65	0.03	2.3840	<i>yo pa</i>
<i>Dorichandrone crispa</i>	625	46.06	5.06	1.60	0.65	0.28	2.6320	<i>khae foi</i>
<i>Dilenia obovata</i>	625	11.50	3.75	1.69	0.65	0.21	2.5586	<i>san</i>
Total	98,875	11,312.94	1,789.63					

Source: [Prachaiyo *et al.* 1995]

Table 58 The Value of Trees Standing in *Pa Don Pu Ta*, Ban Khok Kruea Village, Kalasin

Number	Species	Volume (m ³)	Value (baht)					Remark
			1995	2000	2010	2015	2020	
1	<i>teng</i>	261.98	471,564	2,766,478	6,831,341	12,803,959	21,579,695	<i>Shorea obtusa</i>
2	<i>phluang</i>	104.41	208,820	1,225,064	3,025,084	5,669,904	9,556,013	<i>Dipterocarpus tuberculatus</i>
3	<i>daeng</i>	27.03	108,120	634,297	1,566,287	3,935,686	4,947,783	<i>Xilia xylocarpa</i>
4	<i>hiang</i>	15.79	31,580	185,267	457,486	857,464	1,445,163	<i>Dipterocarpus obtusifolius</i>
5	Others	154.18	169,598	994,963	2,456,892	4,604,944	7,761,138	Other species
	Total	563.39	989,682	5,806,096	14,337,090	26,871,957	45,289,792	

Source: [Prachaiyo *et al.* 1995]

The key person who has the spiritual power to protect the *pa don pu ta* is the *cham*. He is a village elder who acts as an intermediary between the villagers and the spirits. There are many belief about his ability to communicate with the spirits. He is usually a learned man, particularly in the Dhamma. He spent some years in the temple to learn these things, especially the magic that allows him to contact the spirits. He is very keen in understanding bad spirits which cause the existing troubles and gives a good solution to the villagers who are in trouble. The *cham* is elected by traditional holy process and continues working in his job up to his death.

The *cham* plays the role in the four important events which concern *pa don pu ta*, as follows.

(A) *Bun boek ban* (good fortune ceremony). This ceremony is traditionally performed in July each year. A temporary hall is built in the center of the village. The villagers bring with them the water, dumplings and thread to the hall to have a sacred performance in the ceremony. The monks from the village temple visit to the hall in the evening and perform Buddhist prayer with the villagers. This ceremony is to invoke good fortune in the cultivating season. The monks leave the hall after finishing the evening performance and then come back again the next morning for a breakfast prepared by the villagers. The sacred pray starts after breakfast. Water, dumplings and thread are then brought back to the villagers' homes. They plow in the dumplings around their house to protect against evil. Water is sprayed on people and animals for good health. Thread is tied to the arms of the family members for good fortune. In the morning, food, candles and flowers are brought to the spirit house by the *cham* to inform the spirits about the performance of the ceremony.

(B) *Bun liang ban* (village opening ceremony). Before the first plowing in the paddy field, this ceremony has to be performed for a good yield of rice. Around May, villagers bring rice, chicken (now money instead of chicken) to the *cham*'s house in the early morning of a Tuesday in the sixth month of the lunar calendar. One chicken will be slaughtered for donation to the spirit at the sacred forest, together with local whiskey, candles, joss sticks and flowers. This is to invoke the spirit to protect the draft animals working in the fields from sickness and to give the farmers a good rice yield. Chicken and other offerings are placed in the front of the spirit house

to invite the spirit for the meal. After some minutes, assuming that he has finished the meal, the chicken is taken back to the *cham*'s house, and accompanied by many villagers, the *cham* has a big feast with the chicken donated by the villagers.

(C) *Kuat khao* (therapy with rice). The health of the children is believed to be troubled by the spirit. The spirit informs the parents about their wrong-doings in the sacred forest such as cutting trees, burning or any personal doings. The child may show some abnormal behavior such as crying with a loud voice. The *cham* is invited to the house in the evening during rice steaming time. After the cooking is finished, he takes cooked rice of the size of child's fist and makes it round into a ball while watching the child. He then plasters the rice on the child's body and speaks an apology to the spirit for any wrong deeds. Responding to his action, most children stop crying and become normal.

The apology is also done in the spirit house if someone does anything unsatisfying to him. The *cham* and the ill-feeling men go to the spirit house with five pairs of flowers and candles and pray in apology.

(D) The invocation of travel safety. Asking for the travel safety, and success in job finding, the parents and the *cham* will proceed to the spirit house with five pairs of candles and flowers and asking the spirit for his support to the children.

(3) *Cremation Forest, Ban Rua Village, Khon Kaen*

Ban Rua village is a large old village tracing back to the last period of the Ayudthaya dynasty. The first settlement occurred around 1770 on the present site on the east of the Huai Yang river. On both sides of this river are the paddy fields of the villagers, but to the west of the village are the upper paddy fields which border with the community forest and cremation forest. The population of the village in 1995 was about 1,077 in 245 households [Phu Wiang 1995].

The cremation forest is on the upper slope separated from the community forest and isolated on the southwest about 2 kilometer from the village. All four sides of the forest are bordered with the paddy fields. Tree components are those of DDF tree species predominated by *teng* (*Shorea obtusa*) of small size. It covers the area of about 0.1 km². Since the settlement of the village, it has been customary to cremate the corpses of villagers brought here for the final funeral ceremonies. There are several rules for using this particular forest.

- Land and trees are limited only for funeral purpose.
- When someone passes away, the household members assisted by relatives and neighbors clear the land to make a cremation ground. Dead and some living trees are cut to make firewood and temporarily piled up for coffin setting.
- After the funeral fire, the bones ash are kept on the site until the final ceremony for some years, then bone will be kept in another container or miniatures pagoda.
- It is punishable to use the forest trees for private aims.
- Villagers, together, must pay attention to fire prevention, particularly in summer.

3) *Conservation Forest for Non-wood Forest Products*

The non-wood forest products (NWFP) as defined by the Ministry of Agriculture and Cooperative (MOAC) (1992) consist of the minor forest products other than timber, such as medicinal plants, edible plants, edible mushroom, rattan, bamboo, bee, lac, latex and resin. The following three cases are examples of the ways of NWFP conservation.

(1) *Latex*

Latex is commonly extracted from *Dipterocarpus* spp., especially from *yang na* (*Dipterocarpus alatus*), *hiang* (*Dipterocarpus obtusifolius*), and *phluang* (*Dipterocarpus tuberculatus*). The latex is used for boat caulking, torch making, bamboo basket coating for water containers and so on. The latex from *phluang* (*Dipterocarpus tuberculatus*) is famous for torch making, and *yang na* (*Dipterocarpus alatus*) is good for boat caulking and bamboo basket coating. The latex is extracted only from mature trees.

To extract the latex, the farmer makes a hole on the stump at about 1 meter above ground. They put some hay or dry wood in the hole and set fire to it. The fire is kept burning for days to warm up the latex ducts in the tree stem. Then, latex gradually come out and accumulate in the hole. Farmer remove off this latex in the following four to five days. The collection will be done once after firing and the next round start again very soon, but not in rainy season. One of the existing activities is exemplified for the case of Ban Bo village.

Ban Bo village, Phu Wiang mountainous area of Khon Kaen, is one of the villages where people conduct latex extraction from *yang na* (*Dipterocarpus alatus*). The village is about 300 years old and consists of 132 households with the population of 1,213 [Phu Wiang 1995]. The main subsidiary income of some farmers is torch making. They collect the latex from *yang na* (*Dipterocarpus alatus*) trees standing on their paddy fields and some from nearby forests. Each family has 2-3 trees but not all the village. The latex is only used for torch making. To make torches, decayed wood, mostly of *phluang* (*Dipterocarpus tuberculatus*), is used. This wood is chopped by knife into small pieces, then mixed with the latex. The ratio of mixing might be around 1 : 5 (latex: decayed wood). Mixing is done in an iron vessel with a wooden stick because the mixture is rather sticky. A dry leaf of *Dipterocarpus tuberculatus* with the size of 40 × 20 cm is used for wrapping the mixture, and the small rod is fastened with bamboo thread. This torch is about 5 cm in diameter and 30 cm in length. Production is about 50 to 70 pieces per family per year and good for both selling and bartering with husked rice.

Farmers collect latex only from their own trees and never interfere with others. They pay a lot of attention to protect the trees from fire hazards especially in summer. During the extraction period, bush and ground cover around the trees are neatly cleared to prevent fire.

The Forest Act 1941 stipulates that latex from *Dipterocarpus* tree is official property. But concessions are permitted to some private firms or persons to collect the latex. Table 59 shows the amount of latex extracted in the country during 1986-92, 3.47 million litre in total.

Table 59 Latex from *Yang (Dipterocarpus)*
Tree in Thailand 1986-92

(million litre)	
Year	Product
1986	0.68
87	0.66
88	0.53
89	0.64
90	0.29
91	0.24
92	0.43
Total	3.47

Source: [Thailand, RFD 1993]

(2) Trees for Bee Hiving

Bee hives are common on the tall *yang na (Dipterocarpus alatus)* trees along the river in the region. Bees prefer to make their hives on the tallest trees for safety from human intrusion. The holy magic for collecting this honey has seldom been studied. The one who knows the magic can easily climb a tree to collect the honey. The following description concerns the magic and the magician.

Name	Mr. On Noa Non Tong (1909-69)
Place	Ban Rua village, Phu Wiang, Khon Kaen
Occupation	Farmer, famed for special skill in climbing coconut tree
Magic study	During the period 1929-30 as a monk and later with personal learning in a village at Surin Province.
Bee honey collecting	1930-60
Ways of distribution	An important part in local Thai medicine, honey is mixed with many medicinal plants for specific curing. He was a local medical doctor and needed a large amount of honey.
	Each hive contains about 20 litres of honey
Successor	None from his family and the whole village as well

He climbs up the tree after an initial ceremony at the foot of the tree. With the belief that some spirit is protecting the bee hive, he offers to the spirit flowers and candles, three pairs each, and asks for permission from the spirit. He carries rope, back sack containing many bamboo pegs and a wooden hammer. After reciting a holy magic, he hits the first peg into the tree stem with only one strike of the hammer. During the climbing, he takes a peg from his sack and hits it firmly into the tree stem, and climbs up step by step, never looking down the earth until he reaches the branch with the bee hive. Slowly, he moves to the bee hive, then recites another chapter of magic, and sweeps out the bees with his right hand. After all bees have left the hive, he

lets down the rope for bringing up a bee honey container from the ground. He cuts the hive with knife, puts in the container, and gradually lowers it. He comes down, taking out the pegs one by one. It is surprising to see how easily the bees are driven off. April is the best season for the collection.

Normally, trees with bee hives grow on the river bank and are protected from official cutting. Because the trees are tall and the specialist of bee honey collector is rare, many bees are still making their hives on the trees without any collection. The younger generations turn away from this hard job. These trees are saved from cutting and become a safe habitat of the natural bees.

(3) *Phak Wan (Melientha suavis) Tree Conservation*

Phak wan is a medium-sized tree growing in DEF and MDF in the northeast. Farmers gather the young leaves and fruit for the main dish in local cooking. The tree bears new leaves in December, flowering and fruiting in February. The plantation of this tree has been far from successful. Only the natural growth in the forests provides the products for the farmers' need. They collect only the young leaves, flowers and some fruit, and keep the ripe fruit for natural regeneration, but this is seldom successful. They never cut down the tree. The products are famous for the taste. Villagers just preserve the mature trees for future gathering.

The trees stand on the cliff, or in deep mountains. Most people know where they are located. They travel for days from home to get the young leaves in this season. The product is not only good for household consumption but also for selling, since all the Northeastern people like to eat it.

Phu Phan Kham mountain in Khao Suan Kwang district of Khon Kaen is one of the famous place for this tree. People in the district or elsewhere in the nearby cities spend almost the whole day to travel along the trails in the forest. After reaching a tree, people make a sign to other people that the tree temporarily belongs to them. Many trees remain to the present day and bear many tons of fresh young leaves around December.

People realize that the trees bring them benefit. This creates the people's norm to protect the trees. Without such trees they may face the lack of typical foods which can not be substituted by any others. Many people try to plant this tree but fail because of the site. There is only one way to get the yield from the tree, that is, to protect it. Fire is not a serious problem because the forests are rather moist. But the cutting of the tree by outsiders who come along with a big truck is the biggest problem. The villages on the entrance to the forests try to form some rules for gathering. Some village rules are as follows:

- no cutting any tree;
- no gathering the mature and ripe fruit;
- trees must be protected from all hazards, particularly from outsider's cutting;
- leaf gathering is allowed only in the leaf-appearing season;
- the duty must be paid by all villagers.

4.4 Trees on Paddy Fields

Paddy fields in the Northeast are characterized by the presence of standing trees. These trees are the remains of once flourishing natural forest which existed on the site before the site was transformed into paddy fields. Newly opened paddy fields on high land even now have many trees, but old fields located on the lower part of the flatland have lost the trees. The trees on paddy fields are mostly natural growth with a very low number of new plantings.

Now, people pay more attention to these trees. *Phluang* (*Dipterocarpus tuberculatus*) tree, for example, produces various kinds of organs for human use, leaves for fresh food and torches, wrapping, roofing and walling for temporary huts, latex for many local use as well as resin and timber. Leaves may be gathered with a few years after planting but latex extraction can not be done while the tree is still small and young. The time required for tree planting is the main reason why only natural trees are found on the paddy fields.

4.4.1 Characteristics of Existing Trees

I made an intensive investigation on the trees grown in the paddy fields. The details of my study are described below.

1) Plot Layout and Site Description

The study plots were established in various parts of the Northeast with the following steps.

- (1) A 40 × 40 meter plot was set in each paddy field.
- (2) Every tree in the plot was surveyed: the local name, DBH, H and Hb were recorded.
- (3) The site description, the local species and number of surrounding trees were recorded.
- (4) Total 31 plots were set up to cover most of the paddy fields in the region.

The 31 study plots were set up in 12 provinces, 31 *amphoe* and 27 villages.

The type and topography of paddy fields were recorded. Types of paddy fields were classified into three categories, old, medium and new, based on the age over 100, 50 to 100, and younger than 50 years respectively. The number of plots in these categories was 15, 4 and 12 respectively. The topography is classified to lower flatland, flatland, middle slope and upper slope. Lower flatland is always flooded in rainy season. Six plots fall into lower-flatland and 12, 1 and 12 plots were on flat land, middle and upper slope respectively (Tables 60 and 61 and Fig. 14).

Table 60 Location, Type of Paddy Field, Topography and Surrounding Trees of the Study Plots on the Paddy Fields in Northeast Thailand

Plot No.	Location	Type/Topography	Surrounding Trees*
1	Ban Tum, Meaung, Khon Kaen	old/middle slope	DI, AI, AS
2	Ban Tawatburi, Tawatburi, Roi-et	old/flatland	DA, HO, DO, PA, SS1
3	Ban Phon Thong, Phon Thong, Roi-et	old/flatland	DA, DO, PA, TT
4	Ban I Kote, Mueang, Roi-et	old/flatland	DA, AC, DI, SR, CQ
5	Ban Haew, Kranuan, Khon Kaen	old/flatland	TI, DA, DO, ES, HO, SS1

Table 60-Continued

Plot No.	Location	Type/Topography	Surrounding Trees*
6	Ban Lao Ma Ba, Kumpawapi, Udon Thani	old/flatland	BF, DA, TI, PA, AL
7	Ban Wan, Nong Han, Udon Thani	new/upper slope	IM, DO
8	Ban Dong Loi, Nong Han, Udon Thani	new/upper slope	DT, DO, TT
9	Ban Nam Thaeng, Ban Dung, Udon Thani	new/upper slope	TT, SO, PM
10	Ban Tum, Ban Dung, Udon Thani	new/lower flatland	PM, DT, XX, SO, SS, SO1
11	Ban A Hong, Pak Kat, Nong Khai	old/flatland	DA, LC
12	Ban Nong Sawan, Bang Kan, Nong Khai	new/flatland	AC, AX, PM, LC
13	Ban Na Sawan, Bang Kan, Nong Khai	new/flatland	DO
14	Ban Phaeng, Ban Phaeng, Nakhon Phanom	old/lower flatland	BM, CM, DA, DO, PA, TT
15	Ban Kon Sawan, Dong Luang, Mukdahan	new/upper slope	DO
16	Ban Pham Phai, Tha Bo, Nong Khai	new/upper slope	TT, PD
17	Ban Chong Sam Mo, Manchakhiri, Khon Kaen	new/upper slope	XX, SO, AC, PM, TT, SO1
18	Ban Sraphra, Nong Bua Khok, Nakhon Ratchasima	new/upper slope	DR, DS, BF, AI
19	Ban Nong Thai, Nong Thai, Nakhon Ratchasima	old/flatland	BF, AC, CM
20	Ban Chakarat, Chakarat, Nakhon Ratchasima	old/lower flatland	CM, CQ, DS, TT, BM
21	Ban Nangrong, Nangrong, Buriram	old/lower flatland	DS, PM, CM, DR, SS, DN, IM
22	Ban Phama, Si Khoraphum, Surin	old/flatland	TT, DO, DT, IM
23	Ban Nong Sim Yai, Huai Taphan, Sri Saket	old/flatland	PA, CM, DI, IM, SS, DN
24	Ban Nong Chik, Maha Chanachai, Ubon Ratchathani	new/upper slope	IM, DO, SO
25	Ban Kantararom, Kantararom, Sri Saket	old/lower flatland	DO, DI, DA, CM
26	Ban Nam Thaeng, Khemarat, Ubon Ratchathani	new/upper slope	DO, SS
27	Ban Nong Mek, Mueang Ruang, Roi-et	old/flatland	DA, SS
28	Ban Chaeng, At Samat, Roi-et	middle/lower flatland	DO, DA, SR, AC, PA
29	Huai Laeng river, Waepatum, Maha Sarakham	middle/upper slope	SO, SS
30	Ban Nong Ku, Prathumrat, Maha Sarakham	middle/upper slope	SR, DI, IM, AI, SS, PM
31	Ban Sok, Ratanaburi, Surin	middle/upper slope	DI, SO, PM, SR, IM, DO

* Details of scientific name in Table 62

Table 61 The Summation Characteristics of the Study Plots

Location	Number of Plots	Paddy Field Type	Number of Plots	Topography	Number of Plots
Khon Kaen	3	Old	15	Lower flatland	6
Roi-et	5	Middle	4	Flatland	12
Udon Thani	5	New	12	Middle slope	1
Nong Khai	4			Upper slope	12
Nakhon Phanom	1				
Nakhon Ratchasima	3				
Buriram	1				
Surin	2				
Sri Saket	2				
Ubon Ratchathani	2				
Mukdahan	1				
Maha Sarakham	2				
Total	31		31		31

2) Tree Dimensions

The field data on tree name (local and scientific), number of trees, diameter at breast height (DBH), total height (H) and the height of the first living branch (Hb) are shown in Table 62. The following methods were used for further analysis:

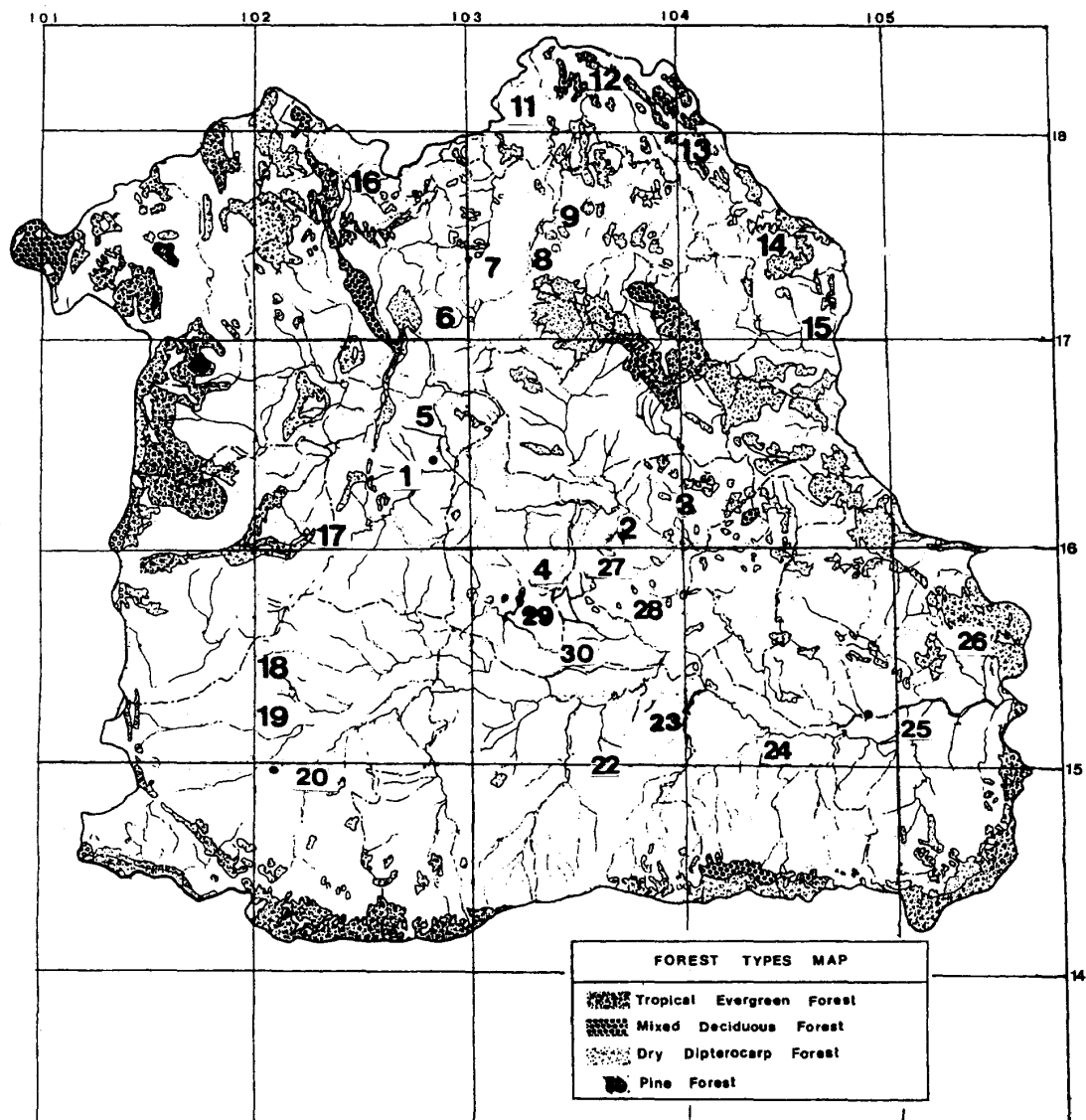


Fig. 14 The Layout of the Study Plots on Paddy Fields in Northeast Thailand

(1) Basal Area

$$BA = 0.7857 D^2 \dots \dots \dots (1)$$

Where

BA = basal area (m²)

D = DBH (m)

(2) Merchantable Volume

$$Vm = BA \times Hb \dots \dots \dots (2)$$

Where

Vm = merchantable volume (m³)

BA = basal area (m²)

Hb = height of first living branch (m)

3) *The Abundance of Tree Species*

The derivation for each parameter followed the procedure referred to by Sahunalu *et al.* [1979] who studied in natural forest.

(1) Relative Frequency (RF)

$$RF = \frac{\text{the occurrence of one tree in the plot}}{\text{the total occurrence of all trees in the plot}} \times 100 \dots (3)$$

(2) Relative Density (RD)

$$RD = \frac{\text{number of one tree species}}{\text{total species}} \times 100 \dots \dots \dots (4)$$

(3) Relative Dominance (RDo)

$$RDo = \frac{\text{Total BA of one species}}{\text{Total BA}} \times 100 \dots \dots \dots (5)$$

(4) Important Value Index (IVI)

$$IVI = RF + RD + RDo \dots \dots \dots (6)$$

4) *Tree Species, Basal Area, Merchantable Volume and Abundance*

The number of existing trees on 31 plots is totally 28 species with the density of 1,491.94 tree/km². These trees consist of deciduous tree species such as *hiang* (*Dipterocarpus obtusifolius*), *sabaeng* (*Dipterocarpus intricatus*), *pradu* (*Pterocarpus macrocarpus*) and so on, and evergreen tree species e.g., *maphok* (*Parinari anamense*), *kabok* (*Irvingia malayana*), *nonsi* (*Peltophorum desyrachis*), etc. The average basal area of these trees is 0.0917 m²/tree and the total area is 136.81 m²/km². These trees create a merchantable volume of 1,259.44 m³/km², and include many valuable tree species, especially *yang na* (*Dipterocarpus alatus*) and *pradu*, which used to be the most needed timber of the country during the first half of this century (Tables 62 and 63).

Table 62 Species and Dimensions of Trees in the Study Plots on the Paddy Field in Northeast Thailand

Plot No.	Tree No.	Tree Species	DBH cm	H m	Hb m	BA m ²	Vol. m ³	Remark
1	1	<i>Dipterocarpus intricatus</i>	7.51	4.0	2.5	0.0044	0.0110	DI
	2	<i>Acacia siamensis</i>	21.54	8.0	4.0	0.0365	0.1460	AS
	3	<i>Azadirachta indica</i> var. <i>siamensis</i>	18.32	7.0	3.5	0.0264	0.0924	AI
2	1	<i>Dipterocarpus alatus</i>	30.52	13.0	8.0	0.0732	0.5856	DA
	2	<i>Hopea odorata</i>	20.04	12.0	8.0	0.0316	0.2528	HO
	3	<i>Dipterocarpus obtusifolius</i>	23.53	12.0	8.0	0.0757	0.6056	DO
	4	<i>Parinari anamense</i>	31.04	12.0	5.0	0.0757	0.3785	PA
3	1	<i>Dipterocarpus alatus</i>	32.03	14.0	8.0	0.0806	0.6448	DA
	2	<i>Dipterocarpus obtusifolius</i>	19.02	13.0	9.0	0.0284	0.2556	DO
	3	<i>Parinari anamense</i>	28.04	12.0	4.0	0.0618	0.2472	PA
	4	<i>Terminalia tomentosa</i>	15.04	12.0	5.0	0.0178	0.0890	TT
4	1	<i>Dipterocarpus intricatus</i>	21.03	12.0	8.0	0.0347	0.2780	DI
	2	<i>Shorea roxburghii</i>	17.05	13.0	7.0	0.0253	0.1772	SR
5	1	<i>Tamarindus indica</i>	49.97	18.0	2.0	0.1962	0.3924	TI
	2	<i>Dipterocarpus obtusifolius</i>	18.02	12.0	7.0	0.0255	0.1786	DO
6	1	<i>Parinari anamense</i>	20.51	13.0	5.0	0.0331	0.1653	PA
7	1	<i>Dipterocarpus obtusifolius</i>	20.98	14.0	8.0	0.0346	0.2767	DO
	2	<i>Irvingia malayana</i>	30.02	13.0	8.0	0.0708	0.5665	IM
8	1	<i>Dipterocarpus tuberculatus</i>	29.97	15.0	8.0	0.0706	0.5646	DT
	2	<i>Terminalia tomentosa</i>	21.50	11.8	7.0	0.0363	0.2542	TT
9	1	<i>Terminalia tomentosa</i>	19.95	12.0	5.0	0.0313	0.1564	TT
	2	<i>Shorea obtusa</i>	21.00	12.0	6.0	0.0346	0.2079	SO
	3	<i>Pterocarpus macrocarpus</i>	25.02	14.0	8.0	0.0429	0.3935	PM
10	1	<i>Pterocarpus macrocarpus</i>	29.97	14.0	8.0	0.0706	0.5646	PM
	2	<i>Xylia xylocarpa</i>	19.98	12.0	7.0	0.0314	0.2196	XX
	3	<i>Shorea obtusa</i>	21.02	12.0	7.0	0.0347	0.2430	SO
	4	<i>Shorea siamensis</i>	18.03	13.0	5.0	0.0255	0.1277	SS
11	1	<i>Dipterocarpus alatus</i>	100.08	24.0	18.0	0.7983	14.3698	DA
	2	<i>Lagerstoeemia calyculata</i>	97.98	20.0	16.0	0.7543	12.0685	LC
12	1	<i>Adina cordifolia</i>	20.96	15.0	10.0	0.0345	0.3452	AC
	2	<i>Azelia xylocarpa</i>	30.90	13.0	6.0	0.0750	0.4501	AX
13	1	<i>Dipterocarpus obtusifolius</i>	20.50	14.0	8.0	0.0330	0.2640	DO
	2	<i>Dipterocarpus obtusifolius</i>	19.95	13.0	7.0	0.0313	0.2189	DO
14	1	<i>Terminalia tomentosa</i>	25.03	14.0	6.0	0.0493	0.2958	TT

Table 62-Continued

Plot No.	Tree No.	Tree Species	DBH cm	H m	Hb m	BA m ²	Vol. m ³	Remark
	2	<i>Pterocarpus macrocarpus</i>	30.10	16.0	8.0	0.0712	0.5695	PM
15	1	<i>Dipterocarpus obtusifolius</i>	21.00	13.0	7.0	0.0346	0.2425	DO
16	1	<i>Terminalia tomentosa</i>	18.82	12.0	6.0	0.0278	0.1670	TT
	2	<i>Peltophorum dasyrachis</i>	18.50	10.0	5.0	0.0265	0.1345	PD
17	1	<i>Xylia xylocarpa</i>	20.95	13.0	8.0	0.0345	0.2759	XX
	2	<i>Adina cordifolia</i>	20.90	15.0	7.0	0.0343	0.2402	AC
18	1	<i>Dolichandrone spathacae</i>	79.95	14.0	2.0	0.5022	1.0044	DS
	2	<i>Diospyros rhodocalyx</i>	21.00	12.0	3.0	0.0346	0.1039	DR
	3	<i>Cissus quadrangulata</i>	10.00	7.0	2.0	0.0079	0.0157	CQ
19	1	<i>Acacia siamensis</i>	17.95	12.0	5.0	0.0253	0.1266	AS
	2	<i>Mitragyna javanica</i> var. <i>microphylla</i>	11.97	10.0	3.0	0.0113	0.0338	MM
20	1	<i>Butea monosperma</i>	20.90	10.0	2.0	0.0343	0.0686	BM
	2	<i>Mitragyna javanica</i> var. <i>microphylla</i>	18.00	8.0	4.0	0.0255	0.1018	MM
	3	<i>Dolichandrone. spathacae</i>	69.95	13.0	3.0	0.3844	1.1533	DS
21	1	<i>Dolichandrone spathacae</i>	65.60	13.0	4.0	0.3381	1.3524	DS
	2	<i>Shorea siamensis</i>	20.05	14.0	8.0	0.0316	0.2527	SS
	3	<i>Diospyros rhodocalyx</i>	25.00	10.0	2.5	0.0491	0.1228	DR
22	1	<i>Dipterocarpus obtusifolius</i>	17.95	14.0	6.0	0.0253	0.1519	DO
23	1	<i>Parinari anamense</i>	27.00	13.0	3.0	0.0573	0.1718	PA
	2	<i>Irvingia malayana</i>	35.05	14.0	8.0	0.0965	0.7722	IM
	3	<i>Dalbergia nigrescens</i>	80.75	20.0	8.0	0.5123	4.0986	DN
24	1	<i>Dipterocarpus obtusifolius</i>	25.07	15.0	8.0	0.0494	0.3951	DO
	2	<i>Parinari anamense</i>	30.00	12.0	3.0	0.0707	0.2121	PA
25	1	<i>Dipterocarpus intricatus</i>	17.95	10.0	4.0	0.0253	0.1013	DI
	2	<i>Dipterocarpus intricatus</i>	19.90	11.0	4.0	0.0311	0.1245	DI
26	1	<i>Parinari anamense</i>	28.00	11.0	3.0	0.0616	0.1848	PA
	2	<i>Dipterocarpus obtusifolius</i>	17.95	14.0	6.0	0.0253	0.1519	DO
27	1	<i>Dipterocarpus alatus</i>	80.68	24.0	20.0	0.5144	10.2286	DA
	2	<i>Dalbergia cochinchinensis</i>	29.95	14.0	8.0	0.0705	0.5638	DC
28	1	<i>Shorea roxburghii</i>	20.45	12.0	8.0	0.0329	0.2629	SR
	2	<i>Irvingia malayana</i>	29.95	12.0	6.0	0.0705	0.4229	IM
	3	<i>Parinari anamense</i>	25.10	10.0	3.0	0.0495	0.1485	PA
29	1	<i>Shorea obtusa</i>	15.60	10.0	8.0	0.0191	0.1530	SO

Table 62-Continued

Plot No.	Tree No.	Tree Species	DBH cm	H m	Hb m	BA m ²	Vol. m ³	Remark
	2	<i>Acacia siamensis</i>	17.98	10.0	6.0	0.0254	0.1524	AS
	3	<i>Terminalia tomentosa</i>	12.00	11.0	7.0	0.0113	0.0792	TT
30	1	<i>Irvingia malayana</i>	30.50	12.0	6.0	0.0731	0.4385	IM
	2	<i>Dipterocarpus intricatus</i>	15.60	10.0	7.0	0.0191	0.1338	DI
31	1	<i>Pterocarpus macrocarpus</i>	30.90	14.0	8.0	0.0750	0.6002	PM
	2	<i>Irvingia malayana</i>	40.40	12.0	6.0	0.1282	0.7694	IM
	3	<i>Dipterocarpus obtusifolius</i>	23.95	12.0	8.0	0.0451	0.3605	DO
Total	74							
Average			28.53	12.72	6.43	0.0917	0.8441	
						(136.81m ² /km ²)	(1,259.44m ³ /km ²)	

Table 63 Statistical Parameters of Trees Standing in Paddy Fields in Northeast Thailand

Parameter	Unit	Value
Density	tree/hectare	14.9194
DBH	cm	28.5272
H	m	12.7162
Hb	m	6.4257
BA	m ² /ha	1.3681
Volume	m ³ /ha	12.5944
Species	number	28

Table 64 Different Abundance Class of Trees in Paddy Fields in Northeast Thailand

Class	IVI	Tree
Abundant	27.5965-33.8085	<i>hiang, yang na</i>
Frequent	21.3844-27.5965	<i>ma phok, khae na</i>
Normal	15.1723-21.3844	<i>rok fa, kabok</i>
Seldom	8.9602-15.1723	<i>chanuan, sabaeng, teng, pradu, tabaek yai</i>
Rare	2.7488- 8.9602	<i>phayung, kan hung, makham, takhian thong, phayom, sadao, phluang, daeng, makha tae, khwao, makha mong, nonsi, tako, sabaeng, kathin phiman, kathum na, chan</i>

These trees can be found in different abundance classes as abundant, frequent, normal, seldom, and rare according to their IVI (Importance Value Index) values (Table 64). From the table we can see that the abundant trees in the paddy fields are *hiang* (*Dipterocarpus obtusifolius*), *yang na* (*Dipterocarpus alatus*). On the other hand, the rare trees are those of the most valuable timber trees such as *phayung* (*Dalbergia cochinchinensis*), *takhian thong* (*Hopea odorata*), and *makha mong* (*Azelia xylocarpa*) among the others.

The abundance of trees refers to the estimation of the total number of individual tree species, especially the tree density. The IVI normally expresses the abundance of tree. The IVI is the summation of Relative Density, Relative Dominance, and Relative Frequency. From Table 65, we can see that each tree species, among 28 species, falls in different range of IVI intervals. The IVI helps to express whether a tree species is abundant in the studied plots. Finally, Table 66 lists in order the 10 most abundant tree species in the paddy field in Northeast Thailand. The first is *hiang* (*Dipterocarpus obtusifolius*), followed by *yang na* (*Dipterocarpus alatus*), and *khæ nam*

Table 65 The Importance Value Index of Trees Standing on Paddy Fields in Northeast Thailand

Tree Species	Number	RF	RD	RDo	IVI	Local Name
<i>Dalbergia cochinchinensis</i>	1	1.3839	1.3514	1.0388	3.7741	<i>phayung</i>
<i>Dalbergia nigrescens</i>	1	1.3889	1.3514	7.5488	10.2891	<i>chanuan</i>
<i>Dipterocarpus intricatus</i>	5	5.5556	6.7570	1.6886	14.0012	<i>sabaeng</i>
<i>Albizia siamensis</i>	1	1.3889	1.3514	0.0578	2.7481	<i>kang hung</i>
<i>Azadirachta indica</i> var. <i>siamensis</i>	1	1.3889	1.3514	0.3890	3.1293	<i>sadao</i>
<i>Dipterocarpus alatus</i>	4	5.5556	5.4056	21.5648	32.5260	<i>yang na</i>
<i>Hopea odorata</i>	1	1.3889	1.3514	0.4656	3.2059	<i>takhian thong</i>
<i>Dipterocarpus obtusifolius</i>	10	13.8890	14.8654	5.0541	33.8085	<i>hiang</i>
<i>Parinari anamense</i>	7	9.7223	9.4598	6.0670	25.2491	<i>maphok</i>
<i>Terminalia tomentosa</i>	6	8.3334	8.1084	2.5610	19.0028	<i>rok fa</i>
<i>Shorea roxburghii</i>	2	2.7778	2.7028	0.8576	6.3382	<i>phayom</i>
<i>Tamarindus indica</i>	1	1.3889	1.3514	2.8910	5.6313	<i>makham</i>
<i>Irvingia malayana</i>	5	6.9445	6.7570	6.4702	20.1717	<i>kabok</i>
<i>Dipterocarpus tuberculatus</i>	1	1.3889	1.3514	1.0403	3.7806	<i>phluang</i>
<i>Shorea obtusa</i>	3	4.1667	4.0542	1.3026	9.5235	<i>teng</i>
<i>Pterocarpus macrocarpus</i>	4	5.5556	5.4056	3.9195	14.8807	<i>pradu</i>
<i>Xylia xylocarpa</i>	2	2.7778	2.7028	0.9710	6.4516	<i>daeng</i>
<i>Sindora siamensis</i>	2	2.7778	2.7028	0.8414	6.3320	<i>makha tae</i>
<i>Lagerstroemia calyculata</i>	1	1.3889	1.3514	11.1147	13.8550	<i>tabaek yai</i>
<i>Adina cordifolia</i>	2	2.7778	2.7028	1.0138	6.4944	<i>khwao</i>
<i>Azelia xylocarpa</i>	1	1.3889	1.3514	1.1051	3.8454	<i>makha mong</i>
<i>Peltophorum dasyrachis</i>	1	1.3889	1.3514	0.3964	3.1367	<i>nonsi</i>
<i>Dolichandrone spathacea</i>	3	4.1667	4.0542	18.0461	26.2670	<i>khæ na</i>
<i>Diospyros rhodocalyx</i>	2	2.7778	2.7028	1.2628	6.7434	<i>tako na</i>
<i>Combretum quadrangulare</i>	1	1.3889	1.3514	0.1164	2.8567	<i>sakae na</i>
<i>Acacia siamensis</i>	2	2.7778	2.7028	0.7471	6.2277	<i>kathin phiman</i>
<i>Mitragyna javanica</i> var. <i>microphylla</i>	2	2.7778	2.7028	0.5423	6.0229	<i>kathum na</i>
<i>Butea monosperma</i>	1	1.3889	1.3514	0.5054	3.2457	<i>chan</i>

Table 66 The 10 Most Dominant Tree Species Standing in Paddy Fields in Northeast Thailand

Local Name	Scientific Name	IVI	Remark
<i>hiang</i>	<i>Dipterocarpus obtusifolius</i>	33.8055	T., R., L.
<i>yang na</i>	<i>Dipterocarpus alatus</i>	32.5206	T., L.
<i>khae na</i>	<i>Dolichandrone spathacea</i>	26.2670	F., M.
<i>maphok</i>	<i>Parinari anamense</i>	25.2491	T., O.
<i>kabok</i>	<i>Irvingia malayana</i>	20.1717	T., F., S., O.
<i>rok fa</i>	<i>Terminalia tomentosa</i>	19.0028	T., S., E.
<i>pradu</i>	<i>Pterocarpus macrocarpus</i>	14.8807	T., S.
<i>sabaeng</i>	<i>Dipterocarpus intricatus</i>	14.0012	T., R.
<i>tabaek yai</i>	<i>Lagerstroemia calyculata</i>	13.8550	T., E.
<i>chanuan</i>	<i>Dalbergia nigrescens</i>	10.2891	T., S.

Note: T. = timber; R. = resin; F. = food; M. = medicine; S. = soil improvement; E. = agricultural equipment; L. = latex; and O. = seed oil.

(*Dolichandrone spathacea*), and the last among the first 10 species is *chanuan* (*Dalbergia nigrescens*).

To avoid misunderstanding, I want to clarify the meaning of tree abundance, since it may differ from that in regards to natural forest. Trees in paddy fields are not a real forest but only the remnant after the clearing process of paddy field reclamation. So, the most appropriate description of abundance in this study should only mean the frequency of some particular tree species. *Hiang*, for example, is most abundant of the total of 28 species, and this means that we can find this tree in all paddy fields in the region.

I want to make one comment on the remaining of *khae na* (*Dolichandrone spathacea*). *Khae na* is a big tree, standing singly on paddy dikes. It produces a white flower during December to March. This flower is usually consumed by the farmers as a vegetable after boiling and as an ingredient in local curry. The taste is a little bitter but it is particularly good in combination with *lap pla duk* (catfish cooked in spicy in Northeastern style). The bitterness of the flower depresses the strong smell of catfish meat and makes more tasty dish. The heartwood of this tree is put in the bathing water for children to cool their body temperature and recover from sickness.

5) Zonation of Tree Distribution

All over the region, trees in paddy fields show greater or lesser differences in species composition. The main factor to divide them is the original forest type in the former days. The following three zones are remarkable.

(1) *Hiang* (*Dipterocarpus obtusifolius*) Zone

The area covers some part of the Sakon Nakhon basin between the latitudes of 17° 00' N and 18° 30' N or up to the north border of the region along Mekong River. This site is under the official administration of Udon Thani Regional Forest Division and consists of Udon Thani, Sakon Nakhon, Nakhon Phanom, Nong Khai, Nong Bua Lam Phu, and Loei. Most of the standing trees

belong to dry dipterocarp forest, such as *phluang* (*Dipterocarpus tuberculatus*), *teng* (*Shorea obtusa*), *sabaeng* (*Dipterocarpus intricatus*), and *daeng* (*Xylia xylocarpa*), and mixed deciduous forest, such as *pradu* (*Pterocarpus macrocarpus*), *tabaek yai* (*Lagerstroemia calyculata*), *kabok* (*Irvingia malayana*), *makha tae* (*Sindora siamensis*), *maphok* (*Parinari anamense*), *takhro* (*Schleichera oleosa*). A few species of evergreen forest are involved such as *yang na* (*Dipterocarpus alatus*), and *chan* (*Butea monosperma*). Planted trees are also common in this zone, with *tan* (*Borassus flabellifer*) and *makhm* (*Tamarindus indica*).

(2) *Yang Na* (*Dipterocarpus alatus*) Zone

The area covers the most of the central region between the latitude of 15° 30' N and 17° 00' N. This zone is under the Khon Kaen, Nakhon Ratchasima, and Ubon Ratchathani Regional Forest Division. Many provinces are involved: Khon Kaen, Maha Sarakham, Roi-et, Kalasin, Chaiyaphum, Yasothon, and Amnat Charoen. The trees remaining in this zone are mostly of evergreen forest such as *yang na* (*Dipterocarpus alatus*), *kabak* (*Anisoptera costata*), *takhian thong* (*Hopea odorata*), *sakae na* (*Combretum quadrangulare*), and *khae na* (*Dolichandrone spathacea*). Trees of mixed deciduous forest are also common *makha tae* (*Sindora siamensis*), *maphok* (*Parinari anamense*), *pradu* (*Pterocarpus macrocarpus*), *kabok* (*Irvingia malayana*), *kathin phiman* (*Acacia siamensis*), *tako na* (*Dalbergia rhodocalyx*), and *takhro* (*Schleichera oleosa*). A few trees of dry dipterocarp forest intermixed with them e.g., *hiang* (*Dipterocarpus obtusifolius*), *phayom* (*Shorea roxburghii*), *teng* (*Shorea obtusa*), *rok fa* (*Terminalia tomentosa*) and *daeng* (*Xylia xylocarpa*).

(3) *Kathum Nam* (*Crateva microphylla*) Zone

The area covers the rest of the lower part of the region and mostly on the lower flatland of the Nakhon Ratchasima basin from latitude of 15° 30' N to the southern border with Cambodia at the Phanomdongrak range. The main area is under the supervision of Nakhon Ratchasima and Ubon Ratchathani Regional Forest Division. The provinces in this zone are Nakhon Ratchasima, Surin, Buriram, Sri Saket, and Ubon Ratchathani. Tree species of flooded areas are commonly found such as *kathum na* (*Mitragyna javanica*) and *chan* (*Butea monosperma*), intermixed with dry dipterocarp forest tree species. Only one planted species is found, *tan* (*Borassus flabellifer*).

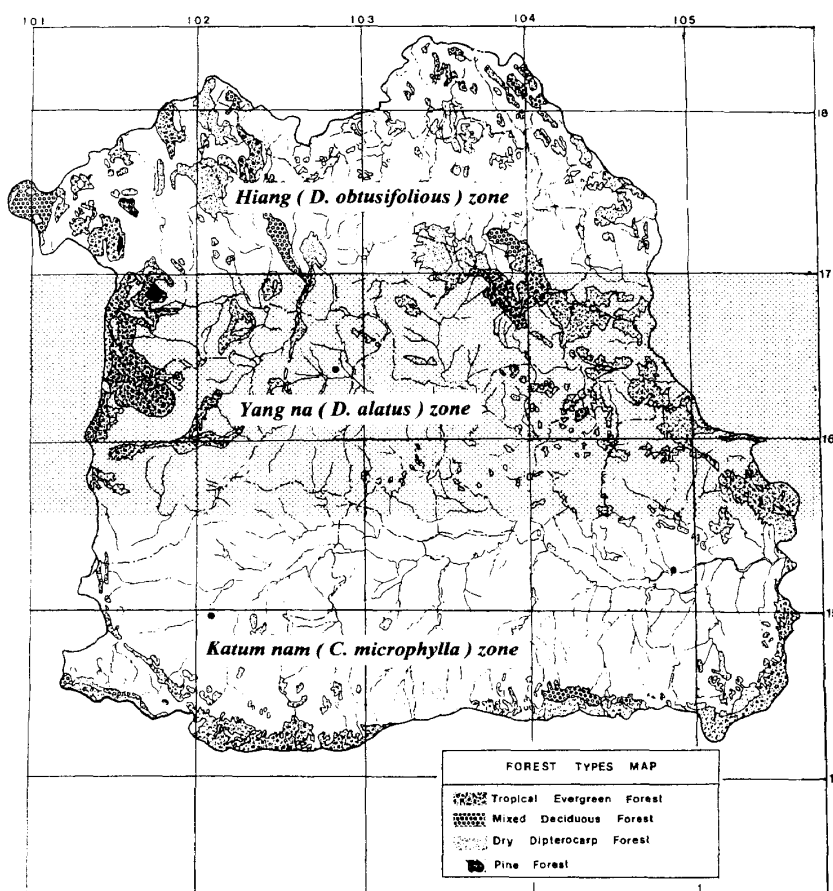
Table 67, and Figs. 15 and 16 show the details of this zonation. The trees on the first rank of each zone show the highest abundance, and those on the last rank show the lowest. Chronological order is arranged on the trees of each group.

4.4.2 *An Indicator Tree of Soil Properties*

Several tree species have their own specific suitability to some particular sites. The suitable species can grow fast on the site, while the unsuitable ones die out in the establishment stage. The metabolism of each tree depends very much on site quality. Once established, the tree predominates the site. Soil properties such as moisture, fertility, depth and type are the main factors to control the tree growth. Therefore, some tree species can be soil indicators.

Table 67 The Zonation of the Tree Distribution in Paddy Fields in Northeast Thailand

Zone	Location	Tree Species	Province
<i>Hiang Zone</i>	17° 00' N to 18° 30' N	<i>hiang, rok fa, pradu, yang na, phluang, teng, tabaek yai, kabok, sabaeng, makha tae, maphok, tan, chan, makham, takhro, and daeng.</i>	UDN, SKN, NKP, NKY, LOI, NBL
<i>Yang na Zone</i>	15° 30' N to 17° 00' N	<i>yang na, hiang, makha tae, sadao, kabok, maphok, phayom, pradu, teng, rok fa, takhian thong, kabok, sakae na, khae na, tan, kathin phiman, tako, makham, takhro and daeng.</i>	KKN, KLN, MKH, MHK, RTE, CHY, YSN, UMN
<i>Katum nam Zone</i>	14° 00' N to 15° 30' N	<i>kathum nam, kabok, hiang, pradu, teng, sabaeng, makha tae, sakae na, rok fa, khae na, maphok, phayom, phluang, tan, kathin phiman, chan, and tako.</i>	NKM, SRN, BRM, SSK, UBL

**Fig. 15** Tree Zonation on Paddy Fields in Northeast Thailand

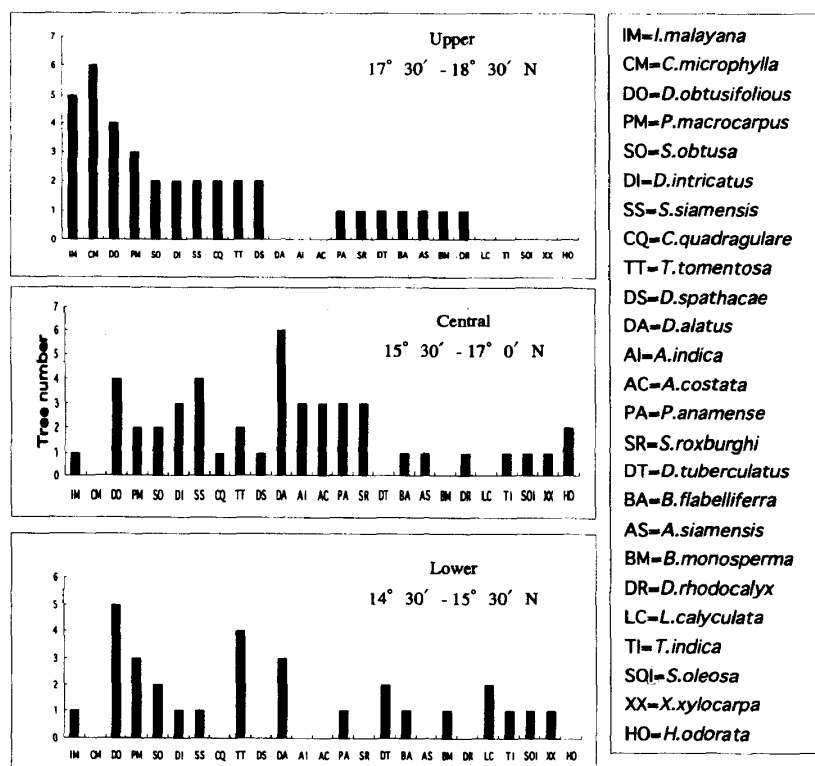


Fig. 16 The Ratio of Tree Species in Paddy Fields in Each Zone in Northeast Thailand

1) Soil Moisture

Trees in flooding areas have special organs for adaptation. These include suckers and aerial roots for holding the main stem and transpiration. On the other hand, trees in arid areas are those of succulent plants, whose leaves become small or change to another shape. Three categories are found. The common flooding vegetation includes *khai nun* (*Salix tetrasperma*), *wa* (*Eugenia cumini*), *yang na* (*Dipterocarpus alatus*), *taeng saeng* (*Cananga latifolia*), and *kum nam* (*Crateua magna*). The terrestrial vegetation is found nearly everywhere in paddy fields and includes *phluang* (*Dipterocarpus tuberculatus*), *kabak* (*Anistonia costata*), *pradu* (*Pterocarpus macrocarpus*), *daeng* (*Xylia xylocarpa*) and so on. Halophytic vegetation includes thorny and creeping types, such as *nam khom* (*Zizyphus cambodiana*), *masang* (*Feronia lucida*) and so on.

2) Soil Fertility

In the best sites (fertile soil), trees with big trunks and canopies and deep root systems predominate, such as *pradu* (*Pterocarpus macrocarpus*), *makha mong* (*Azelia xylocarpa*), *makham* (*Tamarindus indica*). On the moderate soil, trees are those of *Dipterocarpus* species. *Shorea* species cover poor soil, such as *teng* (*Shorea obtusa*), *rang* (*Shorea siamensis*), *phayom* (*Shorea roxburghii*) and so on.

Soil fertility might be related to the forest types: best soil with SRF, moderate soil with MDF, and poor soil with DDF.

3) Soil Depth

The soil on lowland and lower slopes is commonly deeper than on the upper slopes. Tree species also play a significant role in indicating the depth of soil. Trees on deeper soil have big, tall stems, and big, round canopies; those on shallow soil are smaller. Soil depth categories are related to dominant species.

Deeper soil (100 cm): *yang na* (*Dipterocarpus alatus*), *kabak* (*Anisoptera costatus*), *takhian thong* (*Hopea odorata*), *phluang* (*Dipterocarpus tuberculatus*), *pradu* (*Pterocarpus macrocarpus*) and many kinds of rattans.

Moderate soil (50-100 cm): *Shorea* spp., *Terminalia* spp., *Albizia* spp., *sak* (*Tectona grandis*), *sabaeng* (*Dipterocarpus intricatus*), *hiang* (*Dipterocarpus obtusifolius*), *phayung* (*Dalbergia cochinchinensis*), *chingchan* (*Dalbergia oliveri*) and *cham churi* (*Samanea saman*).

4) Soil Salinity

Trees standing dead as a result of saline soil are becoming more numerous. Salt-resistant species are *nam daeng* (*Maytenus mekongensis*), *nam phung do* (*Azima sarmentosa*), *son thale* (*Casuarina*

Table 68 Indicator Trees of Soil Properties of the Paddy Fields in Khon Kaen, Northeast Thailand

Soil Properties	Indicator Trees	
	Local Name	Scientific Name
Moist soil	<i>yang na</i>	<i>Dipterocarpus alatus</i>
Deep soil	<i>phluang</i>	<i>Dipterocarpus tuberculatus</i>
Fertile soil	<i>pradu</i>	<i>Pterocarpus macrocarpus</i>
Dry soil	<i>kathin phiman</i>	<i>Acacia siamensis</i>
Saline soil	<i>nam phung do</i>	<i>Azima sarmentosa</i>
Flooded soil	<i>khai nun</i>	<i>Salix tetrasperma</i>
High water table	<i>khanun</i>	<i>Artocarpus heterophyllus</i>
Low water table	<i>kabok</i>	<i>Irvingia malayana</i>
Poor soil	<i>yopa</i>	<i>Morinda coreia</i>

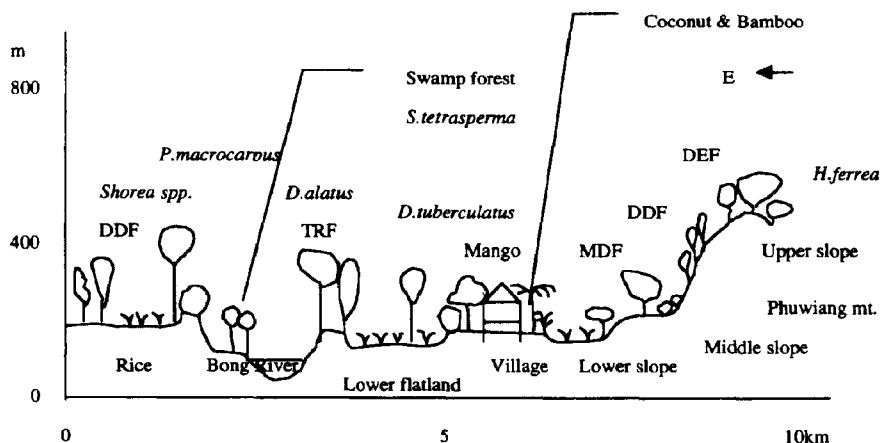


Fig. 17 The Overall Diagram of the Indicator Trees of Soil Properties at Ban Phon Phek Village, Phu Wiang, Khon Kaen, Northeast Thailand

equisetifolia), *nam khom* (*Zizyphus cambodiana*), *chaeng* (*Lithocarpus wallichianus*), *rang sai* (*Buchanania siamensis*) and many *Acacia* spp.

4.4.3 Wood and Non-wood Forest Products from Trees on Paddy Fields

Trees standing on paddy fields provide the farmers with many products. They play the same role as trees growing in the natural forests. The farmers are keenly aware of what products they can collect from the trees at what time. Most of the 28 tree species provide wood products to the farmers, but many of them produce non-wood products such as the latex and soil from *yang na*. *Sadao* provides the farmers with leaves and flowers as food, seeds as insecticide, and wood as timber. Leaves, latex, and resin are also collected from *phluang* tree. Table 69 lists the products from 28 tree species on the paddy fields.

Table 70 summarizes the uses of various tree organs used for timber, latex, food, medicine, seed oil, fodder, resin, tools, fertilizers and so on. Timber of various quality is obtained from all 28 tree species. Poles of *makha tae* (*Sindora siamensis*) timber are most favorable of all farmers

Table 69 Products from 28 Main Tree Species on Paddy Fields in Northeast Thailand

Local Name	Scientific Name	Products
<i>hiang</i>	<i>Dipterocarpus obtusifolius</i>	T., L.
<i>yang na</i>	<i>Dipterocarpus alatus</i>	T., L.
<i>khae na</i>	<i>Dolichandrone spathachae</i>	F., M.
<i>maphok</i>	<i>Parinari anamense</i>	T., O.
<i>kabok</i>	<i>Irvingia malayana</i>	T., O., S.
<i>rok fa</i>	<i>Terminalia tomentosa</i>	T., E., S.
<i>pradu</i>	<i>Pterocarpus macrocarpus</i>	T., D., S.
<i>sabaeng</i>	<i>Dipterocarpus intricatus</i>	T., R., L.
<i>tabaek yai</i>	<i>Lagerstroemia calyculata</i>	T., E.
<i>chanuan</i>	<i>Dalbergia nigrescens</i>	T., S.
<i>teng</i>	<i>Shorea obtusa</i>	T., R.
<i>tako</i>	<i>Diospyros rhodocalyx</i>	F., M., Y.
<i>daeng</i>	<i>Xylia xylocarpa</i>	T.
<i>makha tae</i>	<i>Sindora siamensis</i>	T.
<i>khwao</i>	<i>Adina cordifolia</i>	T.
<i>phayom</i>	<i>Shorea roxburghii</i>	T., M., D., R.
<i>khatin phiman</i>	<i>Acacia siamensis</i>	T., M.
<i>kathum na</i>	<i>Mitragyna javanica</i> var. <i>microphylla</i>	T., F.
<i>makham</i>	<i>Tamarindus indica</i>	T., F., S.
<i>makha mong</i>	<i>Azalia xylocarpa</i>	T., S.
<i>chan</i>	<i>Butea monosperma</i>	T.
<i>nonsi</i>	<i>Peltophorum desyrachis</i>	T.
<i>phluang</i>	<i>Dipterocarpus tuberculatus</i>	T., R., L., W.
<i>takhian thong</i>	<i>Hopea odorata</i>	T.
<i>sadao</i>	<i>Azadirachta indica</i> var. <i>siamensis</i>	T., M., F.
<i>phayung</i>	<i>Dalbergia cochinchinensis</i>	T., S.
<i>kang hung</i>	<i>Dalbergia siamensis</i>	T., S.
<i>sakae na</i>	<i>Combretum quadrangulare</i>	T., M.

T=timber, L=latex, F=food, M=medicine, O=seed oil, S=soil improvement, E=equipment, D=fodder, R=resin, Y=dying, W=wrapping

Table 70 Use of Products from Different Organs of Trees on Paddy Fields in Northeast Thailand

Use	Tree Species	Tree Organ	Remark
Timber	All 28 tree species	Stem	
Latex	<i>hiang, yang na, phluang, sabaeng</i>	Stem	
Resin	<i>sabaeng, teng, phayom, phluang</i>	Stem	
Food	<i>daeng</i> <i>sadao</i> <i>khae na</i>	Stem Leaf, flower Flower	
Medicine	<i>khae na</i> <i>tako</i> <i>phayom</i> <i>kathin phiman</i> <i>sadao</i>	Bark/Heartwood Heartwood Heartwood Heartwood Root	Antipyretic Muscular pain Diuretic Antipyretic Stomach pain
Soil improvement	<i>kabok, rok fa, daeng, makham, pradu, makha mong, phayung, kang hung</i>	Leaf	Nitrification
Agricultural equipment	<i>rok fa</i>	Bark fiber Wood	Rope Tool handles
Fodder	<i>pradu, phayom</i>	Leaf	
Seed oil	<i>maphok, kabok</i>	Seed	Vanish oil
Dye	<i>tako</i>	Fruit	Black color
Wrapping	<i>phluang</i>	Leaf	Fresh food wrapping

because of their durability. Some timbers keep more than 50 years. *Teng* (*Shorea obtusa*) is multi-purpose wood for house construction, poles, floor, planks, doors and window frames. *Teng* is among the most popular woods for flooring. *Hiang* (*Dipterocarpus obtusifolius*) is now becoming popular timber for house construction because of its abundance in every paddy field.

The farmers in the Northeast prefer to build their house from several kinds of trees. Table 71 shows the various parts of houses made from some particular tree species, which is compiled from my own observation.

The farmers in Ban Rua village, Phu Wiang collect products from trees on paddy fields in a fixed period. Table 72 shows their collecting calendar through out the year, compiled from my own observation.

Table 71 Main Part of the Phu Wiang Farmer's House

Part of House	Tree Species
Pole	<i>makha tae, teng, rok fa</i>
Plank	<i>teng, hiang, yang na, phluang</i>
Floor	<i>yang na, tabaek yai, teng, pradu, makha mong, nonsi, khwao</i>
Frame	<i>takhian thong, pradu, phayom, makha mong</i>
Door	<i>takhian thong, yang na, hiang, phayom</i>
Window	<i>takhian thong, yang na, hiang, phayom</i>
Ceiling	<i>yang na, hiang, phluang</i>
Wall	<i>takhian thong, yang na, phluang</i>
Ladder	<i>daeng, makha mong, pradu</i>
Roof	<i>phluang, tabaek yai</i>

Table 72 The Collecting Calendar of Wood and Non-wood Forest Products from Trees on Paddy Fields in Ban Rua Village, Phu Wiang, Northeast Thailand

Tree Organs	J	F	M	A	M	J	J	A	S	O	N	D
<i>phak wan</i> leaf	×	×	×	-----								
Bamboo shoot						×	×	×				
<i>sadao</i> leaf	×											×
flower	×											×
<i>khae na</i> flower		×	×									
<i>khae ban</i> leaf	×	×	×	×	×	×	×	×	×	×	×	×
flower					×	×	×	×				
<i>tan</i> fruit			×	×								
<i>khilek ban</i>	×	×	×	×								
Paddy herb					×	×	×	×	×	×		
<i>kum bok</i> leaf		×	×	×								
<i>daeng</i> fruit							×	×				
<i>yang na</i> latex				×	×							
<i>phluang</i> latex				×	×							
<i>hiang</i> latex				×	×							
Firewood	×	×	×	×	×						×	×
Mushroom*					×			×	×	×	×	×
Charcoal		×	×	×								
Winter crops**	×	×									×	×

* *Leutiuns* spp., ** onion, garlic, cucumber, bean, corn, green leaf vegetable etc.

4.4.4 Nutrients from Trees

The nutrients contained in litter fall are released into paddy soil through the decomposition process. This is the fundamental principle for the sustainability of paddy soil in the region. The nutrients come from trees standing on and from the nearby forests. In the rainy season, surface runoff transports some nutrients from the forest to paddy soil. Adulprasertsuk [1993] made a chemical analysis on the leaf litter from main six tree species on the paddy fields (Table 73).

Vitayakorn *et al.* [1988] made an intensive study of the paddy fields with zero, low and high density of standing trees. They found from chemical analysis of soils from tree study sites that soil in paddy fields with high tree density contains twice as much organic matter as fields with low tree density, and more than eightfold the phosphorus level of the plot without trees. Some details of their study are cited in Table 74.

Table 73 Nutrients of the Leaf Litter under the Trees on Paddy Fields in Khon Kaen, Northeast Thailand

Tree Name	Chemical Composition(%)							
	C	N	C/N	P	K	Ca	Mg	
<i>kabok</i>	46.75	0.70	67.10	0.028	0.203	0.06	0.233	<i>Irvingia malayana</i>
<i>cham churi</i>	52.55	2.04	25.8	0.060	0.195	1.50	0.112	<i>Samanea saman</i>
<i>teng</i>	53.08	0.58	90.9	0.022	0.188	1.50	0.150	<i>Shorea obtusa</i>
<i>daeng</i>	47.53	1.25	38.1	0.051	0.815	0.63	0.315	<i>Xylia xylocarpa</i>
<i>phluang</i>	44.73	0.62	71.8	0.059	0.213	0.68	0.233	<i>Dipterocarpus tuberculatus</i>
<i>makham</i>	45.87	0.89	51.7	0.062	0.230	2.30	0.398	<i>Tamarindus indica</i>

Source: [Adulprasertsuk 1993]

Table 74 Chemical Properties of Paddy Soil under Different Degrees of Tree Cover in Northeast Thailand (0-20 cm soil depth)

Tree Covering	Organic Matter(%)	pH ppm	P	N	K	Ca	Mg
High density	0.81	6.5	8.3	0.04	11.0	172.5	21.0
Low density	0.37	6.3	8.2	0.04	11.0	172.5	21.0
Without tree	0.47	5.8	0.7	0.034	14.0	203.8	42.0

Source: [Vitayakorn *et al.* 1988]

4.5 *Mitigation of Forest Degradation*

Forest degradation causes economic problems for people and hazardous effects on the environment of the region and the whole country. The government in several sectors takes intensive care to implement projects for each particular purpose, and aims at developing the forest lands in the national forests which have almost lost their covering vegetation. The governmental organizations concerned are Royal Forest Department (RFD), Forest Industry Organization (FIO), Department of Land Development (DLD), Cooperative Promotion Department (CPD), Agricultural Land Reform Office (ALRO), Community Development Department (CDD) and Department of Public Welfare (DPW). The activities of each department are different, but their common target is to rehabilitate the national forest.

4.5.1 *Forest Rehabilitation*

1) *Forest Plantation*

The projects aim at creating a number of forests on deteriorated forest lands. General forest plantation emphasizes the following objectives.

Economic

Planting any selected tree species means to benefit the planter with direct products such as timber or hewn logs after harvesting and indirect products such as medicinal plants, foods as well as fodder for animals. All products provide cash income for the farmers.

Conservation

Tree planting has rehabilitational purposes on the watershed areas. The soil will be protected from the direct raindrop impulse, and better root cementing and surface mulching will be obtained. The soil will have more stability and soil nutrients from litter-fall. Water supply to catchment areas will be more regular. The forest will be more satisfying to the people with its fresh air under the canopy and cooler temperature in the day time. The canopy of planted trees will act as a wind-breaker for the village. The planted tree community will gradually increase the regeneration of weed, grasses and seedlings, which become grazing material for animals.

Social

The forest plantation increases the hiring of labor from the nearby villages and stimulates the people to stay home and work with their family. This will stabilize social conditions.

Forest plantation is carried out by different methods, traditional and *taungya* system. The former aims to rehabilitate the mountainous areas where the original trees have disappeared as a result of logging. The planting aims to restore the green and wilderness of the forests. On the lowland, the reforestation aims to protect soil from erosion. The budget for this planting is mostly from the government and partly from the concessionaires who make compensation payment for the logging. RFD is responsible for producing the seedlings, preparing the site, transplanting and tending.

The *taungya* system was modified into the forest village system for effective working and to match conditions in Thailand. There is a big amount of abandoned lands in NRFs which were encroached upon by farmers. To bring these encroachers together in the same place, RFD

started a project in 1975 with the objectives of preserving and protecting the remaining forest in NRFs, and restoring the forest on watershed areas which are not suitable for agriculture. RFD allocates proper lands for crop planting to the landless people scattered in NRFs and tries to settle them in a permanent settlement.

Chuntanaparb and Wood [1986] stated the principles of the forest village as follows.

- (1) To set up a place outside the watershed area for people who have encroached into the forest by organizing a group with a headman and committee chosen and administered by themselves.
- (2) The government gives them up to 0.024 km² (15 *rai*) of land to each family. For this land they have the right to occupy (but not ownership) and can leave the right to their heirs. This is to protect them from financiers who might obtain the land by default of loan and other means.
- (3) The RFD and other related government departments concerned with helping the people in a forest village develop suitable occupations and provide basic amenities such as water supply, road, school, health station credits etc.
- (4) The government (RFD) hires, at fair rate, the labor from the forest village to plant trees in the area around the village.
- (5) When the village is well set up, the Cooperative Promotion Department (CPD) helps the people to form an Agricultural Cooperative and they get the right to various benefits available to the members. This includes obtaining additional land on long-term rent from RFD for the Cooperative's agriculture development.

There are so many encroachers in the forests that it seems to be hard to choose them as forest village members. The procedure for admitting new members is carried out by the Project Management Committee (PMC), which is formulated with many people from official sectors in the area (Table 75).

The committee also administers the project and assigns land to the farmers in each village according to the target and plan, and solves the various problems including speeding up work related to local security, education, vocational promotion and other development works as

Table 75 The Forest Villages Project Management Committee

Government Officer	PMC
Provincial Governor	Chairman
Provincial Police Inspector	Member
Provincial Land Officer	"
Provincial Agricultural Officer	"
Provincial Cooperative Officer	"
District Forest Officer	"
Provincial Forest Officer	"
Regional Forest Officer	"
Head, Forest Village Project	Member & Secretary

considered appropriate to the area. When there are problems in policy implementation, the committee will consult with the Committee of Forest Resource Conservation in each local province to find a solution. The new members of a forest village project must satisfy the following qualifications:

Thai nationality, adult and family head, good health and not have anti-social disease, able body and able mind, diligence, good behavior, farmer who has not enough land for farming or in a small scale, must use or manage the land allocated by the committee and finally observe the rules and regulations and accept the condition of land allocation.

The private sectors in the region carry out some tree planting projects on their lands. They plant fast-growing trees and emphasize short rotation harvesting and selling their products as material for pulp making. Some big owners run the whole process by themselves. Private plantations are notable in Udon Thani, Buriram and Khon Kaen.

The FIO runs a forest plantation project to plant *sak* in the North and other economic tree species in the other areas with the forest village system. *Eucalyptus* is among the common trees planted in the Northeast. The forest plantation area under forest village system in the Northeast totals 600 km² in 47 projects [Thailand, RFD 1994b; Thailand, FIO 1994], of which 33 projects with the area of 480 km² are controlled by RFD and the remaining 14 projects on 128 km² by FIO's.

2) *Forest Land Allotment Project*

Most of the degraded forests areas are claimed by rural poor farmers both on watershed and non-watershed areas. They have no right to the land or even to any tree planted. But they still spend all of their effort to cultivate several kinds of plant for earning their living. Solving the problem of land rights and limiting their encroachment into the forest are the main objectives of this project, which covers the area outside the watershed.

The detailed objectives of the project, set up by the RFD are the following:

- (1) To help the people occupying and cultivating areas of national forests (NFs) get land use right in order to produce confidence and pride in land belonging to them, give the forest encroachers a permanent home and prevent them migrating to clear other forests.
- (2) To encourage the people to plant trees in NFs where trees have been destroyed outside the area received from the project. The RFD distributes seedlings and gives technical assistance to the people to plant trees. Those who plant receive permission to take care of trees and to harvest them for their own use.
- (3) To create good relations between Forestry Officers and the people.
- (4) To build the foundation on which other work units can develop occupations for the people.
- (5) To know the area of NFs occupied by farmers and the area where forest is still in good condition and needs to be protected. Officials must inform the people of the value of keeping forest and the bad effects of destroying it and try to gain the cooperation of the people to protect the forest.

- (6) To help the Forest Protection Unit in identifying proper areas to be protected and the RFD to make a plan for restoring the destroyed NFs by planting trees on the remaining destroyed forest area.
- (7) To improve work in NFs areas on a technical basis.

Procedure for land allotment is as follows.

The RFD people seeks the land outside the watershed areas with the slope of less than 30% which had been encroached upon before 1982. Each family has the right to plant crops in 0.024 km² (15 *rai*). If the cleared land is bigger but less than 0.048 km², the rest can be assigned to the encroacher to plant tree seedlings distributed by the project. Thus, they can cultivate crops on 0.024 km² allotment and plant trees on the annexational area. But selling of the land is prohibited. It should be an inheritance for the encroacher's children. Most of the allotment lands are limited to the high slopes and suitable only for upland crops.

The project assures the farmers by giving them a certificate of land use right, STK-1 and STK-2 five and ten years later. Up to 1990, the allotted land under the project in the Northeast reached 5,440 km² in 375,182 plots [Thailand, RFD 1990a].

3) *Agricultural Land Reform Project*

The government, through the Agricultural Land Reform Project (ALRP), undertakes projects on the degraded forest lands to promote the stability and productivity of the lands. The target lands will be reformed each year depending on the annual plan and budget. Such lands are occupied by many encroachers who claimed as much land as they could. But according to the reformation rule, only 0.048 and 0.096 km² of land will be given to each family for agriculture and livestock respectively. The rest of the encroached lands must be assigned to another family. In addition, 20% of the land will be preserved as the forest area for environmental purposes.

The farmers who participate in the project are screened by the ALRP committee¹⁾ with regards to qualifications in a similar ways to the Forest Village Project.

Various infrastructures are constructed within the framework of the reformation program, such as roads, reservoirs, electricity, deep wells, water tanks, shallow wells, irrigation canals,

1) Committee in Agricultural Land Reform Project;

Minister of	MOAC	Chairman
Permanent Secretary of	MOAC	Member
“	MOC	“
“	MOI	“
“	MOIRD	“
Director General of	DLD	“
“	DAE	“
“	DPA	“
“	LD	“
Managing Director of	DAAC	“
Selective members		“
Secretary General	ALRO	Secretary

community wood-lots, cooperatives, farm-training courses, fertilizer distribution programs. All of these activities aim to support the farmers' cultivation within the reformation areas and to keep the farmers settled in their lands without encroaching into the forests. The land reform in the Northeast in 1990 was six units with 480 km² of land.

4) *The Self-help Settlement Program*

The government assists landless farmers to obtain land for living and cultivation in the degraded forests through the DPW. The aim is to relocate on government land the landless farmers who suffered from drought, flood after dam construction, optical conflict or poverty. The farmers are given certified land rights which can only be inherited by their heirs. After receiving the Land Use Document (NS 3) and/or Land Title Deed, usually within five years, they can assign the land for any use.

After settlement, the DPW provides many activities to each community to meet the farmers' need, such as the following.

Occupation development

The activities include the production increment, marketing, research for finding an economic crop for each site, extension for supplementary occupation outside agriculture for earning more income.

Social development

The activities emphasize compulsory education at the primary level and encourage higher education in college and university. Public health is also one of the main activities to guarantee the better ways of living. Malnutrition is a common hazard among these farmers, and the department improves a lot on the source of drinking water and on sanitary aspects.

Administration development

The DPW takes the lead in settlement of the new communities. First, rules and regulations are formulated to meet the needs of their members. An official village headman is elected by the members under the supervision of the department. Programs for developing the living status and morals were implemented as well as programs for generating income for the stabilization of each family member. The programs in 1990 covered an area of 3,520 km² with 17 units in the Northeast.

4.5.2 *Research and Study*

RFD plays an important role in conducting research to improve the degraded forests. With support from international agencies and some collaborating countries, RFD staff and researchers at national universities conduct many research projects. In the Northeast some research projects supply field tools to support field RFD staff and personnel who carry out research for the further management steps.

1) *The Improvement of Tropical Wasteland Project*

The project aims to improve the wasteland after forest degradation. Tree planting was the highlight of the project, particularly reforestation and silvicultural practice after planting. The

Table 76 The Growth of *Eucalyptus camaldulensis* Planted on the Fertilized and Non-fertilized Plot at Somdet Plantation, Kalasin

Age yr.	Fertilizer				Non-fertilizer	
	Chemical DBH	H	Compost DBH	H	DBH	H
1	0.10	1.15	0.01	0.92	0.06	1.06
2	2.83	3.95	1.82	2.77	2.23	3.20
3	5.87	7.48	4.93	6.05	5.27	6.82
4	6.67	9.26	6.04	8.24	6.47	8.93
5	7.01	9.35	6.45	8.96	6.84	9.23
6	7.58	11.66	7.18	11.06	7.96	11.56
7	7.86	11.98	7.26	11.31	8.10	12.02
8	8.52	12.65	7.95	11.76	8.47	12.13
Average	5.81	8.47	5.21	7.60	5.68	8.12

Source: [Yoda and Sahunalu 1991]

details of the study are reported elsewhere [Yoda and Sahunalu 1991]. The lesson learned from this study is that *Eucalyptus* seedlings can be planted without applying either chemical fertilizer or compost (Table 76). This will reduce the cost of tree plantation for many poor farmers.

2) *The Integrated Development of the Phu Wiang Watershed (Phu Wiang Project)*

The project was carried out by RFD staff with technical and financial support from FAO/UNDP during 1984-89, coincidentally with the National Socio-economic Plan aiming at the improvement of the living standard of local villagers and backing up social stability by development and utilization of natural resources on the upper part of the catchment area. The watershed management was the core activity of the project. The integrated land use planning to protect the upper watershed area was introduced as well as the economic development of the local villagers by increasing income, and by applying the learned lessons from the project to the implemented level in many RFD areas in the region [UNDP/FAO 1991].

Phu Wiang forest covering an area of 301 km² is a small tributary of Nam Phong Watershed in Khon Kaen, Loei, Udon Thani. The mountain is a big crater with trees. The forest is on the out-ridge, and 17,187 people in 32 villages live on the main terrace close to the outlet. The forest produced a large amount of timber from the early 1930s through the harvesting by local sawmills which got permission from the government. The logging was halted in 1989, and the forest is still one of the better forests in the country. The land use is divided into eight categories (Table 77).

The project was implemented to stop the villagers from invading the natural forests. During the last two decades, some of the farmers started to encroach into the forest through the logging road and planted cash crops, mainly cassava. This actively accelerated the soil loss on the steep slope. To keep them out, the project promoted some pilot projects. The final results of the project seem to fulfill the original objectives, and the activities became the permanent jobs of the farmers

after the termination of the project in 1989. Table 78 shows the implemented project.

Two committees were set up to start the working of the project. The first committee, Executive Cooperation Committee (Table 79) was chaired by the Inspector of MOAC and many members from the departments concerned. The second committee, the Local Advisory Committee, was chaired by the District Chief, and included the head of each section in the district office as well as the sub-district headman in the watershed area (Table 80). The committee took responsibility for discussion and brain-storming for comments on the working on the project's activities.

Table 77 Land Use Pattern in Phu Wiang Watershed, Khon Kaen (1989)

Land Use	Area, km ²
DEF	30
DDF	50
Forest plantation	13
Field crop area	51
Paddy field	48
Outcrop	3
Water tank	2
Residence	5

Source: [Thailand, RFD 1990a]

Table 78 The Final Results of Phu Wiang Project during 1983-89

Number	Type of Work	Unit/area	Remark
1	Forest plantation (km ²)	15	
2	Forest fire-line protection (km)	80	
3	Land use demonstration		
3.1	Agroforestry (km ²)	0.2	
3.2	Rangeland (km ²)	0.6	
3.3	Fruit tree plantation (km ²)	0.4	13 species
3.4	Rotation crop (km ²)	0.5	
3.5	Bamboo plantation (km ²)	0.08	
3.6	Conservation agriculture farm (km ²)	0.2	
3.7	Compost demonstration, village	8	
3.8	Seedling production, million	1.5	
4	Extension and training		
4.1	Local training, participant/time	898/24	
4.2	International training, participant	4	
4.3	Village organizer, village	8	
5	Research and study, topic	31	

Source: [UNDP/FAO 1991]

Table 79 The Executive Cooperation Committee of Phu Wiang Project

Official Position		Committee
Inspector General	MOAC	Chairman
Deputy General	RFD 1	Vice-chairman
Representative	DAE	Committee
“	DF	“
“	DL	“
“	DLD	“
Rep/Director	NEAO	“
Chairman Local Advisory Committee		“
Project Director		Committee & Secretary
Project Coordinator		Committee & Vice Secretary

Table 80 The Local Advisory Committee, Phu Wiang Project

Official Position		Committee
Phu Wiang District Chief		Chairman
District Agricultural Officer		Committee
District Local Development Officer		“
District Land Officer		“
Representative NEAO		“
Representative Khon Kaen University		“
Representative RFD, Khon Kaen		“
Sub-district Headman		“
Chief, Forest Protection Unit, Phu Wiang		“
District Livestock Officer		“
Chief, Technical Adviser		“
Project Field Director		Committee & Secretary
District Forest Officer		Committee & Vice Secretary

The lesson learned from the project gives a clear methodology for tackling similar sites and problems. Extension, for example, is one of the fruitful result of the project. Many villagers who attended the course got a broad view of how to tackle the environment and improve their daily life. Good understanding developed among the villagers and the RFD staff is one of the credits. To maintain their income and security of the forest, training programs help very much on fruit tree propagation, mushroom and fish raising as well as grazing ground improvement for domestic animals.

3) *The Northeast Thailand Upland Social Forestry Project*

The Ford Foundation is a financial supporting organization to the project since 1986. The target

of the project is clearly seen in the comment made by Chuntanaparb and Wood [1986] that

It is generally recognized in Thailand that there is an urgent need to review and improve the role of the government agencies in protecting, managing and planting forest, in order to protect the remaining forest from degradation and destruction and to increase the area of planted forest as a resource base for industry, for the protection of watershed and to restore reserved forest. This has mainly arisen from the increasing awareness on the part of politicians, the public and government officials towards the importance of forest in maintaining soil, water supplies, and climate and from the awareness of the people involved in rural development of the importance of forest in maintaining local communities, especially in the dry season, through the provision of numerous forest products such as fuel-wood, construction materials, edible herbs, shoot and fruits, and medicinal plants both for consumption and sale.

To meet with the target, RFD as the core government department with technical collaboration of the professors of Khon Kaen University selected sites for the project. Dong Mun forest in Kalasin is the site of the project in the region.

Dong Mun forest used to be the dense jungle in the early 1970s and some logging was launched up to 1989. The migration of people became masked from around 1980s and caused huge loss of forest. The forest was completely destroyed and turned into housing and planting areas of many farmers. The project covers a total of 15 villages on the site. These farmers have no right to the land they live on and the plant. The forest is the reserved forest according to the NRF Act 1964. There are many activities such as the working collaborately with many institutes on multi-discipline, working with the villagers through Community Organizer, demonstration of vegetation planting, the villager seminar, data and information collection, promotion of tree planting program.

The case study from Ban Nong Amnuai community forest [Prachaiyo 1991] is part of the project. Ban Nong Amnuai village is located in Dong Mun NRF, Kalasin. In the early 1980s, the village headman understood that a community forest was important to the stability of his village of 30 households. He and other villagers looked for a suitable forest area for a community forest and found Phu Noi forest as a suitable site.

Phu Noi, a small mountain within Dong Mun, is only 1.5 km from the village and covers an area of 0.32 km² of undulating terrace. The trees standing are most of MDF such as *makha mong* (*Azelia xylocarpa*), *takhian thong* (*Hopea odorata*), *tabaek yai* (*Lagerstroemia calyculata*) in the upper layer, many younger trees in the lower story, and *ya kha* (*Imperata cylindrica*) as the ground cover.

They demarcated the forest by clearing around its perimeter and applied to the District office for permission to manage the forest because it was inside the NRF. In 1988, the initial phase of the Social Forestry Project was implemented in Dong Mun. By this time, pressures on forest resources were increasing due to migration, and the number of the village households reached 200. Most of the trees in the community forest had been cut, scattered only small trees of DDF,

makha tae (*Sindora siamensis*), *teng* (*Shorea obtusa*) and *rang* (*Shorea siamensis*) remained. Many farmers cut the trees for cremation, especially on the area of 0.05 km² assigned as the village cremation forest. This was observed by the CO²⁾ who worked with the people in this village. He proposed a tree planting scheme on the cremation forest by many means. The details of the planting scheme were announced each morning through a speaker in the village. He explained the benefit of tree planting, the planting method to be used, and the subsequent management and harvesting plans of the plantation. The CO and the members of the village talked about the scheme in the monthly meeting of the village. The villagers discussed the tree planting plan for community forest among themselves. The CO worked for months before getting the final agreement from the whole village.

After building a broad consensus for tree planting, the CO provided about 3,000 seedling of *Eucalyptus camaldulensis* which were obtained from RFD project in Dong Mun. The CO, the village committee, and the villagers worked together throughout the entire rainy season to prepare the site and planted all the seedlings on the 0.05 km² site. The trees were planted in 4 × 4 meter spacing in order to obtain the bigger timber for fuel and several sprouts after cutting.

4.5.3 Forest Protection

Forest protection is the main assignment of the RFD to keep the natural forest for future use. Many acts and regulations have been formulated for the purpose of protection of the national forest. RFD is the only government department to take a heavy task for the vast forest, and forest protection is only one activity among the routine work of the department. The District Forest Office has only one member of staff in the office. His responsibility covers on forestry work in the district, permission, extension and forest protection. It's quite a hard job that has continued in the office since the establishment of RFD a century ago.

1) Forest Protection Unit

This is the ground base of the RFD's forest protection program. The unit was administered under the Regional Forest Office in the region from 1957 to 1991, since when it has been under the Provincial Forest Office in each province. It consists of seven to eight permanent and temporary staff and eight temporary laborers who work as forest guards with one or two light trucks, guns, motorcycles, and wireless transmission radios in each unit. The main responsibility is to protect trees and natural forests, NRFs/NFs, on the designated areas from any kind of destruction. The

2) Community Organizers (COs) are temporary staff who have practical agricultural experience and have completed certificate level study at the Institute of Agriculture. They work closely with RFD and Social Forestry Research Project (SFRP) staff from Khon Kaen University for the duration of project implementation. Before working on a project, they attend an intensive social forestry course to familiarize themselves with project guideline and methods involved for project field work. Monthly meetings are held among COs, RFD and staffs from SFRP to evaluate the work carried out in the field during the previous month, to discuss problems encountered in the field, and to adjust the work plan for the upcoming month.

unit has official buildings in the forest and some resident houses for each member of staff. The total number of units in the region was 111 in 1991. The official assignment of each unit is as follows:

- (1) Patrolling the forest areas by walking or driving to drive out the encroachers or any wrongdoers in the forest.
- (2) Arrest evident poachers who are logging without government permission, and take them to the prosecuting process in the local district to continue any further subsequent steps.
- (3) Protect wood and non-wood forest products from illegal gathering.
- (4) Teach local people about forestry laws and ways to conserve natural trees and forests.
- (5) Cooperate with other officers in the local district especially for forest protection.

Most works of the unit have been carried out in the NRFs, which number 352 forests in the region and cover an area of 55,119 km² [Thailand, RFD 1992].

2) *National Parks*

The forests with natural features such as waterfalls, cliffs, caves, unique big standing trees and strange stones valued for sightseeing and amenity aspects have been managed for recreation purpose. Roads for convenient access, resting houses for tourists and camping grounds are arranged under a national budget by RFD. Phu Kradueng, for example, is among the famous national park in the region. Located on a high plain on the top of a mountain at an elevation of over 1,600 meter, it has become a unique site for pine trees and many wild animals. This is a

Table 81 National Parks, Location and Areas, in Northeast Thailand

Name	Location	Area (km ²)
Phu Kradueng	Loei	348
Nam Nao	Chaiyaphum	966
Phu Phan	Sakon Nakhon, Kalasin	665
Phu Ruea	Loei	121
That Tone	Chaiyaphum	218
Kaeng Tana	Ubon Ratchathani	80
Phu Ko-Phu Phan Kham	Khon Kaen, Udon Thani	322
Phu Chong Na Yong	Ubon Ratchathani	686
Huai Huat	Sakon Nakhon, Mukdahan	829
	Nakhon Phanom	
Mukdahan	Mukdahan	49
Phu Wiang	Khon Kaen	325
Phu Pha Man	Loei, Khon Kaen	350
Pha Taem	Ubon Ratchathani	340
Phu Sara Dok Bu	Mukdahan	231
Sai Thong	Chaiyaphum	319
Total		5,849

Source: [Petchaburi 1995]

place for Thai people to enjoy traveling and staying especially in the winter to experience the cold weather. Table 81 shows the details of the national parks in the region. As a rule, visitors to the parks can not gather any products from the forest. The forest is under intensive protection to keep it in the good condition and make it more attractive to the people.

3) *Wildlife Sanctuary*

Forests flourishing with trees, herbs, natural water and grasses and providing a good habitat and feeding ground for wild animals have been managed as wildlife sanctuaries for safe living and reproduction for numerous animals. RFD takes responsibility for this activity. Budget, personnel and vehicles are assigned to each unit and have full management of the animals. Private traveling to the site is normally prohibited so as not to disturb the animals. Phu Luang in Loei province is one of the active units where there are many elephants migrating from the nearby degraded forests. The total number of the wildlife sanctuaries in the region is seven and the covered area is 3,815 km² in 1994 [Thailand, RFD 1994b].

Other small areas of typical habitat particularly for birds are under the RFD's protection as non-hunting areas. The rules for working are similar to those for the wildlife sanctuaries. There are such eight areas in the region, covering an area of 610 km².

Chapter 5

The Role of Forest in the Socio-economic Life of the Farmers

Forest provides farmers with several kinds of fundamental commodities. Forest releases the main plant nutrients to maintain its forest soil. Many studies have revealed that more fertile soil was seen in the forest than outside [Tsutsumi 1977]. The fertility of forest soil comes from the accumulation of litter-fall. On the other hand, if the soil cover lost is due to outside factors, this will alter the soil properties as a whole. Forest after clearing for rice cultivation and housing shows this phenomenon: soil erosion is the most severe disaster. Soil erosion causes soil degradation as well as fertility loss. Forest acts as a shield to protect soil, but after heavy encroachment it can not preserve the same status. Farmers who live in such places cannot secure sufficient forest products. Domestic animals, which seem to be the farmers' treasure, also suffer since feeding grounds have become limited or disappeared.

5.1 *Trees and Farmers*

There are two phases of this relationship, the forest dependency before 1960 and the forest encroachment after 1960.

5.1.1 *Forest Dependency of the Farmers*

Before 1960, farmers had a steady relationship with forest. Farmers depended on wood and non-wood forest products, but there were many trees flourishing in forests all over the region. The farmers had no idea to invade forest land. The forests were wilderness areas where only small communities lived. The farmers had enough land for rice cultivation and living. Land hunger did not yet exist. Hunters and gatherers seldom entered the forest without a companion. The wilderness of the forest was also the main obstacle for entering the forest. The closed forest with several strata of trees ranging from ground vegetation to the high canopy was a dark and a mysterious place for people. Big trees were hard for them to cut with knives and axes. Many people still believed that gods or forest ghosts live in the forest. These were the main factors that protected the forest from human intrusion at that time.

5.1.2 *Forest Encroachment after 1960*

The Thai population increased at an alarming rate with the infrastructure construction in accord with the first National Social and Economic Development Plan (NSEDP) in 1958-63. Roads were constructed passing through many dense forests, and logging was carried out by logging companies all over the country. Logging roads were constructed for log transport. These small roads allowed farmers to travel easily into the forests. This was the beginning of the forest encroachment in the country that continues to the present. People encroached to find new sites for paddy fields, field crops and living. A similar process of forest encroachment was described by

Thomson [1988] with respect to forest destruction in the African continent. He mentioned that “agricultural land clearing and cutting for urban fuel supply caused most of woodstock destruction . . . commercial lumbering plays no role at all. . . .” This has occurred not only in African countries but in all tropical countries where people live in and around the forests and the forests offer them these kind of necessities.

With these two scenarios, forests still play a big role, but the farmers’ need has changed from the dependency on forest products to forest land for living and commodities. In the Northeast, 12.91% of the forests seems to be the minimum limit to cope up with the farmers’ needs. This amount of forest should be taken under intensive protection from encroachment and destruction. The success in the private sector is meaningful to stop illegal encroachment. Some examples are given below.

1) *Initiation of Cottage Industry*

The lessons learned from Phu Wiang project, include fish raising in the paddy fields. Normally, fish are common in paddy fields in the rainy season, but after the rainy season the paddy fields dry up. The farmers get only small amount of fish. In order to obtain constant water supply, the project proposed to dig small water tanks along the paddy dikes. The proposal was achieved by digging a small trough of 1 meter in width and 0.5 meter in depth in each paddy field. This trough trapped the fish and water at the end of rainy season. Fish kept living longer than before, and the harvest for family consumption or selling increased.

Cash-generating jobs should be created: seedling nurseries might be attractive to the farmers. They like to grow trees of many species, fruit, timber, fodder and so on, but very often seedlings are in short supply. Bamboo seedlings in governmental or private nurseries are also in short supply. A similar situation is also found for *Eucalyptus* seedlings, which are most needed in the region. A private nursery would be profitable. This job should be stimulated by the RFD, MOAC and the commercial banks in a tree-planting program.

Fabric production of silk and cotton should receive more attention. Most village women are keen on silk and cotton weaving but the product is only for home consumption. If a subsidized project is promoted by the government sector, the home industry will give a large benefit to the farmers. This kind of job is now being promoted with a limited number of farmers, but the main obstacles are funds and markets.

2) *Commercial Tree Planting*

The farmers in the Northeast are very much concerned with four kinds of trees: trees in the homestead, trees in paddy fields, trees in natural forest, and trees in man-made forest. The trees in the homestead are planted within each house compound for food production and to being good fortune.

(1) The trees planted in the home garden or kitchen garden to obtain a lot of products for cooking. Many farmers depend on these products for daily foods. This is a self-help process. Planted trees range from ground cover, with many herbs used in cooking such as *cha phlu* (*Piper*

sarmentosum), *kaphrao* (*Ocimum sanctum*), *maeng lak* (*Ocimum canum*), climbers including *di pli* (*Piper retrofractum*), *phak hai* (*Momordica charantia*) and citrus trees. Big trees in the upper layer include coconut, betel palm, mango, *khae ban* (*Sesbania grandiflora*) and so on.

(2) The fortune trees are planted in the home compound because of the belief that they bring good luck. This belief stems from the local name of the trees. *Khanun* (*Arthocarpus heterophyllus*), a big tree with good smell and tasty fruit, is always planted in the backyard of the house because its name in Thai means to overcome all bad things and unfriendly neighbors. *Makham* (*Tamarindus indica*) is planted on the two sides of each house to give the house a tint of a powerful owner. *Mayom* (*Ailanthus triphysa*) is believed to bring respect to the house owner if planted at the front and close to the main gate of each house. *Yo ban* (*Morinda citrifolia*) is planted anywhere in home compound to bring fame to the planter or owner. The trees with many products are not only for spiritual support but provide fruits in different seasons or medicine from fruit throughout the year.

Trees in paddy fields and natural forest have been mentioned earlier in this paper. The commercial planting as a private plantation will be the new alternative to the farmers to replace the natural forests that have disappeared. They still need a lot of products from the forest, especially the timber for house construction. The commercial planting is a challenging program to the farmers because they have to make a balance between the need for paddy fields and forest products.

They know very well that the commercial products from trees support their home economy. Many small farmers started growing *Eucalyptus* around 1983 on their own lands and they could earn some income within 4-5 years. *Eucalyptus* planting is becoming popular in the region. It is planted everywhere, even on the dikes of farms. This is a good start to farmers' commercial planting. However, seedlings of *Eucalyptus* are in short supply. Some raise seedlings themselves, and some buy from private nurseries.

Seedlings of many indigenous species are produced and distributed to the farmers. They have to wait longer for the final products of these trees because these are slow-growing. Some have a planted of *pradu* (*Pterocarpus macrocarpus*) in a big lot recently in Nong Khai province, aiming to harvest the first products in 20 years' time.

Formerly, *sak* (*Tectona grandis*) and *yang* (*Dipterocarpus alatus*) were the two important tree species. But the Forestation Act 1992 paved the way for people to grow these trees for their property.

3) *Planting of Multi-purpose Tree Species*

After the government started the program of tree planting in around 1980, many farmers understood the profit obtainable from the program and became eager to plant trees more. It is important to involve multi-purpose tree species (MPT) in the project. This will be the main job of RFD staff in the near future. Of the 60 species of seedlings that are distributed annually, some species are MPTs. Table 82 compiles some MPTs from the nurseries in the region with their specific products.

Table 82 Products from Multi-purpose Tree Species in Nurseries in the Northeast

Local Name	Scientific Name	Tree Organ	Product
<i>sadao</i>	<i>Azdiracta indica</i> <i>var. siamensis</i>	leaf, flower	food
		fruit	insecticide
		root	medicine
		wood	timber, fuelwood
<i>khilek ban</i>	<i>Cassia siamea</i>	leaf, flower	food
		wood	timber, fuelwood
<i>makham</i>	<i>Tamarindus indica</i>	fruit	food
		leaf	food, nitrification
<i>phai ban</i>	<i>Bambusa blumeana</i>	wood	timber, charcoal
		shoot	food
		stem	raw material for several uses, windbreak, fence
		root	strengthen soil
<i>phai ruak</i>	<i>Thyrsostachys siamensis</i>	"	"
<i>krathin yak</i>	<i>Leucaena leucocephala</i>	leaf	fodder, nitrification
		wood	timber, fuelwood
<i>krathin ban</i>	<i>Leucaena gluaca</i>	"	"
<i>khae ban</i>	<i>Sesbania grandiflora</i>	leaf, flower, fruit	food
		bark, root	medicine
		wood	fuel
<i>marum pa</i>	<i>Albizia lebbeck</i>	leaf	fodder, nitrification
		wood	timber, medicine
<i>fang daeng</i>	<i>Ceasalpinia sappan</i>	leaf	nitrification
		wood	medicine
<i>makham thet</i>	<i>Pithecellobium dulce</i>	fruit	food
		leaf	fodder, nitrification
		wood	timber, fuelwood
<i>cham churi</i>	<i>Samanea saman</i>	fruit	fodder
		leaf	nitrification
		wood	timber
<i>pradu</i>	<i>Pterocarpus macrocarpus</i>	leaf	nitrification
		wood	timber
		flower	decoration
		resin	medicine

5.2 Trees and Paddy Fields

Repairing of the dikes of paddy fields seems to be one of the main troubles of the farmers in the rainy season. The dikes of sandy soil are frequently destroyed. Repair needs to be done year after year. Some farmers in Ubon Ratchathani, plant *siau* (*Phyllanthus polyphyllus*) to maintain the dikes. *Siau* is propagated by planting the cut stems and easily established after planting. The roots penetrate the dikes and strengthen them as a cementing agent. Branches and stems of this tree provide fuel-wood for the farmers, too.

The farmers in other areas plant many kinds of bamboo such as *phai ruak* (*Thyrsostachys*

siamensis), *phai pa* (*Bambusa arundinacea*), and *phai liang* (*Bambusa nana*) for the same purpose, and obtain more products than *siau* tree. Bamboo is the principal MPT among the farmers. *Tan* (*Borassus flabellifer*) is also planted in a small amount. In the *thiang na* compound, *cham churi* (*Samanea saman*) is regularly planted as a shelter tree for the hut where farmers and their animals live in the cultivating season. This tree has a big round canopy, grows fast, fixes nitrogen, produces fruits, is good for cattle feeding, and effective for raising lac on the big canopy. Some studies show a high nitrogen content in the leaf-litter [Adulprasertsuk 1993; Saelee *et al.* 1992].

Paddy fields are common feeding grounds for cattle in the summer. Tree planting is also important for birds and insects. Birds eat the fruits of *Ficus* spp. and *takhop ban* (*Flacortia siamensis*). The regeneration of these species is very fast. In March to April, *maeng chinun* (*Lepidiotia bimaculata*) is a common insect trapped by farmers. Many insects like the young leaf of *makham* (*Tamarindus indica*), *makluea* (*Diospyros mollis*) and *khun* (*Cassia fistula*) as their food, and a big group come to eat at night time. The farmers, carrying torch or lamp to the tree, beat the tree canopy with bamboo rod. The insects fall down to the ground, and the farmers collect them on the mats. The eggs of *mot daeng* (*Oecophylla smaragdina*) are popular in summer. The ant only lays egg on some specific trees such as mango, rose apple, *teng* and *rang*. In my observation, *krathin thepha* (*Acacia mangium*) is one of the host trees to this ant. The plantation of *Acacia mangium* is not only for ants but also for pulp-making material.

5.3 Farmers, Trees and Paddy Fields

The main process of deforestation in the region is related with the search for the new paddy land. As a result, 3 million *rai* (4,800 km²) of forest disappeared annually during the 1980s, and the forest cover in the region decreased to 12.91%.

Paddy land is the key issue of the society. It is not only the land where rice is produced but the fundamental base of the whole system. In addition to producing rice, it stores rain water and provides a habitat for plenty of aquatic animals and weeds. Rice, fish, and vegetables are the main products from paddy fields, especially in rainy season. On the other hand, in summer many

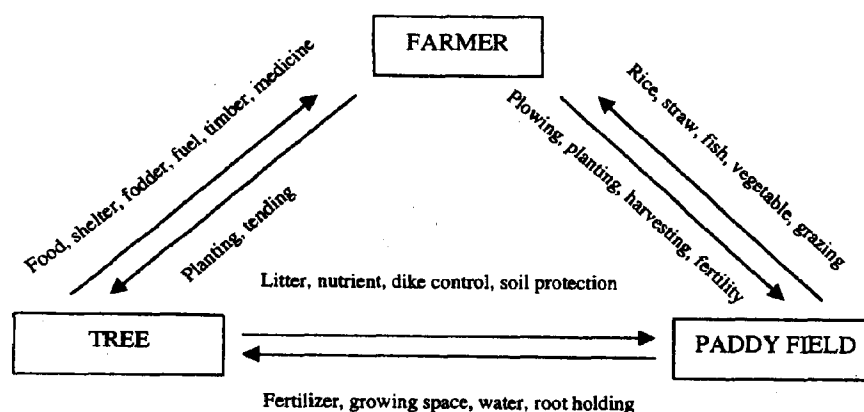


Fig. 18 The Roles of Trees in Paddy Fields in the Farmers' Socio-economic System

standing trees bear new leaves, which are of use to trappers of edible insects. Rice straw and grasses on the paddy floor are the main grazing stuff of the cattle as well. Fig. 18 illustrates the relationship of this system.

The living style of the farmers is sometimes far from rational. Their living style integrates the understanding of various natural phenomena with religious belief in an everlasting life chain, which forms a custom or tradition. A short-cut understanding of their value system by outsiders is far from a true understanding. The farmers live not only today but also live in a succession from the previous generation and even to the next generation to come. Little by little they realize about the phenomena surrounding them. By heart, they learn after many practices, trial and error, and reach to the balanced ways of living as seen in *het sip song* and other rites in the region.

The relationship among farmers, trees and paddy fields is the main factor maintaining the stability of rural society. Fig. 19 illustrates this relationship.

The farmer is the core of this relationship, and the tree and the paddy field are the main supports. Although per capita income is the lowest in the country, most of the farmers in the region have never been as miserable as some might expect. If we look at the description of poverty made by Baker [1993], we can easily recollect the way of living of the northeast farmers.

Poverty, to Americans, is characterized by deprivation of material goods, homelessness, and hunger are factors. But in many so called poor, traditional societies people have a home, enough to eat and relative security, yet we regard them as poor because they don't generate much in way of (monetized) gross national product. Before commerce and Christianity intruded into many of these societies, there is no evidence that the people thought of themselves as poor.

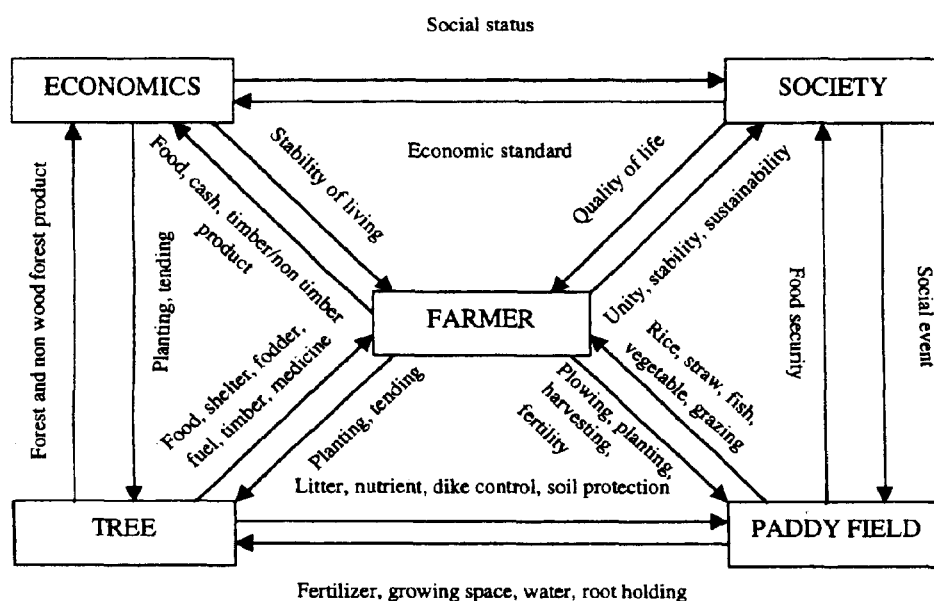


Fig. 19 The Value System of Farmers

Looking at the lives of the Northeast farmers, one may see the farmers obtain many products from the home compound, beef, vegetables and rice from paddy fields. The need to use cash does not arise often, except for buying extra drinks and side dishes for special feasts. In most of their daily lives, these products are more than they need. The highlight of their living is “*yu di-kin di*” (living well eating well). They live happily among friends from the whole village. Many guests, parents’ friends, children or relatives, who visit their houses will be made welcome by the housewives. They will be served with food and drink or even accommodation in their house. *Lap* and *tom yam* are the typical food in each house. Plenty of vegetables and fruits are available within the home garden. Rice is from their barn and cooked with fuel-wood from paddy fields or nearby forests. This is done for *kin di* of the guests. To give good food and a bed to a guest is common. The guests will have their turn to reciprocate when visited by the farmers in the future.

Cash, because of its normal shortage among the farmers, does not play a big role. Instead, rice in the rice barn, poultry in the pens, vegetables in the home garden, paddy fields, and cattle are more important. Fish both naturally grown and cultured, play a big role in the farmers’ living. There is a way of life in which rice, vegetables, and protein food are available in sufficient amount, even if they have a limited amount of cash. They are really *yu di-kin di* with a higher degree of satisfaction than urban dwellers. Table 83 compiles the animal raising and crop calendar of the farmers in Ban Rua village, Phu Wiang.

Apart from *yu di-kin di*, social events are the most important activities to the farmers. Merit-making (*tham bun*) in Thai Buddhist society broadly means to integrate to get social satisfaction and mental happiness. *Tham bun* is a religious performance and traditional to all Thais. They

Table 83 Animal Raising and Crop Calendar of the Farmers in Ban Rua Village, Phu Wiang, Northeast Thailand

Event	Time											
	J	F	M	A	M	J	J	A	S	O	N	D
Cattle raising	×	×	×	×	×	×	×	×	×	×	×	×
Chicken raising	×	×	×	×	×	×	×	×	×	×	×	×
Duck raising	-----		×	×	×	×	×	×	×	×	×	×
egg	-----									×	×	×
Pig raising	×	×	×	×	×	×	×	×	×	×	×	×
Fish raising	-----				×	×	×	×	×	×	×	×
fishing	-----				×	×	×	×	×	×	-----	
Insect hunting												
<i>mot daeng</i>	-----	×										
<i>maeng chi nun</i>	-----		×	×	×							
<i>chakachan</i>	-----		×	×								
Rice harvesting	×	-----									×	×
Winter crop	×	×	×								×	×
Mushroom	-----				×	×	×	×	×	×	×	-----
Paddy herb	-----		×	×	×	×	×	×	×	×	×	×
Bamboo shoot	-----							×	×	×	-----	

customarily believe that after *tham bun* many good results will come to their life. This kind of good results is only a mental support to normal living. In *bun khao sat*, for example, the offering of specific foods to the spirit who takes care of their paddy fields, they hope to benefit from a good rice yield in harvesting season. The farmers who get the good rice yield will pay more attention to each *tham bun* performance by donating several goods and by working hand-in-hand with their neighbors. *Tham bun* also means to share the social welfare where the rich and poor can have the same status. In Ban Suan Nong (Chapter 4; 4.2.6), poor families are provided with the products from community forest to build houses. In *tham bun*, poor families as well as the rich ones share the same chance for obtaining happiness.

The general characteristic of most of the farmers is that they are open-minded, generous, and believe in human goodness. They learn this moral from their close relation with nature. They spend half of the year on working in the paddy fields. They live on the *thiang na* during the cultivating season. This season has a particular meaning in shaping their way of living, which depends on the mercy of nature. The way of working, living and eating seem to be smoother in this circumstance without any obstacle. They concentrate on rice cultivation. After harvesting, they pay attention to social events in their villages, mostly merit-making to support mental relaxation. Merit-making is also the main event to pay respect to nature by donating goods to the several spirits who look after farmers, animals and paddy fields. Bartering and free exchange of goods among the villagers are also common. This situation has changed little since the first settlement, especially in the traditional villages with fertile paddy fields.

5.4 *Trees and Home Economy of Farmers*

As mentioned elsewhere, the economy of the farmers depends heavily on paddy land. The sustainability of the paddy fields makes the farmers realize the importance of maintaining each component of the paddy fields. The main component is the trees existing in the paddy fields. These trees play a big role not only for maintaining the longevity of the paddy soil, but also produce important goods for each family.

5.4.1 *Maintaining the Rice Field*

As seen previously, the monthly income of farmers in the Northeast is only 3,563 baht. With this amount of income, the cash available for family needs is limited. Their treasures are in the form of paddy fields, poultry, cattle, fruit gardens and so on. Without doubt, paddy fields are the most important treasure of the family. The average rice yield for each family is about 2,181 kg [Thailand, CFAS 1994] or about 410 kg per person. This amount is equivalent to 1.12 kg of unhusked rice per person per day, which is enough to guarantee a supply of staple food at least. The expenditure for fertilizer is only 2,043 baht per family per year. This input of fertilizer for soil improvement is insufficient to supply the needed nutrients to rice plants. The shortfall is supplemented by the tree litter, which according to Vitayakorn *et al.* [1988] and Saelee *et al.* [1992] amounts to 493 ton per km² supplied on paddy fields every year, or 9 ton per km² of plant nutrients. This addition is important to keep the fertility of paddy soil.

5.4.2 The Value of Timber Products from Paddy Fields

With limited income, it is hard for farmers to buy timber from the market for house construction. Those who live close to the NRFs or NFs usually have a big house using many valuable timbers. Based on normal economic standards, these farmers would be unable to build such big houses with many valuable timbers because of the high cost. The price of each timber in the 5-year period 1990-94 is listed in Table 84, and the average cost of the lumber used for house building in Table 85 is around 14,278 baht per cubic meter. Each local house uses about 8-15 cubic meter for such building [Thailand, RFD 1963]. This would cost 114,228 to 214,228 baht at market prices. This amount of money is not available for most farmers. They cut these trees from nearby forest and from their paddy fields.

Fuel-wood is another commodity used in the house without any charge. Based on Table 41, each household uses 2,170 kg of fuel-wood per year, and this would cost more than 4,340 baht a year. They save this amount of money by collection of their own fuel-wood.

Table 84 Price of Common Lumber Used in House Construction in Northeast Thailand (1990-94)

Species	Use	Price (baht/m ³)					Average
		1990	1991	1992	1993	1994	
<i>yang na</i>	Wall	10,075	9,935	10,146	11,585	12,288	10,806
	Floor	9,830	9,830	8,812	10,357	11,585	10,137
	Pole	8,425	8,741	9,198	11,059	11,761	9,836
<i>kabak</i>	Floor	9,830	9,830	8,461	9,654	11,234	9,802
<i>teng/rang</i>	Plank	16,500	16,500	20,081	22,293	24,575	19,989
<i>takhian thong</i>	Plank	16,500	16,500	20,081	22,293	24,575	19,989
<i>takihan hin</i>	Plank	16,500	16,500	20,081	22,293	24,575	19,989
<i>daeng</i>	Floor	16,887	16,887	20,362	20,784	23,767	19,737
<i>makha mong</i>	Floor	22,504	22,890	26,225	27,454	31,140	26,042

Source: [Thailand, RFD 1994b]

Table 85 Price of Lumber for Each Use in Northeast Thailand (1990-94)

Use	Price (baht/m ³)
Floor	16,429
Wall	10,860
Pole	9,836
Plank	19,989
Average	14,278

5.4.3 Income from Planted Trees

Many farmers obtain cash income from planted trees, including *Eucalyptus* and bamboo. There are many kinds of bamboo planted in the villages or private gardens. Formerly, people used bamboo stems for household utensils and bamboo shoots for cooking. A few stems from each clump were sold at 10 baht/stem. Since around 1985, with the establishment of a pulp factory in Khon Kaen, bamboo cane is used as a raw material. A lot of bamboo clumps were completely cut for stems selling at the price of 0.65-0.70 baht/kg fresh weight, and this caused big damage to bamboo ecosystem. The bamboo planting started around 1990 with *Dendrocalamus asper*, which aim at stem selling through a selective cutting system. Planting of *Eucalyptus* was booming around 1985 and in 1990 many farmers sold some of the products for pulp making at the same price as bamboo and made a lot of money. The massive planting of bamboo is booming now. Table 86 shows the different products from *Eucalyptus* planting at Somdet plantation, Kalasin.

Farmers who own *sadao* (*Azadirachta indica* var. *siamensis*) on their fields harvest the leaves and flowers of this tree for daily consumption, especially at the time of year when the tree bear new flowers. *Makham* (*Tamarindus indica*) produces a pod for selling, with sweet tamarind fetching a particularly good-price. *Khao ban* (*Sesbania grandiflora*) which is planted on pond dikes yields young leaves as the main products, pods and flowers. These incomes are always outside the official record, which is made only for a few particular tree species (Table 87).

Table 86 Products from *Eucalyptus* Planted at 2×2 Meter at 4 and 5 Years
at Somdet Plantation, Kalasin

		(m ³ /km ²)	
Type of Product	Part of Tree	4 yr	5 yr
Pulp	stem	3,078	3,076
	branch	156	156
Charcoal	stem	1,327	1,326
	branch	116	116
Firewood	stem	272	272
	branch	56	56
Residue	stem, branch	389	389

Source: [Kalampabutra 1994]

Table 87 Crop Farm Income in Northeast Thailand, 1992

(baht/household)		
Crop	Income	Remark
<i>makham</i>	42.56	
<i>Eucalyptus</i>	9.24	
Others	6.82	<i>makok, makhwit, mayom, mak</i>

Source: [Thailand, CFAS 1994]

Table 88 The Governmental Tree Planting Subsidising Program for the Rural Farmers during 1994–98 at 3,000 baht/*rai* (1,600 m²)

Cost of	1994	95	Year 96	97	98	Total
Site preparation	200	—	—	—	—	200
Seedling	200	100	—	—	—	300
Transplanting	100	—	—	—	—	100
Fertilizing	50	100	100	—	—	250
Second transplanting	100	100	—	—	—	200
Fire protection	100	100	200	200	200	800
Weeding	50	100	100	100	100	450
Miscellaneous	—	200	200	200	100	700
Total	800	700	600	500	400	3,000

Source: [Thailand, RFD 1994b]

The government implemented the Tree Planting Subsidising Program (TPSP) in the region during 1994–98. The program provided the farmers with 3,000 baht for tree planting in 1 *rai* (40 × 40m) but not more than 50 *rai* for each household. The trees for planting were several species other than *Eucalyptus*, bamboo, *Acacia mangium* and *Leucaena leucocephala*. The trees after planting belong to the planters as well as *sak* and *yang na* (*Dipterocarpus alatus*). The details are shown in Table 88.

5.4.4 Food Security

Forest provides many kinds of food to the farmers, especially protein from wild animals. Mungkorndin [1987] explained the reason why the meat from wild animals is favored by many farmers:

... wild meat also tends to have less fat than domestic meat and can be a good source of iron, vitamin A and B. Some insects are particularly nutritious. Bee larvae, for example, contains ten times as much vitamin D as fish liver oil and twice as much vitamin A as egg yolk ...

5.5 Farmers and Society

The farmers' society has some social events that work for strengthening social stability, such as *het sipsong*, donation, and religious believings.

5.5.1 Het Sipsong

This gives a frame for the villagers to perform many rites throughout the year. The farmers' well-being which is assured by rice, vegetables and fish in paddy fields and gathering of many forest products is the master key for every performance. Farmers are ready to participate with other villagers to hold the rites each month for the well-being. The 12 rites in *het sipsong* provide mental

coherence for the villagers. Traditionally, the rite must be performed every month and needs many donations from the villagers. Also, working hand-in-hand on each activity is one of the main aims. This coherence will keep the community going on well with social events that were handed down from their ancestors and actively done even now. *Wat pa* and the sacred forest play a role as the place for cooling and purifying the villager's mind.

5.5.2 *Donation*

The ceremony in the village is possible only with cooperative working of the villagers. The *ubo sot* (Buddhist church) construction in each village, for example, is based on the donation from villagers. Many government projects are successfully achieved in the villages which have a tight cooperation among the villagers. This situation becomes particularly important when a plan for a community forest starts which requires full-scale cooperation for seedling production, transplanting and harvesting. Each step needs sincere villagers to work for their communities. The well-off villages find no difficulty for such project.

5.5.3 *The Group Working*

The *cham* plays a big role in each village as an unofficial community leader or spiritual village leader. The village headman is officially elected to serve as the village leader for four years. He leads all official routine works assigned to the village. The *cham* has no official authority but seems to collect more respect from the villagers. He is the real headman not only in the village but also for the sacred forest. Thais are aware of the teaching made by Luang Pho Atoo, a dynasty, who said “*Ya uat kla kap phi ya uat di kap tai*” (don't challenge ghosts and the dead).

This is the famous teaching that keeps many Thais working and living with caution. They pay every respect to tree and forest as the main habitat of ghosts and refrain from bringing any troubles to the ghosts. Everybody has the same belief. To enter the forest for any purpose, they have to pay respect to the forest shrine and beg for permission. They always care about the invisible living things and pay respect to them. The *cham*'s advice for any deed is highly evaluated.

The *cham* acts as the mediator between people and ghosts who brings a good life to people. He is the spiritual leader of the villagers, particularly in the big, old and well-off villages. The functions of the *cham* and the village headman are very similar in a sense. But the latter depends on laws in unity-building, while the former depends on spontaneous will of the villagers, and because of that his advice is more concrete and more powerfully enforcing. *Tham bun* is a good example. *Tham bun* is a spiritual cooperation without any rules or regulation, but people are willing to join. Some official projects, on the other hand, often get stuck because of the lack of spontaneity among the participants. The role of the *cham* is never attained by any official regulation, and also never conflicts with the civilian laws.

Chapter 6

Conclusion and Proposals

6.1 *Conclusion*

6.1.1. *Communal Use of Forests and Forest Products*

Various types of natural forests still remain in Northeast Thailand, including the closed forests located in scattered spots, and secondary shrubs and some dense forests covering wider areas. These natural forests continue to provide the Northeastern farmers with both wood and non-wood products. The communal use of the forest environment and the forest products has been the half side of the traditional value system on which the building of communities has been based. This traditional value system is the social basis on which we can rely for any reforestation programs.

6.1.2 *Paddy Fields*

The opening of paddy fields is another aspect of the traditional value system. For each farmer, the paddy field has been the basis for his daily life, for his family's staple foods such as rice, fish, insects, and vegetables. The paddy field is not only the cultivating ground, but also it is the grazing ground for his cattle. It also provides woods and non-wood products from the trees left in the paddy fields. The creation of the paddy field as a multi-purpose ground is a unique invention of this society.

6.1.3 *The Community*

The value system of the community has been formed on the communal use of the forests and forest products on one side and on the private efforts to open paddy fields on the other. The close contact with nature through these activities has formed the indigenous way of understanding nature, which has been assimilated with the religious beliefs of Buddhism. Various rites of Buddhism, together with indigenous beliefs in natural and supernatural spirits, strengthened the community ties, social stability and welfare in a unique way.

6.1.4 *The Disappearance of Natural Forests*

Several causes are related to the disappearance of the natural forests.

- 1) The land hunger of the poor rural farmers for housing and rice cultivation after the sharp increase of the population.
 - 2) Neglect of the laws and communal regulations.
- Two types of people are responsible for the neglect. One is the local people who needed timber for house construction and lands for living and planting. The other is the outside migrants who spread to the area in search of lumber and land for cassava planting. They always cut and invade the national forest without any consideration for the rules and regulations.

3) Low awareness of forest protection.

Both government and the general public show little awareness of the need for forest protection. The protection of trees and forests has been left to RFD staff, and other peoples look at the trees and forests as free material for their living, not so important. Some still look at wildlife in a similar way, or as something trivial. Panther's leather, the *bun teng*'s horn, and the big lumber of *makha mong* (*Azelia xylocarpa*) are looked at as their symbol of power or status.

4) Due to the lack of cash income, farmers could not improve the agricultural production by applying fertilizer, herbicide, or water supply. The single solution to increase production was to enlarge the planted area by opening the forest.

6.1.5 The community forest plays very important roles in the farmers' way of life and should be taken as the core for reforestation projects.

1) This is the main body of the existing forests, and support the spiritual harmony of the villagers.

2) The regular performance of many social events and rites maintain these forests.

3) The community forest discipline is passed to the younger generation through many events. This is a good way to maintain the traditional value system.

4) Families pay attention to social events and the performance of rites concerning to the community forests.

6.1.6 The community forest programs for tree planting are hampered in the implementation because of the lack of funds and understanding about tree planting. The official sectors have to pay more attention by giving funds and energy to assist local farmers to create community forests. This is the only way to increase the community forests in the country.

6.1.7 Home gardens and trees on paddy fields are both valuable to the farmers for their daily living. The commercial tree plantation is not popular among farmers because of the limitation of land and funds. A seedling distribution program needs to be enforced to give them more seedlings especially of species suitable for food such as *marum* (*Moringa oleifera*), *phe ka* (*Oroxylum indicum*) and *khae ban* (*Sesbania grandiflora*).

6.1.8 The rural people still have a strong belief that they live closely with many spirits, such as forest spirits, paddy field spirits, and village spirits. This tradition is to be respected as a substantial basis for reforestation programs. The belief in these spirits plays a significant role in protecting many community forests.

6.1.9 The abbot and the sub-district headman are the most important persons to create or protect the community forests. The National Forest Policy must not ignore them but pay more attention to them, supporting RFD staff to work cooperatively with them to maintain the remaining national forests.

6.1.10 Forest conservation by rural farmers is a good lesson to be learned by the RFD staffs. Also, their duties should not be limited to the physical use of trees and forests, but broadened to include public relations with rural people who really need to protect the forest for future use.

6.1.11 The government must promote commercial tree planting programs by permitting full scale autonomy for private and communal forest management to the rural people. As the first step to stimulate tree planting for domestic use, seedling distribution on a larger scale should be implemented. This is the initial step to convince the farmers of the benefits obtainable from tree planting, and might be gradually developed to commercial tree planting programs in the future.

6.1.12 Domestic tree planting for household use must be widely promoted by the government. The farmers have less choice now than before to get wood from natural forests. The only way to produce more timber for their own use is to plant trees. Firstly, the official sectors must support them by supplying the seedlings of valuable tree species especially the fast growing ones in the first step, and then slow-growing species with higher commercial value. Bamboo of many species are also a popular choice of the farmers.

6.2 *Recommendations*

6.2.1 *Model for Fuel-wood Production*

Fuel-wood is the main energy source of the farmers. Many people are troubled in fuel-wood gathering. They mainly gather fuel-wood from the trees standing in the paddy fields, which will run short in the near future.

1) The site for planting should avoid any watershed areas in the region, be located on rather poor soil, close to the road for convenient access, and be big enough for community use. The site, however, should be located far from village compounds, which are crowded by private and public lands.

Tree species for planting are also the first priority to the farmers. Sahunalu [1982] showed clear guidelines for selection: high tolerance to natural conditions, low mortality rate after planting, fast growing species with multiple purposes, regular flowering and fruiting to secure the number of seedling, and smell-free wood with high calorific value.

The tending operation is the key to fuel-wood plantation. The regular tending includes fertilizer application, weeding and fire protection. Table 89 lists the names of tree species suitable for fuel-wood planting.

2) Some abandoned land in the forest, wasteland, communal forest are now covered with very few trees. These forests are where villagers gathered fuel-wood for a long time in the past. The heavy usage of forests for fuel-wood gathering and other uses destroyed the original characteristics. The lands still have a capability for tree planting. The management of these lands for fuel-wood production must be done as follows.

(1) Carry on a reconnaissance survey on the sites to determine location, area, vegetation

Table 89 Trees for Fuel-wood Plantation in Northeast Thailand

Local Name	Scientific Name	Calorific Value (cal/gm)
<i>krathin narong</i>	<i>Acacia auriculaeformis</i>	–
<i>makham thet</i>	<i>Pithecellobium dulce</i>	6,912
<i>krathin yak</i>	<i>Leucena leucocephala</i>	7,617
<i>yukhalip</i>	<i>Eucalyptus camaldulensis</i>	–
<i>nonsi</i>	<i>Peltophorum desyrachis</i>	7,030
<i>sakae na</i>	<i>Combretum quadrangulare</i>	7,030
<i>khilek ban</i>	<i>Cassia siamea</i>	6,160
<i>son pradiphat</i>	<i>Casuarina junghuhniana</i>	7,410
<i>sadao</i>	<i>Azadirachta indica var. siamensis</i>	–

condition, topography, climatic condition, stage of encroachment, and former land use. The information obtained will be used in decision-making for any project implementation.

(2) Maintain the original vegetation if the survey found that the natural regeneration is sound. Educate the people to understand the situation of the forest and the need for cooperation to protect the forest until the appropriate time for cutting for fuel. Fire seems to be a serious hazard in the region in summer if there is no measure to prevent it. Grazing may be harmful at the young stage of covering. Animals should be kept off the site during this time. After some years, the trees are regenerated and reach the size for using, but some tending is also needed to keep the stem shape for other usage. Pruning is needed. The inferior quality trees should be cut earlier to make space for better quality trees.

(3) Enrichment planting in lines and groups should be introduced to control the ill-shaped natural regeneration of the forest.

6.2.2 Model for Tree Planting on Paddy Fields

The planting of trees in this program will be one of the big targets of both the RFD and the farmers. It is aimed to sustain the way of living of the rural farmers by providing commodities which they need from trees. The Northeast is usually dry in summer. Many rivers, creeks, and water tanks run out of water. The success of any projects is hampered very much by this severe circumstance. On the other hand, tree planting needs a smaller amount of water than other development programs such as rangeland management, fish culture and fruit tree planting. Rain water in the rainy season is more than enough for growing of trees. The first cost of investment in tree planting is also small since site preparing and transplanting can be done by the farmers without any extra labor.

1) Purpose of Planting

- to increase amount of vegetables from tree products
- to the increase edible insects
- to produce tree branches and stems for fuel-wood

- to improve soil property by litter-fall
- to produce timber for any construction
- to increase grazing stuff for animals

2) *Species for Planting*

Table 90 The Tree Species on Paddy Fields and Their Use

Use	Tree Species
Food	<i>sadao, khilek, phai, khae ban, kum bok, makham, makham thet, mamuang, krathin ban, guava</i>
Fuel-wood	<i>makham thet, khae ban, khilek, guava, krathin ban</i>
Timber	<i>yukhalip, sadao, khilek ban</i>
Soil improvement	<i>phai, cham churi, krathin ban</i>
Fodder	<i>phai, cham churi, krathin ban</i>

3) *Planting Site*

- (1) Paddy field border: *yukhalip, khilek ban, sadao*
- (2) Pond dike: *makham tet, phai liang, khae ban, kum bok*
- (3) *Thiang na*:
 - upper layer tree: *mamuang, cham churi, makluae, ton farang, makham*
 - fence: *phai, krathin ban*
 - lower vegetation: *phak sap, phak wan ban*
- (4) Paddy dike: *makluae*
- (5) River bank: *phai ruak, phai sang*

4) *Tending Operation of Trees after Planting*

- (1) Stem shape control for *sadao* and *khilek ban*:
planting in a high density, 1 × 1 and 2 × 2 meter is common to keep self-competition of trees and the high growth.
- (2) *Yukhalip* planting at 2 or 4 meter spacing will give a slender stem better for both pulp and timber.
- (3) Bamboo shoots and stems are important products; to provide a bigger stem a proper number of shoots will be left for further growing at about 5-7 shoots per clump.
- (4) Fire, animals, theft are normal obstacles to tree planting if there is no intensive caring. Drought is not so harmful to these trees because of their tolerance. This is the excellent benefit of the trees where summer lasts as long as half of the year.

5) Final goals. Tree planting may need some time for harvesting. During this time, the planter can devote his efforts to tending trees and protecting them from disasters. The final results might be excellent; cash from *yukhalip* stem selling, foods from various products, timber for house

construction. These improve living standards, nutrition, and economic conditions of the farmers. Soil, animals, and the environment may, by the same package, be improved for the whole system. "Any products they need are obtained from tree planting."

6.2.3 *Model for Tree Planting in Home Gardens*

The promotion of home gardens should be one of the urgent targets. Home gardens represent an integrated management system of land to meet the home need. Fernandes and Nair [1986] defined the home garden as "a land use practice involving deliberate management of multipurpose trees and shrubs in association with annual and perennial agricultural crops and livestock within the household compound; the whole crop-tree-animal unit being intensively managed by family labor."

There are many kinds of trees, herbs and shrubs planted in the home garden. All of them are mainly used for cooking on direct consumption. Trong and Rambo [1993] classified trees planted in home garden into many categories such as fruit trees, food crops, vegetables, ornamental plants, spices and medicines, and miscellaneous.

The products from the home garden match the way of living of the rural farmers. With a garden, they have no need to buy any food from outside. This is also a way to save their income. The main products are from trees, shrubs and herbs which are good for vegetable and many kinds of ingredients for cooking; and fish, pigs, chickens and ducks are raised in the same compound. The home garden output might not be for selling because the neighbors are practicing in the same line, but goods exchange may be available among them.

In the Northeast, particularly in the new settlement communities, home gardens should be raised up as the main activities of each household. Malnutrition is common among the settlers. Home gardens may provide them with more food. Some models should be taken into consideration.

1) *Home Garden for Fruit Production*

The trees in upper layer should be fruit bearing trees such as mango, pomelo, jack fruit, coconut, guava, lemon, papaya. These are typical local fruits. Several herbs and shrubs are easy to plant and grow under the canopies of these fruit trees, such as home mint, ginger, chili, sweet basil, hairy basil, holy basil, long pepper, bitter gourd, lemongrass and so on.

2) *Home Garden for Fuel-wood*

The fuel trees also produce such the fruit and food such as the horse raddish tree (*Moringa oleifera*), *phe ka* (*Oroxylum indicum*), *sesban* (*Sesbania grandiflora*), *carambola* (*Averrhoa carambola*), *sadao* (*Azadirachta indica*), and *khilek ban* (*Casia siamea*).

3) *Home Garden for Timber*

Many tree species in home gardens produce multiple products and good timber, such as *sadao* tree, Bengal quince (*Aegle marmelos*), *khilek ban*, *myrobalan* wood (*Terminalia chebula*), mango,

betel nut (*Areca catechu*).

6.2.4 *The Management of Natural Forest for Phak Wan (Melientha suavis)*

Phak wan now regenerates only naturally. The soil and micro-climate may play the big role as the limitation factor to control its growth. It is a popular food in Northeast. It bears the young shoots and leaves once a year. This leaf is a favorite. But young tree are few, and existing trees are old and may die out. To encourage the planting of this tree is highly recommended.

- 1) Make the inventory map for the tree site.
- 2) The mother tree should be selected with good protection for seed collection. Picking of leaves may be allowed in proper amount, but flowers and fruit are forbidden.
- 3) Make a fence or fire-line to identify the site and prohibit the human intrusion.
- 4) Promote the natural regeneration from the stumps and encourage the seedling planting.
- 5) Silvicultural practices should be applied to the newly transplanted seedlings, such as watering, fertilizing, fire and pest control.
- 6) Tending operation should be done up to the permanent establishment.
- 7) Time table for leaf collection should be made to control the maximum amount of each collector.
- 8) Protection and maintenance should be assigned to the nearest communities as the community forest of their villages.

6.2.5 *Model for Bamboo Planting for Village Wind-break*

Most of the permanent well-being villages are surrounded by *phai ban* (*Bambusa blumeana*). This bamboo plays a big role as wind-break and living fence. Villagers in new settlements are not interested in planting this bamboo. The bamboo serves not only for protection but provides the villagers with many products, especially food from bamboo shoots, and stems for many kinds of uses such as fish traps, agricultural tools, kitchen utensils and material for pulp.

- 1) The promotion of this bamboo planting might start with seedling production because the shortage of seedlings prevents many farmers from planting. The government must take a responsibility for massive seedling production. The free distribution of seedlings to each village might be helpful to persuade the farmers to plant them. Without official support, the seedling production and distribution is likely to fail.
- 2) The program for planting bamboo as a wind-break needs the cooperation of the people. The transplanting of distributed seedlings should be done by volunteer farmers or all the villagers.
- 3) Tending and protection after transplanting will be important tasks that need the farmers' cooperation. Animal grazing is common because of its green leaf. Collecting of bamboo shoots should be forbidden for 4-5 years after transplanting.

Bibliography

* The papers marked with an asterisk are in English, the rests are Thai with or without English summary.

- Adulprasertsuk, M. 1993. The Effects of Leaf Litter Decomposition on Paddy Soil Fertility. M.S. Thesis, Mahidol University, Thailand.*
- Baker, R. 1993. *Environ Management in the Tropics*. Fla., USA: CRC Press.*
- Ban Rua. 1995. *Home Profile*. Ban Rua Village, Phu Wiang, Khon Kaen.
- Bray, J.R.; and Gorham, E. 1964. *Litter Production in Forests of the World*. Adv. Ecol. Res.*
- Bunyavejchivin, S. 1986. Ecological Studies of Tropical Semi-evergreen Rain-forest at Sakaerat, Nakhonratchsima, Northeast Thailand. I. Vegetation Patterns. *Nat. Hist. Bul. Siam Soc.* 34 (1): 35-37.*
- Chamrasphunth, V.; Kunurat, P.; Yongwanit, S.; Homnetra, T.; Sornnork, P.; and Saengkrai, D. 1992. *The Management of Community Forests by Local Organizations*. Social Forestry Research Project, Khon Kaen University.
- Chinthaganan, V.; Homnetra, T.; Kamolpan, K.; Suchino, D.; and Yongwanit, S. 1990. *Migration*. Project Document 11. Social Forestry Research Project, Khon Kaen University.
- Chinthaganan, V.; Yongwanit, S.; Homnetra, T.; Saengkrai, D.; and Suchino, D. 1993. *Phuphek Conservation Group*. Social Forestry Research Project, Khon Kaen University.
- Chomcharn, A. 1983. *Analytical Report on Different Wooden Fuel*. Royal Forest Department.
- Chuntanaparb, L.; and Wood, Henry I. 1986. *Management of Degraded Forestlands in Thailand*. KU-KKU-FORD 850-0391. Kasetsart University.*
- Conklin, Harold C. 1980. *Ethnographic Atlas of Ifugao*. American Geographical Society of New York.*
- Eckholm, E. 1980. *Introduction to Firewood Crops*. Washington: National Academy of Science.*
- Faculty of Pharmaceutical Sciences, Mahidol University. 1992. *Suansirirukkachaat*.
- FAO. 1995. *Forestry Food Security*. FAO Forestry Paper No. 90.*
- Fernandes, E. C. M.; and Nair, P. K. 1986. An Evaluation of the Structure and Function of Some Tropical Home Gardens. *Agroforestry System* 21: 179-310.*
- Fukui, Hayao. 1993. *Food and Population in a Northeast Thai Village*. University of Hawaii Press.*
- Furukawa, H.; Hattori, T.; Prachaiyo, B.; and Yamada, I. 1992. *Application of Reforestation and Agro-forestry to Soil Management in Korat Plateau*. Bangkok: The Mekong Secretariate.*
- Hoameaungkaew, W.; Chuntanaparb, L.; and Ongprasert, P. 1994. *Non-Timber Forest Products and Household Economy of Communities in and around Phatam National Park, Ubolratchathani*. KU-FORD 870-0535-3. Working Document 6. Kasetsart University.
- Kalumpabut, P. 1994. Biomass of Different Parts of *Eucalyptus camaldulensis* Coppice at Four and Five Years from First Rotation Planting with 2 × 2 Meter. M. S. Thesis, Kasetsart University.
- Komkris, T. 1966. *Forestry in Thailand*. University of Hawaii Press.
- Kongkajan, V.; Kheoying, K.; and Prachaiyo, B. 1990. *Extension of Firewood Plantation for Rural People Consumption*. Khon Kaen University.
- Kunstadters, P.; Chapman, E. C.; and Sabhasri, S. 1978. *Farmers in the Forest*. University of Hawaii Press.*
- McNeill, J. R. 1988. *Deforestation in the Araucaria Zone of Southern Brazil 1900-1983*. World Deforestation in the 20th Century. Duke University Press.*
- Mungkorndin, S. 1981. *Forest as a Source of Food for Rural Communities in Thailand*. No RAPA 52. FAO, Bangkok.*
- Nagata, Y. 1995. Personal communication.
- Parinyano, P. 1982. *Esarn Thai Former Classical Custom*. Bangkok: Wat Mahatat Temple.
- Petchaburi. 1995. Regional Forest Division, Petchaburi.
- Phongamphai, S. 1976. *Dendrology*. Faculty of Forestry, Kasetsart University.
- Phragtong, K. 1991. *Concept on Community Forest in Social Forestry in Thailand*. Royal Forest Department.
- . 1992. *Community Forest in Thailand*. Royal Forest Department.*
- Phu Wiang. 1995. *Annual Report*. Phu Wiang District, Khon Kaen Province.
- Prachaiyo, B. 1983a. *Preliminary Study on Wooden Fuel Consumption of the Rural People, Phu Wiang, Khon Kaen*. Annual Forestry Symposium. Bangkok: Royal Forest Department.

- . 1983b. Litter Production in Dry Dipterocarp Forest Dominated with *Phluang* (*Dipterocarpus tuberculatus*), Lampoa, Kalasin. Forth Year Student Seminar, Khon Kaen University.
- . 1984. Research Need for Improvement of the Management of Dry Dipterocarp Forest in Thailand. In *IUFRO Symposium on Forest Management Planning and Managerial Economics*, pp.364-372.* Japan: The University of Tokyo.
- . 1985. *The Merit of Forest Plantation*. Tech. Pap. No. 18. Reg. For. Div., Khon Kaen, Thailand.
- . 1986a. Litter Production of *Daeng* (*Xylia xylocarpa*). Paper presented at the Forestry Annual Symposium, held by Royal Forest Department, Thailand.
- . 1986b. *Firewood*. Technical Bulletin Number 20, Regional Forest Division. Khon Kaen.
- . 1991. A Case Study: The Ban Non Amnuay Community Forest Project. Paper presented at Forth Writing Workshop on Community Forest, EWC, Honolulu.*
- . 1993. Primitive Villagers' Management Method on the Standing Trees Remaining in the Paddy Field, Phu Wiang, Khon Kaen. *Thai Jour. of For.* 12: 215-242.
- Prachaiyo, B.; Chinthaganan, V.; Kenvises, P.; and Srisak, P. 1995. *A Case Study: Don Pu Ta Forest, Ban Kok Krea Village, Kalasin*. The Community Forest Study Project, Regional Forest Division, Khon Kaen.
- Prachaiyo, B.; Chinthaganan, V.; Srisak, P.; and Chuntanaparb, L. 1993a. *Quantity and Diversification of Vegetation at Phu Phra, Dong Mun National Reserved Forest, Kalasin*. KU-FORD. 870-0535-2. Working Document 10. Kasetsart University.
- Prachaiyo, B.; Chunutai, S.; and Srisak, P. 1992. *A Case Study: Suanmon Sub-district Council Community Forest, Munchakiri, Khon Kaen*. The Community Forest Study Project, Regional Forest Division, Khon Kaen.
- Prachaiyo, B.; Sahunalu, P.; Dhanmanonda, P.; Suwanapinanda, W.; Puriyakorn, B.; and Enpruksa, Jamro. 1979. Litter Production in Dry Evergreen Forest above Namphrom Dam, Chaiyapoom Province. *For. Res. Bull.* 71. Kasetsart University.
- Prachaiyo, B.; Supari, N.; and Srisak, P. 1993b. *A Case Study: Wat Pa Phrompratarn Forest, Phontong, Roi-et*. The Community Forest Study Project, Regional Forest Division, Khon Kaen.
- Prachaiyo, B.; and Tsutsumi, T. 1989. On the Nutrient Content of Trees in Dry Evergreen Forest in Northeast Thailand. *Thai Jour. of For.* 8 (3): 227-236.*
- . 1990. On the Rate of Wood Litter Decomposition in Dry Evergreen Forest in Northeast Thailand. *Thai Jour. of For.* 9 (3): 212-218.*
- Saelee, S.; Vityakorn, P.; and Prachaiyo, B. 1992. Effects of Trees on Paddy Bund on Soil Fertility and Rice Growth in Northeast Thailand. *Agroforestry System* 18: 213-223.*
- Sahunalu, P.; and Dhanmanonda, P. 1995. *Structure and Dynamics of Dry Dipterocarp Forest, Sakaerat, Northeast Thailand*. Vegetation Science in Forestry. The Netherlands: Kluwer Academic Publication.*
- Sahunalu, P.; Jamroenpruksa, M.; Puriyakorn, B.; Dhanmanonda, P.; Suwannapinunt, W.; and Prachaiyo, B. 1979. Comparative Studies on Structural Characteristics of Three Forest Types at Namphrom Basin, Chaiyaphoom Province. *For. Res. Bull.* 63. Faculty of Forestry, Kasetsart University.
- Samunphraichaoban. 1984. *Villagers' Medicinal Plants*. Bangkok: Komol Kremtong Foundation.
- Senanarong, S. 1986. *Thai Geography*. Thailand: Thai Wattana Panich Press.
- Smittinanda, T. 1977. *Vegetation and Ground Cover of Thailand*. Technical paper No. 1. Faculty of Forestry, Kasetsart University.*
- Sono, P. 1977. *Forestry Development in Thailand*. Bangkok: Royal Forest Department.
- Subhadhira, S.; Supachaimat, N.; Smutkupt, S.; Semaraks, S.; Pakuthai, W.; Subarnbhesaj, K.; and Petchsingha, P. 1988. *Fuel-wood Situation and Farmers' Adjustment in Northeast Thai Villages*. RRA in Northeast Thailand. Khon Kaen University.*
- Sukwong, S. 1974. *Deciduous Forest Ecosystem in Thailand*. Faculty of Forestry, Kasetsart University.*
- . 1984. Principle and Study on Community Forest. Paper presented at the workshop on Curriculum Development on Community Forestry. Kasetsart University.
- Taiutsa, B.; Suwannapinant, W.; and Kaitpraneet, W. 1978. *Production and Chemical Composition of Forest Litter in Thailand*. Forest Res. Bull., No.52. Bangkok: Kasetsart University.
- Takeda, H.; Prachaiyo, B.; and Tsutsumi, T. 1984. Comparison of Decomposition Rates of Several Tree Leaf Litter in a Tropical Forest in Northeast Thailand. *Jap. J. Ecol.* 34: 311-319.*
- Thailand, The Center for Agricultural Statistics (CFAS). 1993. *Agricultural Statistic of Thailand Crop Year*

B. PRACHAIYO: Bibliography

- 1973–1992. The Center for Agricultural Statistics, Ministry of Agriculture and Cooperative.
- . 1994. *Agricultural Statistics of Thailand Crop Year 1993/94*. Annual Report.
- Thailand, Department of Meteorology (DOM). 1977. *Climatic Condition*. Annual Report. Department of Meteorology.
- Thailand, Environmental Plan and Policy Office (EPPO). 1993. *Annual Report*. Thailand: Environmental Plan and Policy Office, Ministry of Science Technology and Energy.
- Thailand, Forest Industry Organization (FIO). 1994. *Annual Report*.
- Thailand, Ministry of Agriculture and Cooperative (MOAC). 1992. *Non Wood Forest Product Development*. Work Plan Package 2.5. Bangkok: Ministry of Agriculture and Cooperative.*
- Thailand, National Statistical Office (NSO). 1992. *Statistical Year Book of Thailand 1990*. Bangkok.
- . 1994. *Population and Housing Census Northeastern Region*.
- Thailand, Provincial Fishery Office (PFO), Khon Kaen. 1995. Personal Communication.
- Thailand, Royal Forest Department (RFD). 1963. *Wood for Construction*. Annual Report. Bangkok: Royal Forest Department.
- . 1990a. *Annual Report*.
- . 1990b. *Phenological Study of Forest Tree Species in Natural Forest*.
- . 1992. *Forestry Statistics of Thailand*.
- . 1993. *Forestry Statistics of Thailand*.
- . 1994a. *Amount and Species of Seedling in Four Large Scale Nurseries in Northeast Thailand*. Annual Report.
- . 1994b. *Annual Framework for Tree Planting Subsidising Program*.
- . 1995. *Annual Report*.
- Thailand, RFD, Khon Kaen. 1986. *Annual Report*. Regional Forest Division, Khon Kaen.
- . 1990. *Annual Report*.
- Thomson, J. T. 1988. *Deforestation and Desertification in 20th Century in Arid Sahelien Africa*. Duke University Press.*
- Trong, Cuc Le; and Rambo, A. T. 1993. *Too Many People too Little Land*. Paper number 15. Occasional paper of the program on environment. EWC, Honolulu.*
- Tsai, L. M. 1974. Litterfall and Mineral Nutrient Content of Litter in Pasoh Forest Reserve. Paper presented at IBP Synthesis Meeting, Kuala Lumpur.*
- Tsutsumi, T. 1977. Storage and Cycling of Mineral Nutrients. *JIBP Synthesis* (Tokyo: University of Tokyo Press) 16: 140–162.*
- Tsutsumi, T. *et al.* 1983. Forest: Felling, Burning and Regeneration. In *Shifting Cultivation*, edited by Kazutake Kyuma and Chaitat Pairintra, pp.13–57. Faculty of Agriculture, Kyoto University.*
- UNDP/FAO. 1991. *Integrated Development of the Phu Wiang Watershed*. Terminal Report. FO/DP/THA. 84–002.*
- Vallibhodom, S. 1991. *Esarn Civilization Site*. Bangkok: Matichon Press.
- Vijarnsorn, P. 1985. *General Soil Map of the Northeast Region Thailand*. Bangkok: Department of Land Development.
- Viriyabancha, C. 1992. Rainfall Analysis and Distribution of Forest Types in Thailand. M. S. Thesis, Kasetsart University, Bangkok.
- Visaratana, T. 1983. Structural Characteristics and Canopy Gap Regeneration of the Dry Evergreen Forest at Sakaerat Environmental Research Station. M. S. Thesis, Kasetsart University.
- Vitayakorn, P.; Smutkupt, S.; and Prachaiyo, B. 1988. Tree in Paddy Field: Their Distribution to Soil Fertility and Sustainability of the Paddy Rice System. Paper presented at the Forth SUAN Regional Symposium on Agroecosystem Research, Khon Kaen University.*
- Wacharakitti, S.; Eadkeo, K.; Intarachandra, P.; Ruangpanit, N.; Kutintara, U.; and Pataratuma. 1979. *Nampong Environment Management Research Project Working Document No. 3*. Mekhong Secretariate.*
- Watanabe, H. 1995. Personal communication.
- William, L. 1965. *Vegetation of Southeast Asia: A Study of Forest Type*. Washington D.C.: Department of Agriculture, Agricultural Research Service.*
- Yoda, K.; and Sahunalu, P. 1991. *Improvement of Biological Productivity of Tropical Wasteland in Thailand*.

Osaka City University.*

Yongwanit, S.; and Homnetara, T. 1991. *The Changes of Land Use in National Reserve Forest: A Case Study of Villages Settlement in Dong Mun National Reserve Forest*. Social Forestry Research Project, Khon Kaen University.

Appendix I: Site Description by a Forester

Source: [Furukawa *et al.* 1992]

1. Salt-producing area: Jan. 20, 1991

Ban Khok Sung Village, Mueang District, Khon Kaen Province

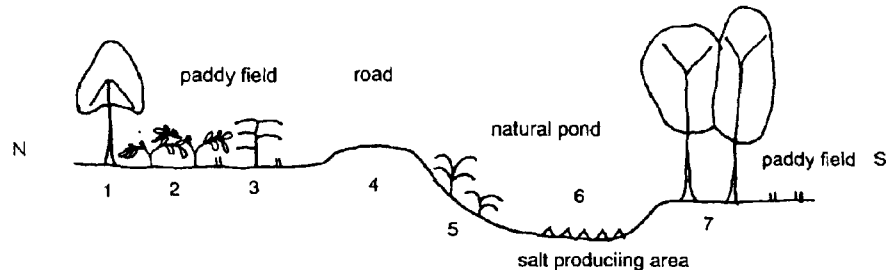


Fig. 1 Diagram of Site 1

Located along the Khon Kaen-Lao Na Di road, there is a salt spot where salt has been produced in a traditional way.

The upper part of the topography is paddy fields. Many trees are standing. (1) *Sakae* (*Combretum quadrangulare*) gives good fuel-wood. (7) *Hiang* (*Dipterocarpus obtusifolius*) is good for general construction. (3) *Jatropha* sp. is also common shrub that grows on acid soil. (2) *Nam daeng* (*Maytenus mekongensis*) and (5) *nam phungdo* are thorny shrubs that indicate saline soil. (4) The road was recently constructed along the (6) natural pond where farmers produced salt.

2. Salt-affected paddy field: Jan. 26, 1991

Ban Tum Village, Mueang District, Khon Kaen Province

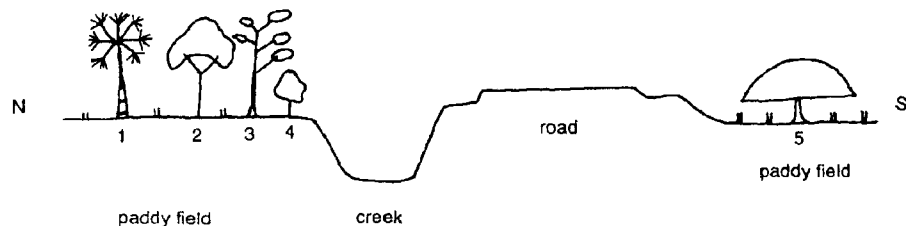


Fig. 2 Diagram of Site 2

Located on the north side of the road number 209 (Maliwan road) about 14 km to the west of Khon Kaen, salt crust occurs along the creek between paddy field and road. People produced salt from this area in former days but not now.

In the rainy season there is usually flow in the creek after each storm, but little water in summer. Many salt crusts are seen in summer. Trees standing sparsely are natural ones. (1) *Lontar palm* (*Borassus flabellifer*) is common; young fruit is good for consuming, and dry fruit is good for local sweet cakes. Its wood is good for high-class furniture making. (2) *Sadao* (*Azadirachta indica* var. *siamensis*), (3) *thon* (*Albizia lebbeck*) and (5) *cham churi* (*Samanea saman*) are common on this type of paddy field. *Sadao* is multiple purpose tree, while *thon* and *cham churi* are good for increasing soil organic matter by litter fall. Latter woods are good for construction. (4) *Sabaeng* (*Dipterocarpus intricatus*) is not so good for any utilization.

3. Study plot on saline soil: Feb. 9, 1991

Phra Yun District, Khon Kaen Province

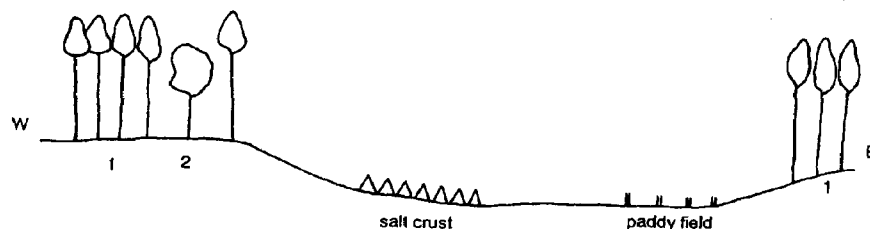


Fig. 3 Diagram of Site 3

Located about 5 km to the west of Phra Yun district. After many trees were cut, soil cover of the narrow valley disappeared and salt-bearing sand strata were exposed. Now severe erosion is proceeding upstream along the valley, and paddy fields in the valley head will be devastated.

(1) *Eucalyptus* tree species were transplanted to study the role of tree on salt-affected soil. A natural stand of (2) *sabaeng* (*Dipterocarpus intricatus*) is very sparse. This is only the remnant tree, roots of which are now exposed high above the ground surface. Salt crusts are found all over the site, even on parts of paddy fields. Some *Eucalyptus* were harvested a few years ago and new shoots show very good growth.

4. Salt mound: Jan. 28, 1991

Ban Nong Sapung Village, Chiang Yun District, Maha Sarakham Province

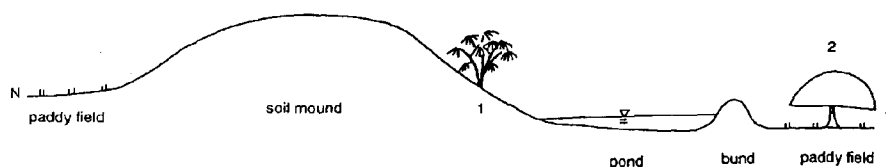


Fig. 4 Diagram of Site 4

Located to the east of Chiang Yun-Kosum Phisai road about 3 km to the south of Chiang Yun. A big salt mound is found beside the man-made pond. (1) *Phai pa* (*Bambusa arundinacea*) is the natural vegetation. Farmers used to plant mulberry for some period on the salt mound. Salt crusts are formed at the foot of the mound. Salt producing might have been conducted a long time ago. Some big (2) *cham churi* (*Samanea saman*) are planted on the paddy field to give shade for domestic animals while its pods are good for feeding them.

5. Soil quarry: Jan. 28, 1991

Ban Suan Kluai Village, Kosum Phisai District, Maha Sarakham Province

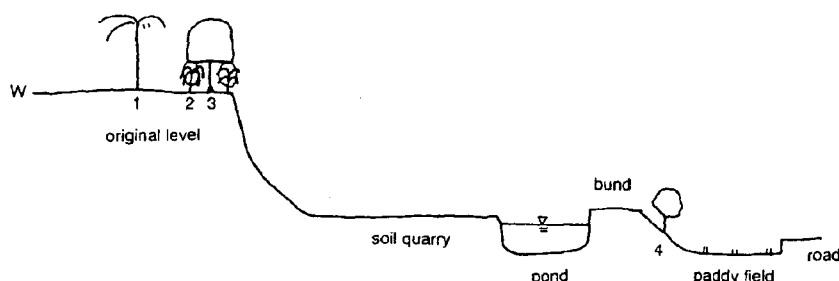


Fig. 5 Diagram of Site 5

Located along the Kosum Phisai-Borabu road, about 10 km to the south of Kosum Phisai. Soil from the quarry was used for road construction. There is a little vegetation on the hill. (1) *Maphrao* is transplanted for various purposes; fruit for cooking, leaves for roofing, stems for some special uses. (3) *Makham* (*Tamarindus indica*), a multiple-use tree species, fruit for cooking and export, leaves for increasing soil organic material, wood for chop-board making and charcoal. One of the drought indicator is (2) *khoei* (*Streblus asper*), whose leaves are good for animal feed. (4) *Phutsa* (*Zizyphus jujuba*) is natural regeneration. Its fruit is edible but not so popular, and wood is widely used for fuel as well as for lac raising in the tree.

6. Namchi river: Jan. 29, 1991

Thavat Ding Daeng Village, Thawachaburi District, Roi-et Province

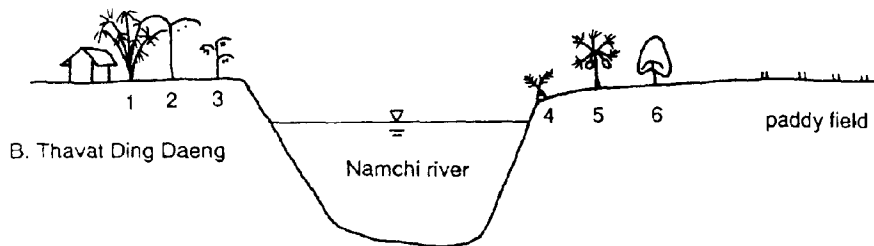


Fig. 6 Diagram of Site 6

Located along the Thawachaburi-Phon Thong road, about 20 km east of Roi-et. This is a very big village on the west bank of Namchi river. Many trees are planted in the home gardens. (3) Betel palm (*Areca catechu*) whose fruit is used for local people's chewing, stem is good for building. (2) *Maphrao* is common, and (1) *phai ban* (*Dendrocalamus hamiltonii*) is a big clump bamboo, very popular among the farmers for house utensils, farm tools, and wind-break for village. On the opposite bank are the paddy fields of the farmers of this village. Small trees of normal standing are (6) *sakae* (*Combretum quadrangulare*), which indicate the flooding of paddy fields in the rainy season. (5) *Lontar palm* grown on the margin of the paddy fields is planted, while some (4) *siau* (*Phyllanthus polyphyllus*) grows naturally along the Namchi river. This shrub-size vegetation is good for bank stabilization, fuel and fencing.

7. Cassava-planting site: Jan. 29, 1991

Ban Nong Song Hong Village, Phon Thong District, Roi-et Province

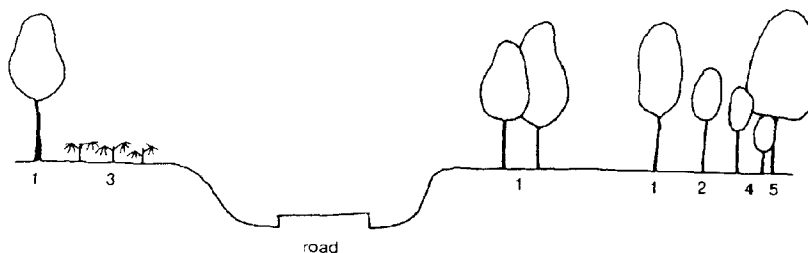


Fig. 7 Diagram of Site 7

Located about 16 km to the north of Namchi river along the Thawachaburi-Phon Thong road. Both sides of the road are new openings for (3) cassava planting. (1) Some big *phluang* (*Dipterocarpus tuberculatus*) are standing with some medium size (2) *pradu* (*Pterocarpus macrocarpus*), one of the valuable tree species. This place is on a high topography. *Phluang* is one of the economic tree species in dry *Dipterocarp* forest (DDF); wood is good for construction, and the use of resin is very common. (4) *Daeng* (*Xylia xylocarpa*), good for timber, and (5) *teng* (*Shorea obtusa*) stands are also common. For opening of DDF for upland crops, people perform thinning cutting and cut the lower branches of remaining trees.

8. Wat Pa Prom Pra Tan temple: Jan. 29, 1991

Ban Ngiu Village, Phon Thong District, Roi-et Province

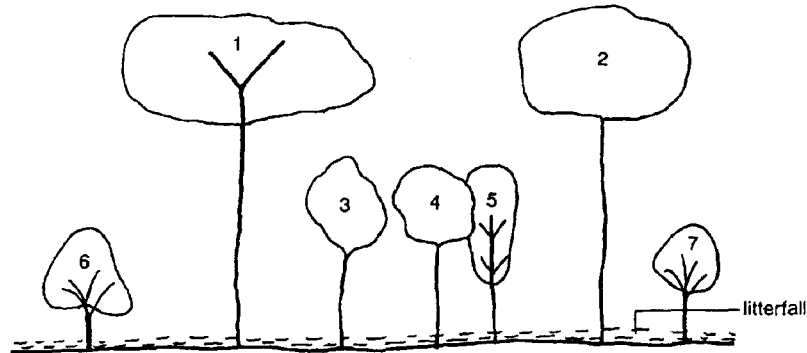


Fig. 8 Diagram of Site 8

The temple was constructed about 20 years ago. The first cottage was built within the village cemetery site covered by *ya kha* (*Imperata cylindrica*) with some secondary growth of DDF tree species. The monks prohibited the cutting of secondary trees. Now the temple is surrounded by dense forest and attractive to everybody. Many big trees are standing in the upper stratum: (1) *krabak* (*Anisoptera costata*) and (2) *takhian thong* (*Hopea odorata*). Some smaller trees occur in the second stratum such as (5) *daeng* (*Xylia xylocarpa*), (4) *makoem* (*Canarium subulatum*) and (3) *yo pa* (*Morinda coreia*). The ground floor is covered by a thick layer of fresh litter fall. Many tree species were planted among the natural stands, e.g., (6) *khilek ban* (*Cassia siamea*) and (7) *khun* (*Cassia fistula*).

9. Salt-making area: Jan. 30, 1991

KM.5, Roi-et-Suwannaphum Road, Muang District, Roi-et Province

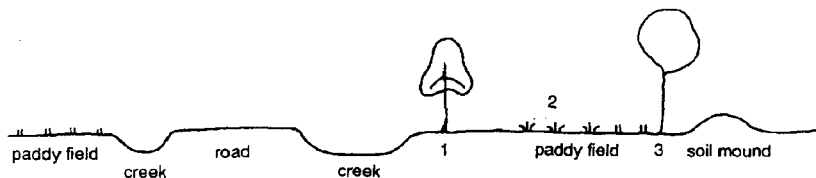


Fig. 9 Diagram of Site 9

Located along Roi-et-Suwannaphum road, about 5 km to the south of Roi-et. Farmers in this area have produced salt here for centuries. The local leaching equipment is a wooden trough made of *phayom* trunk, which lasts for two generations and more. Much fuel-wood is consumed by this process. Farmers collect fuel-wood of many DDF tree species such as *phayom* (*Shorea roxburghii*), *makha tad* (*Sindora siamensis*), *sabaeng* (*Dipterocarpus intricatus*), and *sakae* (*Combretum quadrangulare*). The salt producing is done along a creek. In the paddy fields nearby there are very few trees standing such as *sakae*, (3) *sabaeng*, and salinity indicator grass or (2) *ya khi krak* (*Xyris indica*).

10. Community forest: Jan. 30, 1991

A cemetery forest, Ban Dong Krang Yai Village, Kaset Wisai District, Roi-et Province

A big group of (2) *sabaeng* (*Dipterocarpus intricatus*) occupying the forest on a higher ridge extends into the high area in the paddy fields. The forest was a cemetery where dead villagers were brought and cremated. Branches of *sabaeng* were used for the cremation. *Sabaeng* spots in the paddy fields are higher and rarely flooded even in the rainy season. The road was constructed about 10 years ago and (1) *Eucalyptus* was transplanted on the both sides of the road.

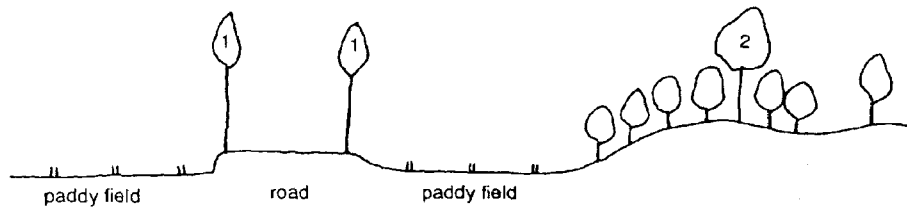


Fig. 10 Diagram of Site 10

11. Ku Prako Na Na temple forest: Jan. 30, 1991

Suwannaphum District, Roi-et Province

A temple is located among the tall trees of *yang* (*Dipterocarpus alatus*). There are three old pagodas. This is one of the attractive ancient places in the region. Until 1923, the temple was covered with deep forest. *Yang* wood is good for general construction, and resin is used for torch making, boat-caulking and water container-coating. Now many monkeys live in this forest.

12. Nong Nang Khao soil mound: Jan. 31, 1991

Ban Nong Chai Village, Muang District, Roi-et Province

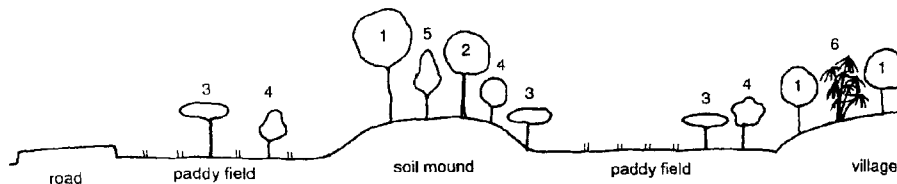


Fig. 11 Diagram of Site 12

A big, old soil mound is located along the Roi-et-Yasothon road about 3 km from Roi-et. People believe that there are many treasures buried under the mound. Human skeletons and potteries were found by digging. The mound is found in the middle of the paddy fields between the road and village. The big trees show the age of the mound. (1) *Yang* is the dominant tree, with (2) *takhian thong*, (3) *wa* (*Eugenia cumini*), (4) *sabaeng* and (5) *phan sat* on the mound. (6) *Phai ban* is also transplanted along the edge of the village as a wind-break and a source of raw material for home utensil making. On the paddy field, *wa* and *sabaeng* are common.

13. Salt-making area: Jan. 31, 1991

Ban Bo Village, Mueang District, Roi-et Province

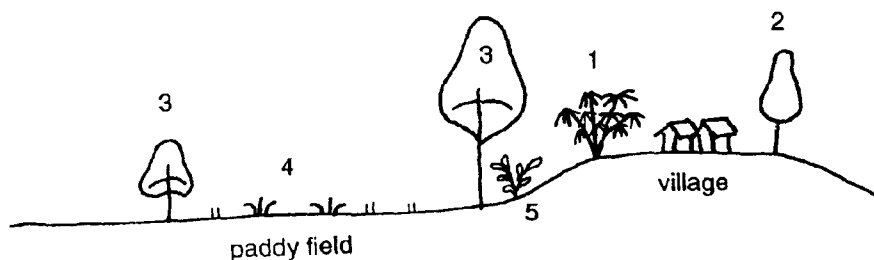


Fig. 12 Diagram of Site 13

Located along the Roi-et-Yasothon road about 5 km to the southeast of Roi-et. There are many salt crusts on the paddy fields. People collect salty soil from the upper layers of paddy fields. Brine can be produced from this soil by mixing with water. The boiling of salt has been done for centuries. Very few and small plants

now exist such as (3) *sakae*, (4) *ya khi krak* and (5) *nam daeng*. The latter two are indicators of a heavily salt-affected area. Some big transplanted trees occur in the village compound, such as (1) *phai ban* and (2) *nun* (*Ceiba tetrandra*).

14. Soil quarry: Feb. 2, 1991

Ban Nam On-Village, Kranuan District, Khon Kaen Province

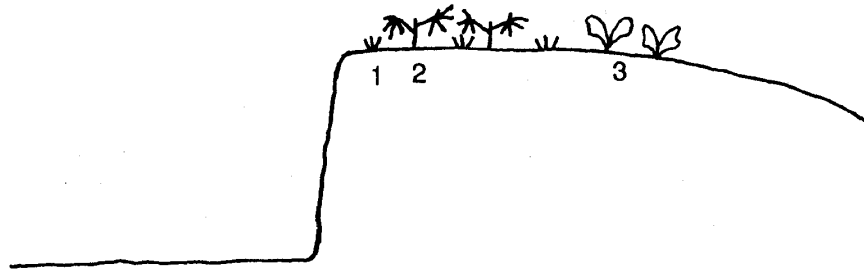


Fig. 13 Diagram of Site 14

Located along the Kranuan-Nong Kungsi road about 10 km to the south of Kranuan. Soil from the quarry was used for road construction. Long convex slopes have recently been opened for cassava plantation in a destructive way. Vegetation is very much simplified; (1) *ya kha*, (2) *cassava* and *sap suea* (*Eupatorium odoratan*). No big trees existing on the site.

15. Dwarf DDF: Feb. 3, 1991

Ban Sam Prao Village, Mueang District, Udon Thani Province

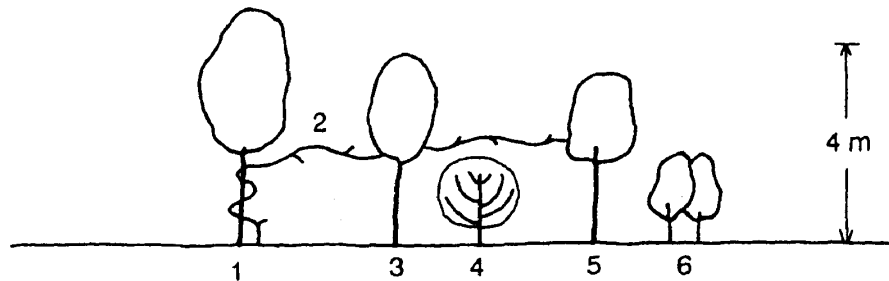


Fig. 14 Diagram of Site 15

A lateritic soil is covered by DDF tree species. Located along Udon-Ban Chiang old road about 9 km to the east of Udon Thani. Most of the trees are small and twisted. The main tree species are (6) *khilek pa* (*Cassia garrettina*), (1) *rang* (*Shorea siamensis*) and (5) *tiu* (*Cratoxylum formosum*). All of them are smaller ones which people may use freely. Some co-dominant trees are (3) *rangkhon* (*Pentacme suavis*), (4) *mueat* (*Symplocos laurina*) and (2) *nam khom* (*Zizyphus cambodiana*), a woody timber which indicates a very dry and poor soil.

16. New cassava planting area: Feb. 5, 1991

Located along the Bung Kan-Pang Kon road about 6 km to the south of Bung Kan. A flat slope is covered with white sandy soil. Formerly this was the site of dense seasonal rainforest. The heavy encroachment was done during the mid-1970s. All of the big trees were cut for cassava planting. Smaller trees remain, like *wa*, *sattaban* (*Alstonia scholaris*) and a pioneer species *takhop ban* (*Flacourtia inermis*); its fruit is food for birds, its wood is soft, and its fiber is good for rope making.

17. Yang site: Feb. 5, 1991

Ban Nong Sawan Village, Bung Kan District, Nong Khai Province

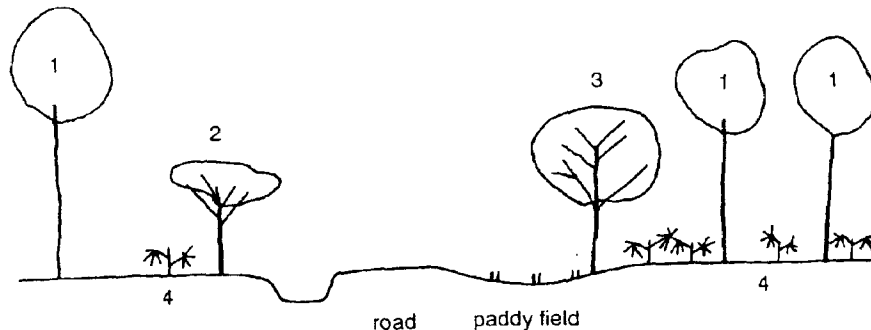


Fig. 15 Diagram of Site 17

Located on NRF named Dong Motong about 13 km to the south of Bung Kan and about 6 km from cassava site no. 16. This used to be the best seasonal rainforest in the region. A heavy cut by both local people and a logging company denuded the land. Now only big (1) *yang*, (3) *tabaek* (*Lagerstroemia calyculata*) stand on the upper slope where cassava is planted. On the lower paddy fields, some (2) *makha mong* (*Azelia xylocarpa*) was left standing without any ground cover. All of these tree species were cut for logging recently. The cleared land is used for cassava planting.

18. Pararubber plantation: Feb. 5, 1991

Ban Chaiyapom Village, Ban Phaeng District, Nakhon Phanom Province

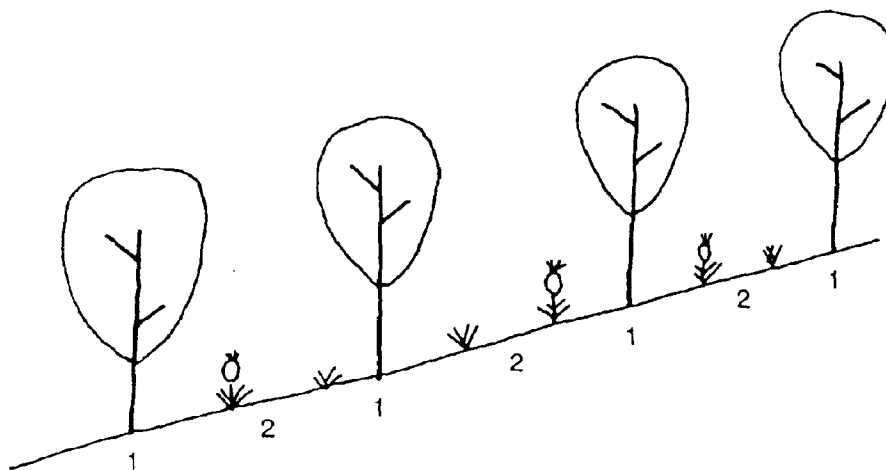


Fig. 16 Diagram of Site 18

Located to the south of Bung Kan-Nakhon Phanom road and about 10 km north of Wat Phu Thok. This area was dense MDF around 20 years ago. After opening, cassava was introduced, then pineapple. At the beginning of the 1980s, pararubber was introduced, which showed satisfactory success. The mixed planting of (1) pararubber and (2) pineapple is also common in this area. Pineapple is harvested year by year after planting, but pararubber starts to be harvested seven years after transplanting.

19. Shifting cultivation on illegal opening: Feb. 7, 1991

Ban Khok Tum Village, Dong Luang District, Mukdahan Province

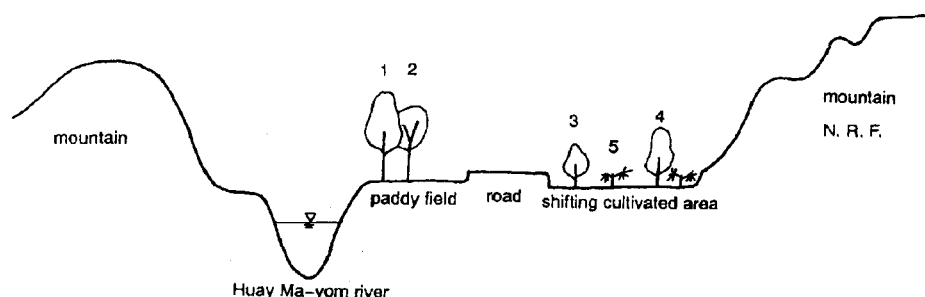


Fig. 17 Diagram of Site 19

Located at the 40 km post on the Dong Luang-Khao Wong road in the Phu Phan range.

An illegal opening of the National Forest Reserve is in progress. Burning was occurring during the trip. Several patches for (5) cassava planting were being opened. The problem of land hunger is the main reason that farmers carry on such illegal opening for shifting cultivation. Main tree species are: (3) *daeng* (*Xylia xylocarpa*), good for general construction; (4) *tabaek yai* (*Lagerstroemia calyculata*), one main species of the forest; on the river bank, there are many (2) *yang* (*Dipterocarpus alatus*) and (1) *ta khian thong* (*Hopea odorata*). Both of them are very valuable tree species, the latter being used to make racing boats.

20. Trees along canal: Feb. 9, 1991

Ban Nong Ku Village, Phra Yun District, Khon Kaen Province

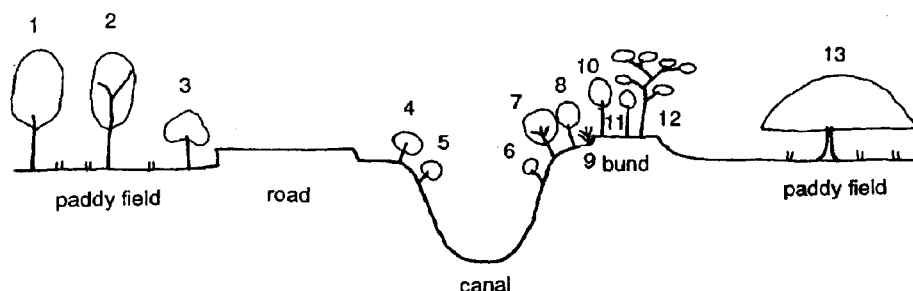


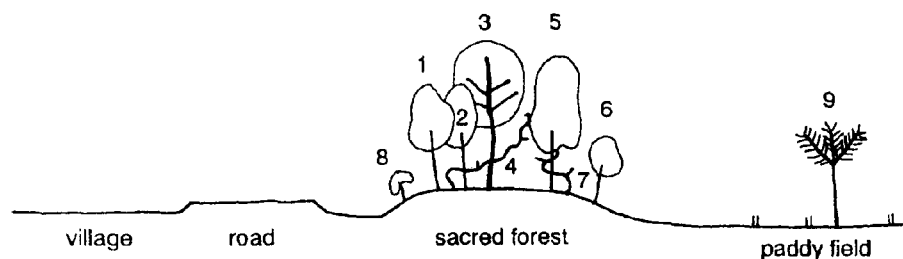
Fig. 18 Diagram of Site 20

Located along the Ban Nong Ku village-Phra Yun district road, about 15 km to the west of Phra Yun. The canal was recently constructed. Formerly the site was paddy fields. After the canal digging, many saplings regenerated on the banks of the canal: (4) *takhop pa* (*Flacourtia indica*), wood being used for fuel and the fruit being edible and for bird feeding; (5) *daeng* (*Xylia xylocarpa*); (6) *makha tae* (*Sindora siamensis*), wood generally used for house poles; (7) *yo pa* (*Morinda coreia*) a soft wood, branches and stems being fuel-wood; (8) *kradon* (*Careya arborea*), leaves being edible, bark for dyeing and stems being good for fuel-wood; (9) *sabu dam* (*Jatropha curcas*), typical index of drought and saline soil, its seed being used for extracting oil. The original trees are standing in paddy fields, such as (1) *teng* (*Shorea obtusa*), and (2) *hiang* (*Dipterocarpus obtusifolius*). Both are valuable trees in DDF and widely used for house building. (12) *Thon* (*Albizia procera*), a leguminous tree, is suitable for general construction and the leaf is good for soil organic matter addition.

Some trees are planted, such as (3) *mamuang* (*Mangifera indica*) and (13) *cham churi* (*Samanea saman*).

21. Sacred forest: Feb. 10, 1991

Ban Samran Village, Mueang District, Khon Kaen Province

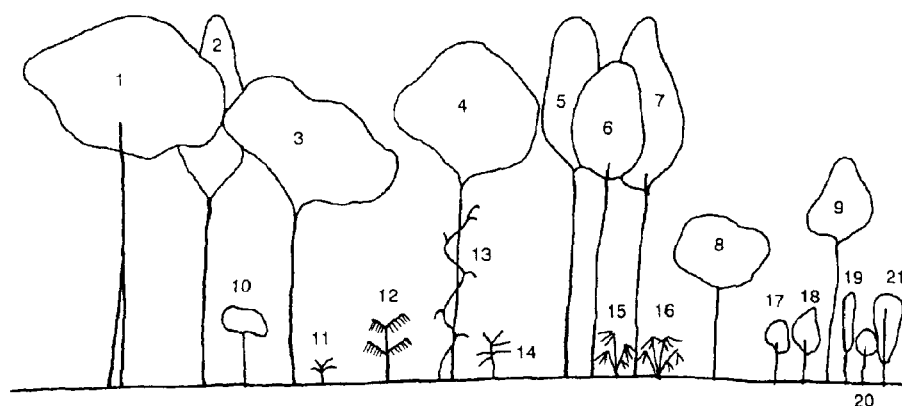
**Fig. 19** Diagram of Site 21

Located along the road No. 2 about 10 km to the north of Khon Kaen. The forest is a group of tall trees between the village and the paddy fields. One spirit house is constructed at the center of the forest under the canopies of trees such as (1) *rang* (*Shorea siamensis*), a valuable tree in DDF; (2) *pradu* (*Pterocarpus macarocarpus*); (3) *makoem* (*Canarium subulatum*); (4) *makha tae* (*Sindora siamensis*) and (5) *thong kwao* (*Butea monosperma*), whose leaf is used for wrapping Thai sweets. These make the upper stratum canopy. The lower stratum consists of (6) *daeng* (*Xylia xylocarpa*), (7) *nam khom* (*Zizyphus cambodiana*), and (8) *sakae* (*Combretum quadrangulare*). The ground floor is covered with *sa suea* (*Eupatorium odoratum*), *ya kha* (*Imperata cylindrica*) and seedlings of *makha tae*.

The main tree species planted on the paddy fields is (9) *tan* (*Borassus flabellifer*).

22. Temple forest: Feb. 11, 1991

Wat Pa Dan Wiwek Temple, Pak Khat District, Nong Khai Province

**Fig. 20** Diagram of Site 22

Located 17 km east of Pak Khat town. The temple was constructed in the forest of 450 *rai*. Primary forest surrounds the temple compound where small houses (*kut-ti*) were built among the trees and especially on pieces of stone (*dan*). Big trees forming the upper stratum are: (1) *yan* (*Dipterocarpus alatus*); (2) *phayung* (*Dalbergia cochinchinensis*), a special tree for high class furniture making; (3) *takhian thong* (*Hopea odorata*); (4) *kabok* (*Irvingia malayana*), with a big canopy and trunk, wood being good for charcoal making but not so popular for construction; (7) *phan sat* (*Erythrophleum succirubrum*), one of the leguminous tree species good for house poles; (8) *phluang* (*Dipterocarpus tuberculatus*); and (9) *teng* (*Shorea obtusa*).

Trees in the middle stratum are very few, only some bamboo such as (15) *phai pa* (*Bambusa arundinacea*). Its young shoot is popular for cooking. (16) *Phai sang* (*Dendrocalamus strictus*) is bamboo with multiple uses, like fencing, walling and some roofing. The ground floor is quite dense with seedlings of: (16)

makoem (*Canarium subulatum*); (12) *tao rang* (*Caryota urens*), of which young shoots are edible; (13) rattan. *Caryota* leaf is used for sweeping and the rattan is commonly used for many home utensils. The flowers of (14) *chanthana* (*Tarenna hoensis*) are edible both fresh and boiled.

A planting program was also introduced ten years ago to the temple with such tree species as (17) *pradu*, (18) *makha mong* (*Azelia xylocarpa*), (19) *makha tae*, (20) *phayung* and (21) *sak* (*Tectona grandis*).

23. Salt-producing area: Feb. 12, 1991

Ban Khok Kom Village, Tha Bo District, Nong Khai Province

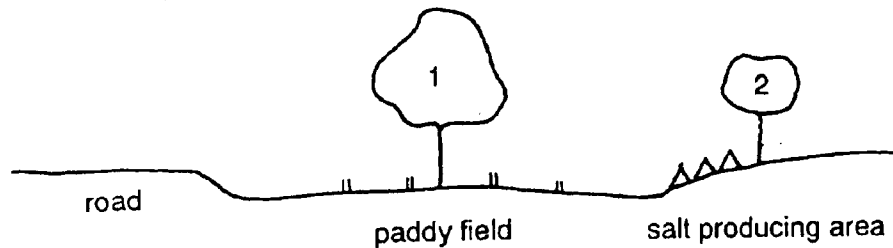


Fig. 21 Diagram of Site 23

Located along the Tha Bo-Ban Phu road, about 10 km west of 9 km post from Tha Bo. This is a typical salt producing area in the region. The salt crust on the paddy fields is collected and dissolved in water to make brine, which is boiled to produce salt. This typical method is an indigenous way of farmers since centuries ago. There are several salt patches in the shallow valleys of this area. Rice straw shows a characteristic decay in summer, which is a good indicator of saline soil. Another indicator is the number and species of standing trees. Two species observed in the paddy fields are: (1) *khae na* (*Dolichandrone spathecea*), its flower being collected for decoration; and (2) *sakae na* (*Combretum quadrangulare*).

24. Shifting cultivation on the mountain: Feb. 12, 1991

Pak Chom District, Nong Khai Province

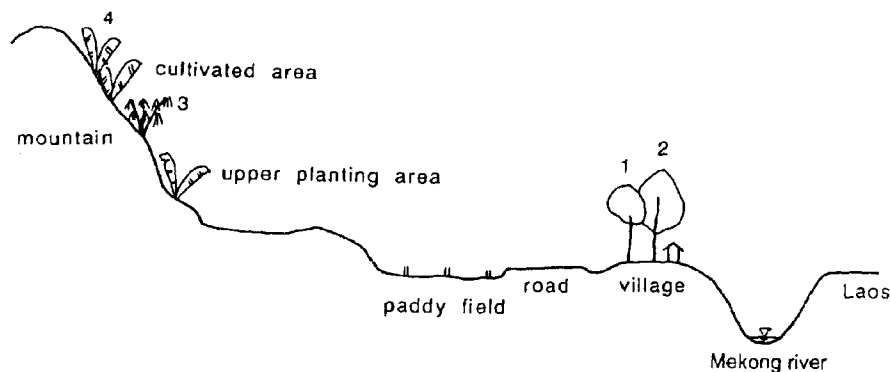


Fig. 22 Diagram of Site 24

The cross-section shows the general topography and landscape along the Nong Khai-Chiang Khan road. The trees on the mountain are completely cut. (4) Banana is planted even on the steep mountain slope. (3) Some remaining bamboo becomes dominant after a couple of years. On the foot of the mountain, (2) some tamarind plantations are made and give good harvest of fruits. Paddy fields, a component of the narrow valley, constitute a permanent planting area where people plant rice once a year. The presence of very few trees found show the old opening of the paddy field. (1) *Longan* (*Euphoria longan*) and *makham* (*Tamarindus indica*) are commonly planted in the home garden.

25. Water tank in paddy field: Feb. 15, 1991

Ban Tum Village, Mueang District, Khon Kaen Province

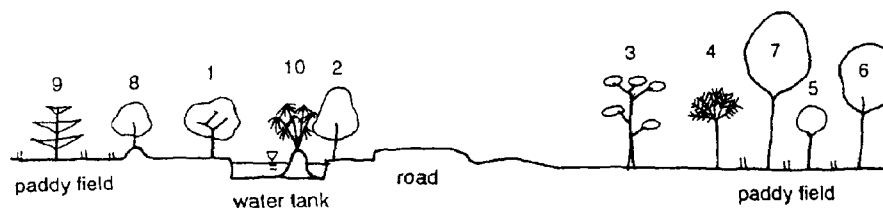


Fig. 23 Diagram of Site 25

Located along the Ban Tum-Mancha Khiri road, about 2.5 km to the south of Ban Tum. People started to plant tomato after rice harvest a few years ago. Many big trees are standing on the paddy fields. They are both planted and naturally regenerated. The planted trees are: (1) *mamuang* (*Mangifera indica*), (2) *makham* (*Tamarindus indica*), (4) *tan* (*Borassus flabellifer*) and (10) *phai ban* (*Dendrocalamus hamiltonii*). The naturally regenerated trees include many deciduous tree species like: (3) *thon* (*Albizia procera*), (5) *makha tae* (*Sindora siamensis*), (6) *pradu* (*Pterocarpus macrocarpus*), (7) *takhro* (*Schleichera oleosa*), with sour but edible fruits and wood for charcoal making. (8) *Tako* (*Diospyros rhodocalyx*) grows naturally on the soil mound in the paddy field. Its fruit is edible after ripening, and unripe fruits are used for dyeing. Heartwood is used for medicine after boiling. (9) *Rok fa* (*Terminalia alata*) is common in the paddy fields in this region. The fiber of the tree can be used for making coarse rope used to harness the buffalo to the plough. Ash from the bark has high potash content and is suitable for applying to sweet tamarind trees, in order to make the fruit taste sweeter.

26. Irrigation canal: Feb. 15, 1991

Ban Bo Ko Village, Phra Yun District, Khon Kaen Province

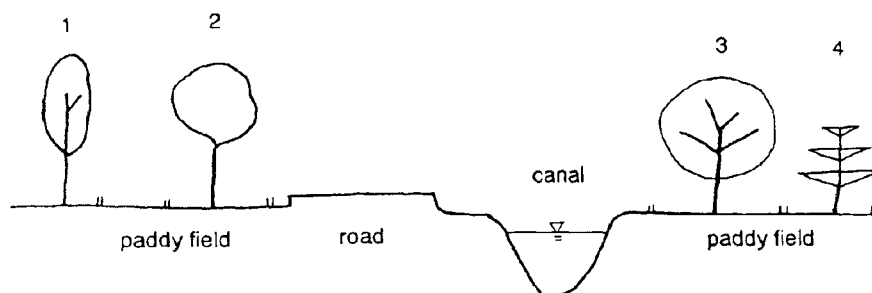


Fig. 24 Diagram of Site 26

Located 1 km south of Phra Yun along the Phra Yun-Mancha Khiri road. The canal was recently excavated along the course of an old creek. The paddy fields are old with very few standing trees. (1) *Hiang* (*Dipterocarpus obtusifolius*) and (4) *rok fa* (*Terminalia alata*) are natural growth, while (2) *makham* and (3) *tan* are planted by the farmers in order to get the fruits for domestic use.

27. DDF on sandstone: Feb. 14, 1991

Ban Nong Ya Plong Village, Mancha Khiri District, Khon Kaen Province

An exposed rock pan of sandstone is located along the Mancha Khiri-Kaeng Kholo road, about 24 km to the west of Mancha Khiri. The pan is washed by water and wind and shows a smooth surface. The natural vegetation of DDF is small and stunted, and some trees are creeping on the rock pan, such as: (4) *khui hin* (*Gardenia collinsae*), the stem of which is used for medicine; (2) *sabaeng* (*Dipterocarpus intricatus*); (9) *prong* (*Cycas siamensis*), an ornamental plant and good indicator of DDF. (3) *Tong mong* in the form of a creeping shrub is also an indicator of rock pan topography.

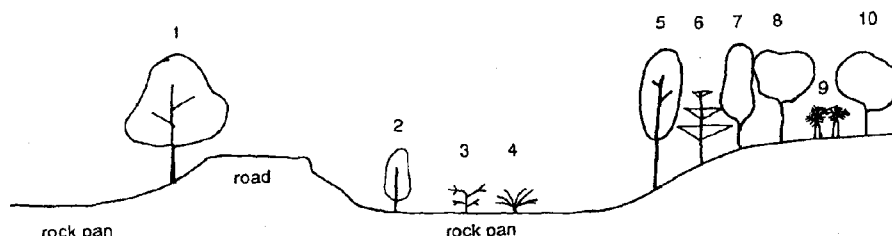


Fig. 25 Diagram of Site 27

The upper tree layer is a colony of small DDF trees such as: (5) *hiang* (*Dipterocarpus obtusifolius*); (6) *samo thai* (*Terminalia chebula*), the fruit of which is used as a medicine for stomach gas; (7) *yo pa* (*Morinda coreia*); (8) *kradon na* (*Careya sphaerica*); and (10) *makha tae* (*Sindora siamensis*). One of the halophytic plants is (1) *krathin phi man* (*Acacia harmandiana*), good for fuel-wood, and bark for dying. This tree grows along both sides of the highway in the region. The leaf color changes from red when young to light green and dark green when old.

28. Quarry on lateritic soil: Feb. 15, 1991

Ban Non Chan Village, Chaturat District, Chaiyaphum Province

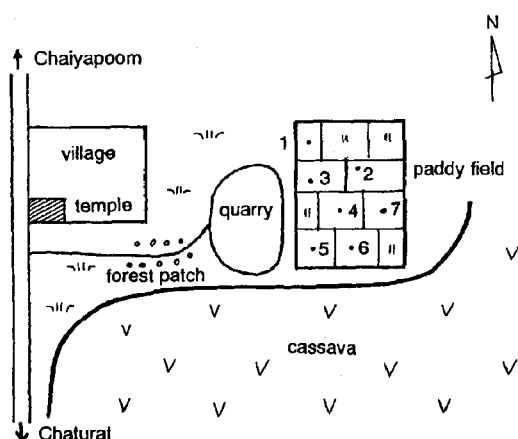


Fig. 26 Diagram of Site 28

A quarry for lateritic slag, along the Chaiyaphum-Chaturat road about 28 km from Chaiyaphum. Soil is very shallow and mixed with small gravel. Trees are very small; even *sadao* (*Azadirachta indica* var. *siamensis*), a drought-tolerant tree, becomes a creeper. Most other trees are also drought-tolerant species, like *chaeng* (*Lithocarpus wallichianus*); *mueat ae* (*Memecylon scutellatum*), a good tree for fuel-wood; *yo pa* (*Morinda coreia*) and *krabok* (*Irvingia malayana*).

Some liane are common in this kind of topography such as *sai tan* (*Aganosma marginata*), the stem of which is used to make spindles for local weaving of both silk and cotton; *nam ua lia* or *phung khi* (*Capparis macropoda*), an indicator of lateritic soil, and a small thorny shrub which is seldom used by the farmers. Paddy field around has many valuable trees. The landscape of paddy fields with trees, soil mounds and rice stubble conveys a stable and refined impression.

(1) *Tako* (*Diospyros rhodocalyx*) grows on the soil mounds; (2) *tan* (*Borassus flabellifer*) was planted on paddy dikes; (3) *khae na* (*Dolichandrone spathacea*) grows naturally on paddy fields; (4) *sadao* (*Azadirachta indica* var. *siamensis*) is naturally regenerated on soil mounds; (5) *makham* (*Tamarindus indica*) is planted for fruit for domestic consumption. It was planted on soil mounds where farm huts (*thiang na*) were built. There are other trees like (6) *thong kwao* (*Butea monosperma*), an indicator of a flooded area, and (7) *thon* (*Albizia lebbek*).

29. Salt mound: Feb. 16, 1991

Nong Phayamuai Mound, Ban Wang Village, Non Thai District, Nakhon Ratchasima Province

Located about 20 km southwest of Non Thai district, on the Non Thai-Nong Suang road. There is a big salt mound, 5 m high and 20 m in diameter. Paddy field covered with salt crusts, which people formerly used for salt-making. Salt pans were introduced nearby a few years ago, and today the paddy fields have been changed to salt pans. Very few trees are found in the paddy fields, only (7) *rok fa* (*Terminalia alata*). There is a group of single trees on the mound (only one tree of each species) such as (1) *sadao* (*Azadirachta indica*), (2) *sakae* (*Combretum quadrangulare*), (6) *krathin pa* (*Acacia harmandiana*), (4) *makham* (*Tamarindus*

indica) and (5) *chaeng* (*Lithocarpus wallichianus*). Trees on the mound are believed to be sacred, and people do not dare to cut them.

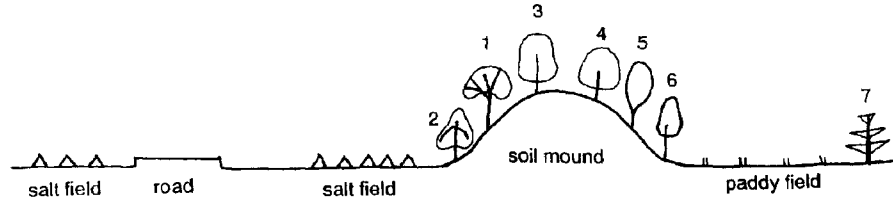


Fig. 27 Diagram of Site 29

30. Salt-affected paddy field: Feb. 16, 1991

Ban Nong Kat Village, Non Thai District, Nakhon Ratchasima Province

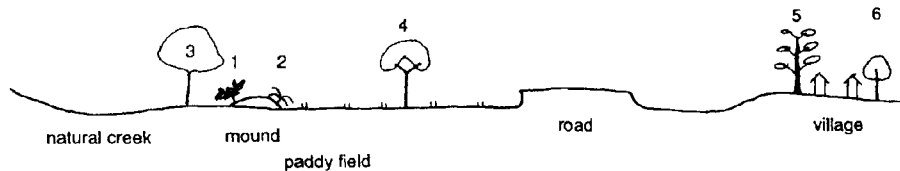


Fig. 28 Diagram of Site 30

An extensive desolated area lies to the south of Non Thai-Nong Suang road and to the east of Nong Suang-Khok Fak road. Rice stubble shows peculiar decay due to the effect of salinity. (1) Some *nam daeng* grow naturally on soil mounds in the paddy field as well as (2) *nam phungdo* (*Azima sarmentosa*). These two species are indicators of heavily saline soil. (3) *Sakae na* is scattered along the creek, while (4) *sadao* grows sparsely on the paddy field. (5) *Ngiw* (*Ceiba pentandra*), the kapok tree, is used for making pillow and mattress, stem being good for pulp making. (6) *Mamuang* (*Mangifera indica*) is a popularly planted tree species in home gardens.

31. *Nam dung*: Feb. 16, 1991

KM. 4 post on Nong Suang-Kham Thale So road, Kham Thale So District, Korat Province

Located along the Non Thai-Kham Thale So road. The paddy field has several moribund calcareous *nam dung* and (9) *sabaeng* (*Dipterocarpus intricatus*) as the sole tree species. (8) *Krathin pa* (*Acacia siamensis*) and (7) *makham thet* are also commonly found along the road. The latter's wood is good for fuel-wood and charcoal making and its fruit is eaten by children. (1) *Sakae na* and (4) *tan* are also tolerant to salty soil, while some shrubs are indicators of saline soil, such as (2) *nam daeng*, (3) *nam phungdo* and (6) *khlu* (*Pluchea indica*). These surround the *tan* tree. (5) *Phikun paa* (*Homalium grandiflorum*) is a flowering shrub which can grow on acidic and saline soil. Its flower has a good smell and its stem has sharp thorns.

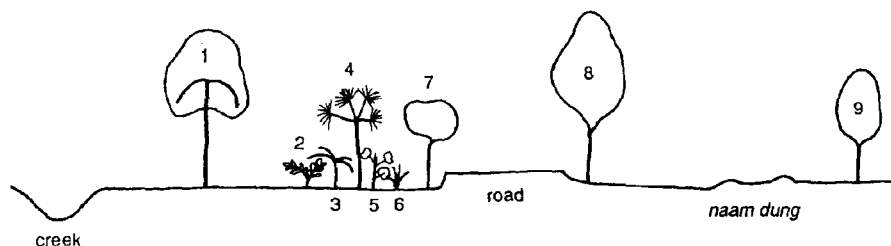


Fig. 29 Diagram of Site 31

32. Salt-producing area: Feb. 18, 1991

Ban Pla Duk Village, Mueang District, Ubon Rathcathani Province

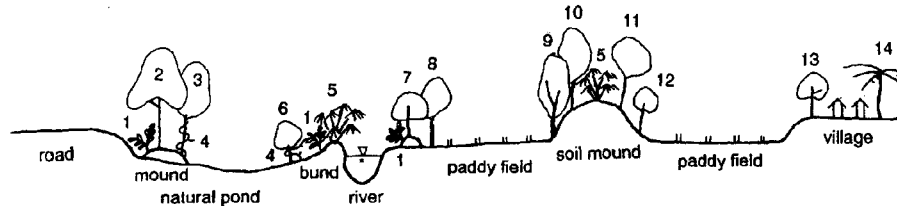


Fig. 30 Diagram of Site 32

Located along the Ubon-Trakan Phuet Phon road, about 9 km to the north of Ubon. The site is in a shallow valley which is always flooded in the rainy season. People collect the salt crust in the dry season from the surface soil of the valley bottom. After boiling the salty leachate, farmers obtain salt, which is suitable for *pla ra* (fermented fish) making. This typical occupation is said to have continued for more than 300 years and still actively done.

There are very good examples of a flood- and salt-tolerant vegetation colony in the salt spot. The duration of flooding is about one week or more. (1) *Nam daeng* is common both in creeping type and tree type. (2) *Sakae*, and *makha tae* and smaller (4) *nguang sum* (*Calycotris floribunda*), a climber with a fragrant flower, are located on the river bank. Bark of *nguang sum* is good for rope-making but not so commonly used. (6) *Wa* (*Eugenia cumini*) is also commonly grown in the Ubon area where flooding is an endemic hazard in rainy season. (5) *Phai pa* (*Bambusa arundinacea*), a drought-tolerant tree species is also grown, as an ornamental tree, and its young leaves are good to cook with *lab* (typical Northeast dish made of spices, beef, pork, chicken and bird meat). It is usually grown on soil mounds and also in acidic areas. The young leaves of (8) *kum bok* (*Crateva religiosa*), a common tree grown in flooded paddy fields are edible after soaking with rice-water and salt.

On the big soil mound is a group of indigenous tree species: (9) *rang thai* (*Buchanania siamensis*), an indicator of acidic and saline soil, of which the young leaf and fruit are edible; (10) *tabaek yai*, (11) *sabaeng*, and (12) *phan sat*, valuable tree species whose wood is used for construction and as fuel for salt boiling. (13) *Mamuang* and (14) *maphrao* are commonly planted in home gardens of Ban Pla Duk village.

33. Vegetation on river bank: Feb. 19, 1991

Kanthararom District, Sri Saket Province

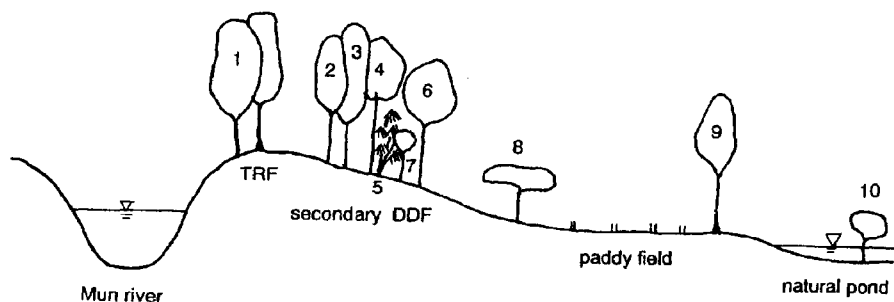


Fig. 31 Diagram of Site 33

Located on the north bank of Mae Nam Mun on the Kanthararom-Yang Chum Noi road. The trees along the river bank are (1) *yang na* (*Dipterocarpus alatus*). This tree is the main species in TRF (tropical rainforest). Trees of DDF occupy the sites higher and further from the river. (2) *Hiang*, (3) *teng*, (4) *daeng*, (5) *makoem*, (6) *phayom* and (7) *kradon* are the dominant tree species. The small size of these trees suggests

that they may be secondary growth. (8) *Wa* grows naturally between DDF and paddy field, and stands in flooding in the rainy season. (9) *Hiang* standing in paddy fields is also natural growth. In the natural pond where water is available all year long, (10) *kratum na* (*Mitragyna javanica* var. *microphylla*) is dominant. Its wood is used for fuel.

34. Sacred forest: Feb. 19, 1991

Ban Wan Village, Rasi Salai District, Sri Saket Province

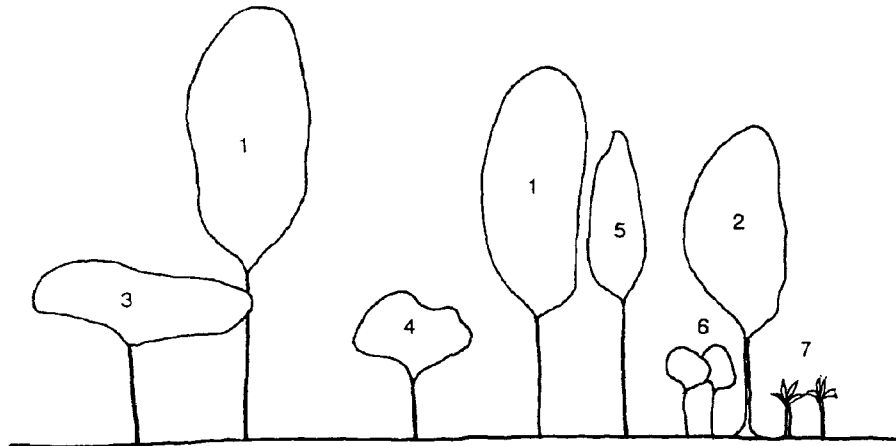


Fig. 32 Diagram of Site 34

Located 4 km to the north of Rasi Salai district, there is a *phi* forest close to the school. Many monkeys live in this forest. The biggest tree is (1) *yang na* (*Dipterocarpus alatus*) which is about 2.1 m in DBH and 40 m in height. (2) *Krabak* (*Anisoptera costata*) is the second biggest, with DBH of 2.0 m and height of about 40 m. The lower layer is the group of: (3) *maphok* (*Parinari anamense*), the seeds of which provide oil for high quality varnish; (4) *khoi* (*Streblus asper*), of which the fruit is eaten by monkeys and the leaves are fed to cattle; (5) *phayung* (*Dalbergia cochinchinensis*), which provides valuable wood for high-class furniture. The forest floor is covered with plenty of litter fall. Seedlings of (6) *yang na* and (7) *plao yai* (*Croton oblongifolius*) are common.

35. Sacred forest: Feb. 19, 1991

Dong Poodin Forest, Ban Phung Village, Rasi Salai District, Sri Saket Province

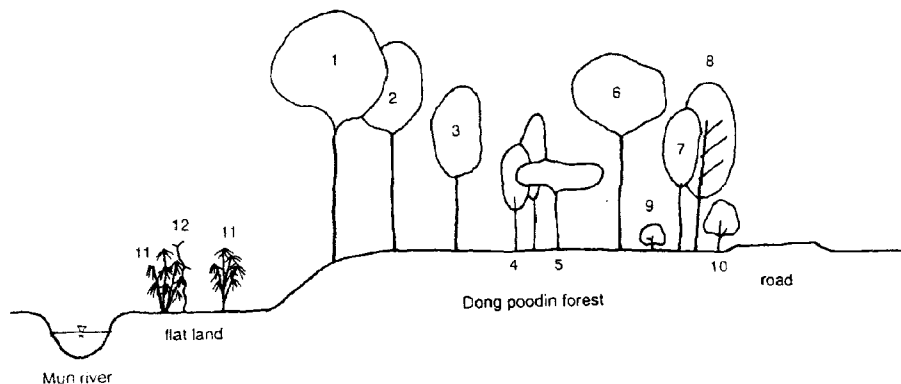


Fig. 33 Diagram of Site 35

This large sacred forest is located about 11 km to the west of Rasi Salai along the Rasi Salai-Suwannaphum road. The primary forest is conserved because people do not dare to disturb the gods in the forest by cutting the trees. They believe that anyone who cuts a tree will be punished by the gods. The natural regeneration seems to be good and results in clearly stratified canopies. The upper layer consists of (1) *yang na*; (2) *takhram* (*Garuga pinnata*), of which the wood is good for construction; (3) *ma phok*; (6) *manuang pa*; (7) *krabak*; and (8) *rak* (*Melanorrhoea usitata*), of which the resin is important for making lacquerware. The second layer consists of (4) *daeng*, (5) *wa*, (13) *hiang*. The lower ground cover is composed of (9) *khat khao* (*Randia siamensis*), a flowering climber with very good smell, and with edible young leaf; (10) *mok man* (*Wrightia tomentosa*); and (14) *khrua sut* (*Parameria barbata*), of which the stem is used for tying many kinds of fishing tools. Many unidentified other climbers grow naturally on the flatland along the river.

36. Quarry: Feb. 21, 1991

Pibun Mangsahan District, Ubon Province

A quarry is located along the Ubon-Phibun Mangsahan road, about 7 km to the west of Phibun. Gravely soil is excavated for road construction. Because of the poor soil, the trees are small and short. (1) *Hiang*, (3) *phluang*, (4) *krabak*, and (2) *mamuang* are natural growth. (5) *Tiu* (*Cratoxylum formosum*) provides edible, sour leaves, and wood for fuel. It grows naturally in the disturbed quarry. The ground cover consists of many seedlings like (7) *mueat ae*, (8) *bong mang* and (9) *yo pa*. *Bong mang* (*Carallia brachiata*) is an evergreen pioneer tree.

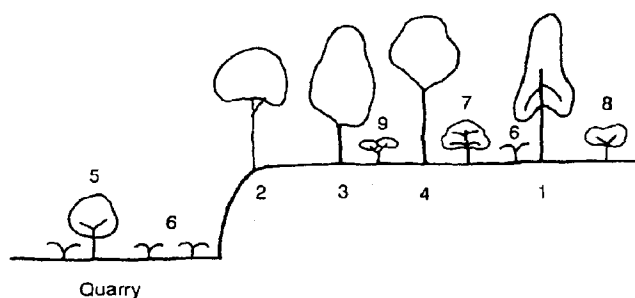


Fig. 34 Diagram of Site 36

37. Quarry: Feb. 22, 1991

Ban Yang Chum Village, Mueang District, Ubon Province

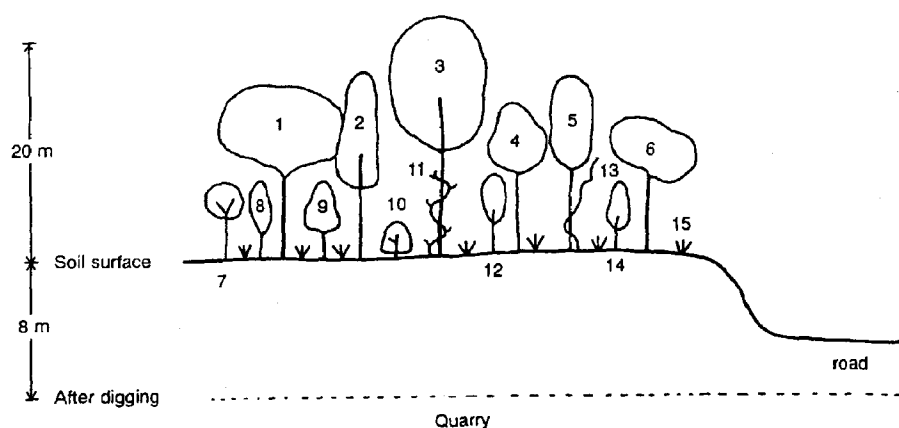


Fig. 35 Diagram of Site 37

A quarry about 8 m in depth is located along the Ubon-Trakan Phuet Phon road, about 10 km to the north of Ubon. It was excavated in a stand of natural DDF, which shows clear stratification. The upper layer consists of big trees like (1) *tabaek lueat* (*Terminalia corticosa*), whose wood is used for general construction; (2) *tiu* (*Cratoxylum formosum*); (5) *phluang* (*Dipterocarpus tuberculatus*), (4) *nonsi* (*Peltophorum dasyrachis*), with a yellow flower, which is good for ornamental planting, and provides wood for construction; (3) *teng* (*Shorea obtusa*); and (6) *kradon* (*Careya arborea*). The second cover is a mix of shrubs and climbers, like (7) *mayom pa* (*Ailanthus triphysa*), whose wood is suitable for fuel and fencing; (8) *nam thaeng* (*Randia*

dasycarpa), a thorny shrub, not popular for domestic use except as fuel-wood; (9) *phluang* seedlings; (10) *khem pa* (*Ixola cibdela*), a flowering shrub. There are small quantities of (11) rattan and (13) *saitan* (*Aganosma marginata*). *Saitan* is also a climber. (12) *Daeng* and (14) *phan sat* are also present as seedlings. One important indicator of DDF is (15) *ya kha* (*Imperata cylindrica*), a multi-purpose grass which people use for roofing of both temporary and permanent houses. Litter-fall is quite thick because it is not used for domestic purpose or as green manure in the paddy fields.

38. Landscape of gravel-capped hill: Feb. 22, 1991

Ban Thung Mon Village, Kham Khuan Kaeo District, Ubon Province

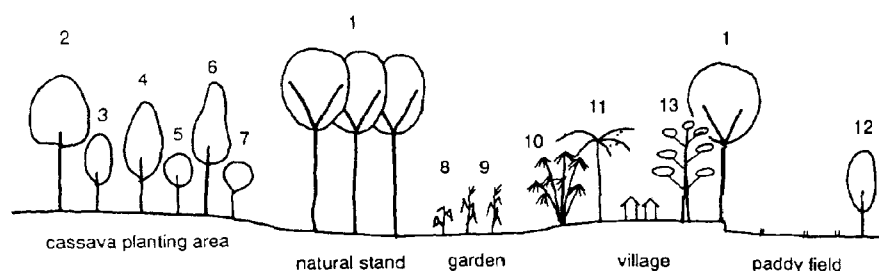


Fig. 36 Diagram of Site 38

This hill is located about 10 km to the east of Kham Khuan Kaeo district. Some forest plots were recently opened to plant cassava. (1) *Yang* trees surrounding the hill give good protection. But the trees left on cassava plantation are sparse. Some of them are big trees such as (2) *kabok* (*Irvingia malayana*); (4) *tabaek yai* (*Lagerstroemia calyculata*), of which the wood is good for flooring; and (6) *phan sat* (*Erythrophloeum succirubrum*). The small trees in the plantation are mostly valuable ones: (3) *daeng, yang*, (5) *pradu*, (7) *phayom* and so on. A garden is located between the village and natural stand. (8) *Chili* and (9) corn are popular crops planted in the garden. (10) *Phai ban* (*Dendrocalamus hamiltonii*) forms a big clump, which shows the old age of the village as well as (13) *maphrao*. (11) *Ngiew* (*Ceiba pentandra*) is also planted in each home garden. In the paddy fields only (12) *sabaeng* (*Dipterocarpus intricatus*) was found standing on the dikes.

39. Paddy field type and tree distribution: Feb. 22, 1991

Thawachaburi District, Roi-et Province

The figure shows the distribution of trees along the Selaphim-Thawachaburi road. Close to the Chi river is a flat plain which is usually flooded every year. Trees are few with scattered, (1) *phai pa* and (2) *sakae na*. On the terrace, which is slightly higher than the alluvial plain, the tree density increases and many deciduous tree species are found such as (3) *hiang*, (4) *phayom* and (5) *sadao*. These trees stand on paddy dikes and in the paddy fields. In Thawachauri district, (6) a pure stand of *yang na* (*Dipterocarpus alatus*) makes a remarkably big group. Trees are old and tall. The forest of this area is protected by the villagers themselves and is an attractive spot to the people and travelers.

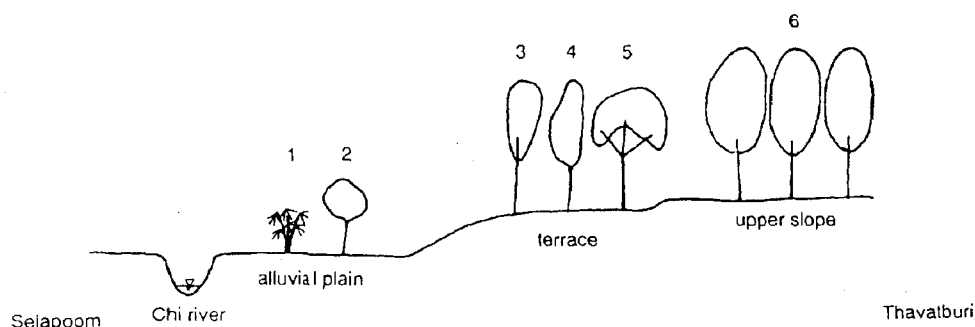


Fig. 37 Diagram of Site 39

40. Old quarry: Feb. 23, 1991

Ban Nong Hin Noi Village, Mueang Suang District, Roi-et Province

Located to the southeast of Mueang Suang district, there are many quarries where lateritic soil was excavated for road construction. Naturally regenerated trees are very small because of the soil hardness. Their roots cannot penetrate the shallow laterite pan. *Nonsi* (*Peltophorum dasyrachis*) is the only big tree. Others are smaller, such as *tiu* (*Cratoxylum formosum*); *takhop ban* (*Flacourtia inermis*), of which the fruit is edible, and fiber is used for rope making; *sakae na* (*Combretum quadrangulare*), *sabaeng* (*Dipterocarpus intricatus*). Some thorny climbers also grow naturally among these trees, such as *saitan* (*Aganosma marginata*) and *nam tanin* (*Acacia comosa*). Both are seldom used, except that spindles for weaving are made of *saitan*.

41. Halophytic plants: Feb. 27, 1991

Ban Man Village Phimai District, Nakhon Ratchasima Province

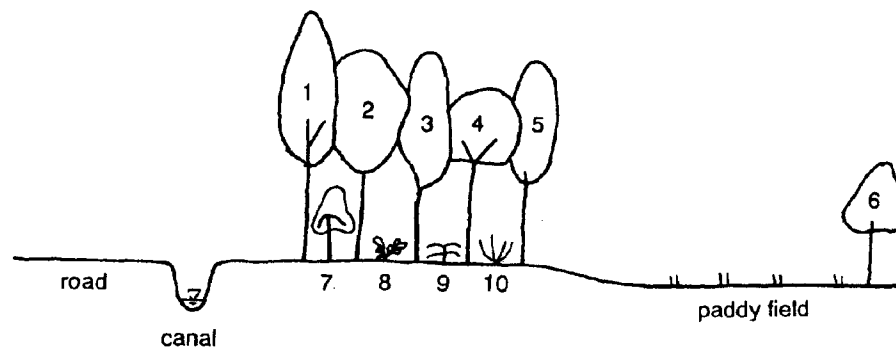


Fig. 38 Diagram of Site 41

The site is located in the alluvial plain of the Mun river, and along the irrigation canal about 12 km to the north of Phimai. There are many small salt mounds on slightly higher rice fields, which are not planted with rice in dry years. The parkland landscape has sparsely standing drought-tolerant tree species, such as (1) *krathin phiman* (*Acacia harmendiana*), (2) *sadao* (*Azadirachta indica*), (3) *masang* (*Fefoniella lucida*), (4) *tako na* (*Diospyros rhodocalyx*) and (5) *rang chai* (*Buchanania siamensis*). All are abnormally small. Shrub layer consists of many salt-tolerant tree species, such as (7) *sakae* (*Combretum quadrangulare*), (8) *nam daeng*, (9) *nam phungdo* (*Azima sarmentosa*), and (10) *khlu* (*Pluchea indica*). Soil is affected by salty water which is transported from upper streams. There are few trees in the surrounding paddy fields, except (6) *sabaeng*.

42. Eroded salt spots: Mar. 1, 1991

Ban Sa Chorakhe Village, Dan Khun Thot District, Nakhon Ratchasima Province

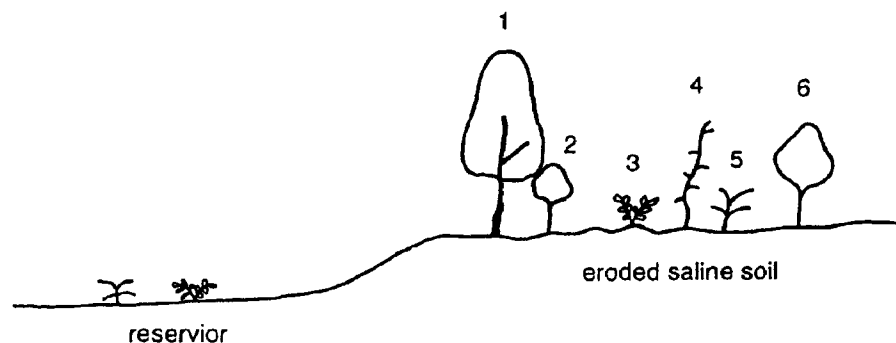


Fig. 39 Diagram of Site 42

The salt spots are located between the Chiang Krai river and the Nong Suang-Dan Khun Thot road, about 8 km east of Dan Khun Thot. A shallow valley plain is nested with many salt mounds and *nam dung*. The whole valley is covered with barren sand, and erosion is proceeding upstream along the valley. Shrubs are scattered on the flowing sand and on the eroded saline soils. On the latter there are: (1) *krathin phiman* (*Acacia harmandiana*), is the shape of a *bonsai*; (2) *sakae na* in creeping style; (3) *nam daeng*; (4) *nam khom* (*Zizyphus cambodiana*); (5) *nam phungdo*; and (6) *chaeng* (*Lithocarpus wallichianus*).

On the flowing sand, only *nam daeng* and *nam phungdo* dominate, which retard the erosion and create a slightly elevated bench.

Appendix II



Plate 1 Trees on Paddy Field, Mukdahan
(Text 2.5.1)



Plate 2 *Thiang Na* (Farm Hut),
Suwannaphum, Roi-et (Text 2.5.3)



Plate 3 Threshing Ground, Ban Rua, Phu
Wiang, Khon Kaen (Text 2.5.3)



Plate 4 Resin from *Teng* (*Shorea obtusa*)
Tree (Text 3.2)



Plate 5 *Maeng Chi Nun* (*Lepidiota bimaculata*) Hunting, Udon Thani (Text 3.2.4)

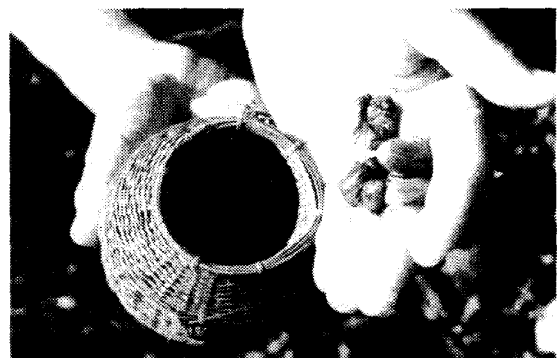




Plate 6 *Kut Chi (Oritits virens)* Hunting, Udon Thani (Text 3.2.4)

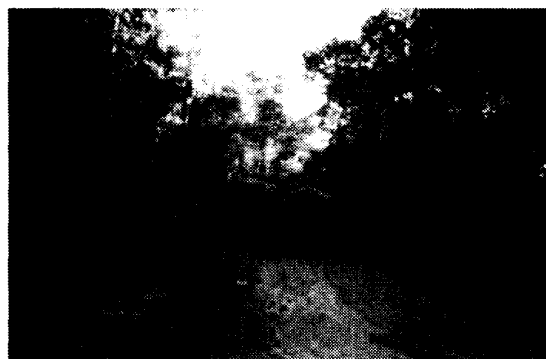


Plate 7 Log Transportation on Logging Road, Phu Wiang Forest, Khon Kaen (Text 3.3.1)



Plate 8 Mushroom Gathering, Roi-et (Text 3.3.2)



Plate 9 Three-rock Fireplace on the Household Common Ground, Phu Wiang, Khon Kaen (Text 4.1)



Plate 10 Silk Production, Phu Wiang, Khon Kaen (Text 4.1)



Plate 11 Charcoal Production, Ban Rua,
Phu Wiang (Text 4.1.5)



Plate 12 Forest Shrine in *Pa Don Pu Ta*,
Kalasin (Text 4.3.2)

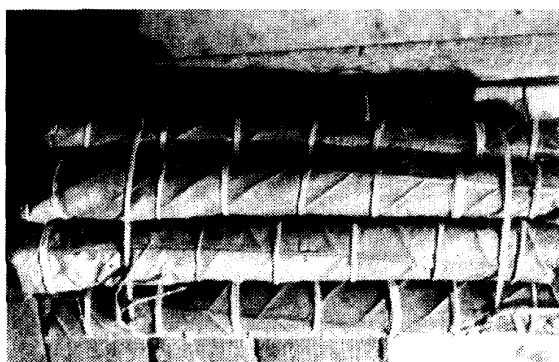


Plate 13 Torch (Text 4.3.2)



Plate 14 Home Compound of the
Northeast Farmers, Khon Kaen
(Text 5.3)