II. ANALYSIS ON THE SUSTAINABILITY OF THE FOREST-TEA PRODUCTION SYSTEM

2.1 Miang Production as the Main focus of the Forest-Tea Production System

As the main play of the forest-tea production system, miang production in Ban Kui Tuai is examined in a systems perspective. This permits the production to be characterized as a production system which transforms the tea leaves into two usable products - *miang* (fermented tea) and Chinese tea. Production systems such as this combine environmental, socio-cultural, amd economic elements. According to Panya and others (1988), "production systems is a structured ... chain of events via which a resource is perceived, passes from its source, through technological transformations, to the creation and delivery of an end - product that satisfies a human need (whether a "real" or a "felt" need).

Within the overall system, the forest-tea production system is divided into a series of logical steps (firewood collection, harvesting, miang processing, packing, transporting, marketing). Within each step, activities and actors, inputs and outputs and external influences are identified, examined, interpreted and interrelated. Information on each step in the miang production is then combined and related so as to trace and understand the overall sequence of events within the production system. This also permits one to see how each step's characteristics not only are influenced by the characteristics of the preceding step, but also influence those of later steps. This knowledge is extremely valuable because it is required to recognize specific problems and constraints, to identify promising

opportunities, and to locate points of entry for development activity within the overall system.

2.2 The Major Actors in the Forest-Tea Production System

The forest-tea production system in Ban Kui Tuai involves three groups of people based on the landsize holdings and the properties for each household. These are: 1) large miang farmers, 2) small miang farmers, and 3) the landless farmers. The distribution of these resources is shown in Tables 16A, 16B, 16C and 16D. Each resource is discussed in the succeeding sections of this Chapter.

At times, the income generating potential of this production system was such that it made some people rich who are the large tea garden owners, enabling them to dominate the production operations like in the acquisition of firewood, processing and the marketing of miang, to send their children to school not at the nearby village where most of the village children attend but in downtown Chiang Mai, and to buy televisions, motorcycles and pick-ups. In the study, it was found out that the rich people in the village are composed of four miang merchants and those who have the most number of resources (e.g. income & landsize holdings) compared with the rest of the 26 households. These merchants have the largest tea gardens or what the local people call *suan miang* in the village. Table 16A shows that they have the highest landholdings (including other land-

Table 16A. Distribution of resources of large tea farmers in Ban Kui Tuai

HHNo.	Annual Family Income (Baht)	PLH No. (rai)	PLH %	Livestock: Cattle No.	Cattle %	Water Buffalo No.	Water Buffalo %	Pig No.	Pig %	Chicken No.	Chicken %	Annual Production: No. of kam	Annual Production: Price (Baht)	No. of Vehicles: Pick-up	No. of Vehicles: Motor-cycle	Total Vol. of firewood used /HH/Yr. No.	Total Vol. of firewood used /HH/Yr. %
2	74700	93	25.27	60	33.33	10	76.92	7	16.67			16000	40000	1	2	45.33	8.51
8	34300	45	12.23					4	9.52	30	40.00	11000	27500	1	1	39.93	7.50
12	37300	55	14.95							4	5.33	14000	35000	1	1	38.00	7.14
24	38750	65	17.66									12500	31250	1	1	42.63	8.01
Total	185050	258	70.11	60	33.33	10	76.92	11	26.19	34	45.33	53500	133750	4	5	165.89	31.16
Average	46263	64.5	17.53	60	33.33	10	76.92	2.75	13.10	17	22.67	13375	33437.5	1	1.25	41.47	7.79

Note: HHNo. - Household number
PLH - Present landsize holdings

Table 16B. Distribution of resources of small tea farmers in Ban Kui Tuai

HHNo.	Annual Family Income (Baht)	PLH No. (rai)	PLH %	Livestock: Cattle No.	Livestock: Cattle %	Livestock: Water Buffalo No.	Livestock: Water Buffalo %	Pig No.	Pig %	Chicken No.	Chicken %	Annual Production: No. of kam	Annual Production: Price (Baht)	Total Vol. of firewood used /HH/Yr. No.	Total Vol. of firewood used /HH/Yr. %
1	25750	20	5.43	16	8.89			1	2.38			6700	16750	24.98	4.69
6	8750	8	2.17	18	10.00			4	9.52			3500	8750	24.98	4.69
7	13250	14	3.80	4	2.22			3	7.14	10	13.33	5100	12750	24.50	4.60
9	9500	10	2.72					4	9.52			3800	9500	30.38	5.71
10	11000	14	3.80	9	5.00			1	2.38			4400	11000	24.50	4.60
22	10700	3	0.82	6	3.33			1	2.38			2600	6500	25.95	4.87
23	10500	10	2.72			3	23.08	3	7.14			4200	10500	24.50	4.60
25	10425	10	2.72									4170	10425	25.22	4.74
4*	6770	14	3.80	5	2.78									2.90	0.54
5*	9100	7	1.90	7	3.89			1	2.38	15	20.00			3.38	0.63
Total	115745	110	36.18	65	36.11	3	23.08	18	42.86	25	33.33	34470	86175	211.29	39.69
Average	11574.5	11	3.62	6.5	3.61	3	23.08	2.25	5.36	12.5	11.11	4308.75	10771.8	21.13	3.97

* These households do not own any tea garden but small areas of paddy fields and orchards.

Note: HHNo. - Household number
PLH - Present landsize holdings

Table 16C. Distribution of resources of landless tea farmers in Ban Kui Tuai

HHNo.	Annual Family Income (Baht)	Livestock: Cattle No.	Cattle %	Water Buffalo No.	Water Buffalo %	Pig No.	Pig %	Chicken No.	Chicken %	Annual Production: No. of kam	Annual Production: Price (Baht)	Total Vol. of firewood used /HH/Yr. No.	Total Vol. of firewood used /HH/Yr. %
3	15850					1	2.38	10	13.33	3500	8750	24.50	4.60
11	20200					1	2.38			2800	7000	21.03	3.95
13	8800											2.90	0.54
14	6300					1	2.38					2.90	0.54
15	6000							3	4.00			2.90	0.54
16	13250					7	16.67			2900	7250	24.50	4.60
17	17050	8	4.44							2700	6750	24.98	4.69
18	13700	7	3.89							2200	5500	21.03	3.95
19	9000	10	5.56									2.90	0.54
20	10700					1	2.38			2600	6500	21.80	4.09
21	7300	30	16.67									3.38	0.63
26	7450					2	4.76	3	4.00			2.42	0.45
Total	135600	55	30.56			13	30.95	16	21.33	16700	41750	155.24	29.16
Average	11300	13.75	6.11			2.17	2.58	5.33	7.11	2783.33	4175	12.94	2.43

Note: HHNo. - Household number

Table 16D. Total number and percentage of resources in Ban Kui Tuai

Grand	Annual Family Income (Baht)	PLH		Livestock				Pig		Chicken		Annual Production		No. of Vehicles		Total Vol. of firewood used /HH/Yr.	
		No. (rai)	%	Cattle No.	%	Water Buffalo No.	%	No.	%	No.	%	No. of kam	Price (Baht)	Pick-up	Motor-cycle	No.	%
Total	436395	368	100	180	100	13	100	42	100	75	100	104670	261675	4	5	532.42	100
Ave.	16784.4	26.29	-	12.00	-	6.5	-	2.63	-	10.71	-	5815.0	11894.3	1	1.25	20.48	-

Note: PLH - Present landsize holdings

Table 17. Two types of miang preferred by the villagers

	Which one is better?			Type of Miang Worked on		Reason				No. of years worked on miang
	White Miang	Red Miang	NA	White Miang	Red Miang	High Income	Deli-cious	Increase in demand	Work as WL	
No.	22	0	4	25	1	15	5	1	5	
Total			26		26				26	
Ave.										16.5
Max.										45
Min.										2

*NA - Not Applicable (Villagers who do not use miang.)

uses such as paddy fields and orchards) with an average of 64.5 rai, average annual family income of 46,263 Baht. In addition, since the large tea farmers own big areas of miang gardens, they collect the highest number of tea leaves harvested averaging 13,375 kam per household and at the same time, use the highest amount of firewood with an average of 41.47 m^3 per year. With these characteristics, they are called large tea farmers.

The small tea farmers comprises villagers who own small areas of tea gardens, paddy fields and orchards. Under this category, there are two farmers who do not own any tea garden but rent them for picking miang leaves. The average annual family income is 11,574.5 Baht. From the average landsize holdings of 11 rai, the average amount of tea leaves collected per year is 4,352.5 kam with 21.13 m^3 of firewood which is the average volume used per year (Table 16B). For the landless tea farmers, most of them are wage laborers hired by large tea farmers for firewood collection and other miang production operations. A number of these farmers rent tea gardens from large owners for harvesting miang. Statistics in Table 16C show that they have the lowest amount of tea leaves collected averaging 5,815 kam per household per year and the use of firewood averages 12.94 m^3 per household per year. A summary on the distribution of resources for the three groups is shown in Table 16D.

Later in the next sections, despite the small landholdings of small tea farmers and those tea farmers who do not any land, they somehow earn enough income for themselves because

they have other resources which can be their other sources of income such as from livestock, which plays a major role in the forest-tea agroforestry system, and pigs which are sold by some households. Some landless villagers, in particular, engage in cutting firewood and picking tea leaves from tea gardens they rent from large owners. A handful of them work as wage laborers.

The rich and poor relationship is discussed more in each operation included in the miang production. Thorough analysis is presented in the next chapter.

2.3 Description of Miang or Fermented Tea

Miang or fermented tea, as the Khon Muang tea producers call it, have two types: *miang daeng* (red miang) and *miang khaw* (white miang). They are generally found in the highlands such as in the Hill Evergreen Forest in the northern part of Thailand. Typically, the amount of white miang is more abundant than the red miang.

Generally, both miang daeng and miang khaw are similar to each other. Despite of their similarities, there are some minor differences that can be observed. The most obvious differences can be found in the area of sizing and pigmentation. The leaf size of miang daeng is normally bigger than the leaf size of miang khaw. In terms of coloring, the pigmentation of miang daeng is fading red while that of miang khaw is green. With regards to taste, miang daeng tastes bitter than miang khaw. Despite of these

differences, the stem and height of both miang daeng and miang khaw are quite similar to each other.

In Ban Kui Tuai, the formal survey revealed that 22 out of 26 households like the taste of miang khaw better than miang daeng. This is the reason why most of the villagers, about 25 households, worked on miang khaw and only one for miang daeng. Four reasons were stated for using miang khaw while no reason for miang daeng was given. The average number of years worked by one household is 16.5. The maximum and minimum number of years are 45 and 2, respectively (Table 17). Table 17 also shows that most villagers chose white miang because it has higher income than red miang. Others stated "delicious", "increase in demand", and "no choice" because they have to work for the tea garden owners who work on white miang.

In harvesting of miang khaw and miang daeng, since they look alike in sizes and general outlook, the farmers always mix them up in each bundle (kam) and sell it as the price for miang khaw which is higher than the price of miang daeng.

2.4 **Miang Production**

2.4.1 **Stages** (In Sequence)

The seasonal activities of the forest-tea production system in Ban Kui Tuai is shown in Figure 13.

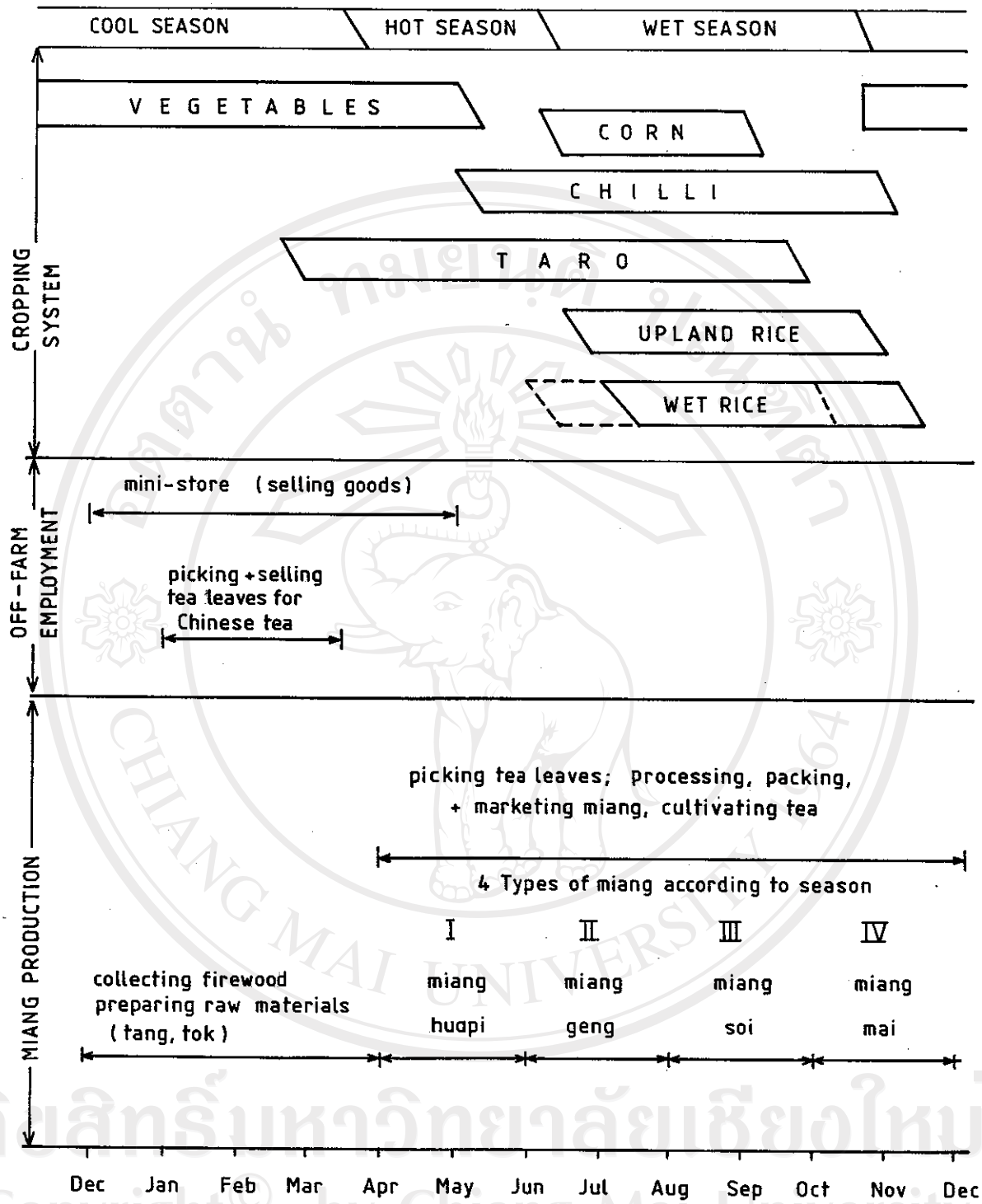

Figure 13. Seasonal activities of the forest-tea production system in Ban Kui Tuai

2.4.1.1 **Firewood Gathering**

The collection of firewood is the first and one of the main activities in miang production. It is an operation wherein the villagers collect firewood for all uses especially for miang processing and cooking. Based from previous studies and the researcher's work, it was found out that processing miang is a high firewood-demanding operation. Because of its large scope, the topic on "Firewood Gathering" is dealt more in one whole section entitled, "The Villager's Tree Cutting Practice". Section 6 is discussed with the following as subtopics: 1) firewood acquisition, 2) firewood usage, 3) decision-making, and 4) attitude of the villagers towards tree cutting.

2.4.1.2 Picking of Tea Leaves/Harvesting

Tea for miang is picked four times a year according to four seasons (from April - November), with the second picking being the largest. Figure 13 shows that there are four types of miang according to four seasons: *miang huapi, miang geng, miang soi and miang mai. Miang kwapi*, considered the miang with the highest quality, is harvested during the months of April and May when there is little rain. *Miang geng* (middle) is then harvested during June and July and has the most number of leaves harvested. *Miang soi* is harvested before the end of the rainy season during August and September. The last type of miang , *mai*, is harvested

before the end of the rainy season in which the condition is foggy. The calendar for miang production including other activities of the forest-tea production system are shown in Figure 13.

In between the harvest seasons, the tea leaf pickers take a rest for above one to two weeks which will allow the regeneration of new leaves for next picking. At the same time, they are also due to do other agricultural activities. For instance, during the middle of the hot season, the first picking starts on the first week of April and stops on the third week of April to plant chilli. Harvesting of leaves are also done. The picking continues on the second week of May until the first week of June. The villagers here start planting wetland and upland rice and corn as this is also the start of the rainy season. There are 25 mandays for the first season. The picking for the second season starts in early June and ends on the third week. During the rest period for about a week, farmers can still be planting upland and wet rice. The picking continues in early July and ends in the third week of July. For the third season having about 30 mandays, the picking starts in early August until the third week of September. The week after is devoted to the harvesting of taro and corn. For the last picking season, it starts in early October and stops on the third week of the same month. There are 25 mandays during this season. Two weeks of rest are needed after this since the harvesting of agricultural crops starts also during this time such as upland and wet rice. The picking then continues until the

end of November in which at the same time, the harvesting of the remaining upland and wet rice and the planting of vegetables are done. There are approximately 20 mandays during this season. Picking starts from 7:00 a.m. to 4:00 p.m.

Except for the miang merchants, the tea leaf pickers are composed of family members including the wives of the merchants. For the large tea garden owners, they hire labor besides family labor because of the vast tea gardens they own. The landless villagers especially those who do not rent land are the ones who work for those large owners. They are paid 1 Baht per kam.

In the case of small tea garden owners and the landless who rent tea gardens, they employ family labor and exchange labor. Exchange labor is done on a rotational basis depending on the target area of tea gardens to be collected for tea leaves for a certain period of time.

2.4.1.3 **Production of *kam* or miang leaves**

The leaf pickers use makeshift bamboo ladders which are needed to pick the larger leaves. These are usually just a notched pole leaning into a forked branch, for the picker to stand on. The pickers, both men and women, go to their work carrying a large basket and a small bundle of bamboo laths (*tok*), about one centimeter in width and cut this enough to tie the leaves into the small, fist-sized bundles called *kam*. An average skilled picker can collect about 30 to 50 kam per day. The total

harvest of miang leaves is shown in Table 18.

For the whole village, the highest average number of kam harvested per season is the second season which has 1627.7 kam and the lowest average number of kam is 859.4 kam from the fourth season. For the whole village, the minimum number of kam harvested in the fourth season is 300 while the maximum is in the second season which is 5000 kam (Figure 14).

The highest total number of kam harvested per season is during the second season (June-July) with 36,000 kam or 34.4% of the total number of kam while the lowest is 15,470 or 14.8%. The total number of kam harvested per year by the village is 104,670 kam.

There is a trend in the figures computed which reveals that the second season really has the highest number of kam harvested because of the high amount of rainfall received during the middle of the rainy season while the fourth season as the Thai name conotes is the end of the rainy season, thus, the growth of new leaves is less. The study also found out that the villagers who have the highest number of kam harvested are the large tea garden owners. The total number of kam harvested is 53,500 or 51.11% of the total number of kam in the village. The small tea farmers have a total of 34,470 kam harvested or 32.93% while the landless who rent tea gardens harvested a total of 16,700 kam or 15.95%. Tables 19A, 19B, and 19C show the total number of kam harvested according to the three groups.

Table 18. Summary on the distribution of amount of tea harvested in Ban Kui Tuai (1989)

No.	Miang Seasons				Total no. of leaves harvested	Total Price (B2.5/kam)
	A-M	J-J	A-S	O-N		
Total	29300	36000	23900	15470	104670	261675
Ave.	1627.7	2000	1327.8	859.4	5815	14537.5
Min.	600	800	500	300	2200	5500
Max.	4500	5000	4000	2500	16000	40000

Note: A-M (Apr-May), J-J (Jun-Jul), A-S (Aug-Sep), O-N (Oct-Nov)

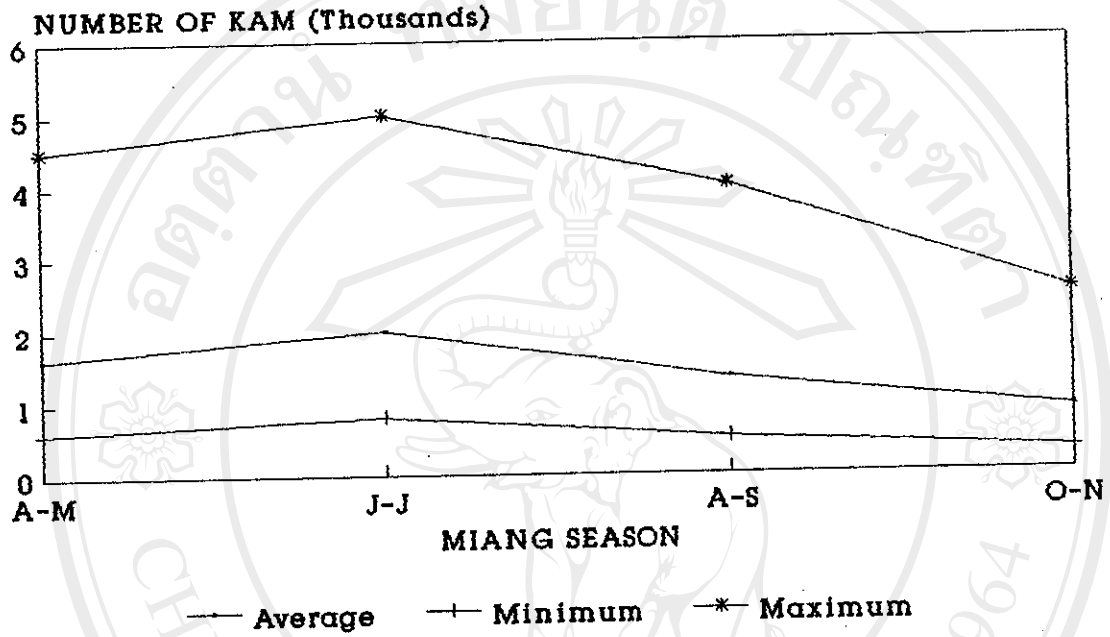

Fig. 14 Amount of tea leaves harvested in Ban Kui Tuai

Table 19A. Distribution of amount of tea leaves harvested for large tea garden owners (1989)

No.	HHNo.	Miang Season				Total no. of leaves harvested	Total Price (B2.5/kam)
		A-M	J-J	A-S	O-N		
1	2*	4500	5000	4000	2500	16000	40000
2	8	3000	4000	2500	1500	11000	27500
3	12	4000	4500	3500	2000	14000	35000
4	24	3500	4500	2500	2000	12500	31250
Total	-	15000	18000	12500	8000	53500	133750
Ave.	-	3750	4500	3125	2000	13375	33437.5
Min.	-	3000	4000	2500	1500	11000	27500
Max.	-	4500	5000	4000	2500	16000	40000

Note: A-M (Apr-May), J-J (Jun-Jul), A-S (Aug-Sep), O-N (Oct-Nov)
HHNo. - Household number

Table 19B. Distribution of amount of tea leaves harvested for small tea garden owners and non-tea garden owners (1989)

No.	HHNo.	Miang Season				Total no. of leaves harvested	Total Price (B2.5/kam)
		A-M	J-J	A-S	O-N		
1	1	1800	2400	1500	1000	6700	16750
2	6	1000	1200	800	500	3500	8750
3	7	1500	1800	1000	800	5100	12750
4	9	1000	1400	800	600	3800	9500
5	10*	1200	1600	1000	600	4400	11000
6	22	800	1000	500	300	2600	6500
7	23	1200	1500	1000	500	4200	10500
8	25	1200	1300	1000	670	4170	10425
Total	-	9700	12200	7600	4970	34470	86175
Ave.	-	1212.5	1525	950	621.3	4308.8	10771.88
Min.	-	800	1000	500	300	2600	6500
Max.	-	1800	2400	1500	1000	6700	16750

* Of the 12 miang garden owners, two households do not have miang stove.
HHNo. - Household number

Table 19C. Distribution of amount of tea leaves harvested for the landless who lease miang gardens (1989)

No.	HHNo.	Miang Seasons				Total no. of leaves harvested	Total Price (B2.5/kam)
		A-M	J-J	A-S	O-N		
1	3	1000	1200	800	500	3500	8750
2	11	800	1000	600	400	2800	7000
3	16	800	1000	600	500	2900	7250
4	17	700	900	700	400	2700	6750
5	18	600	800	500	300	2200	5500
6	20	700	900	600	400	2600	6500
Total	-	4600	5800	3800	2500	16700	41750
Ave.	-	766.7	966.7	633.3	416.7	2783.3	6958.33
Min.	-	600	800	500	300	2200	5500
Max.	-	1000	1200	800	500	3500	8750

Note: There are six out of 12 landless households who lease miang gardens from large landowners.
HHNo. - Household number
A-M (Apr-May), J-J (Jun-Jul), A-S (Aug-Sep), O-N (Oct-Nov)

2.4.1.4 The Processing of Miang

Towards evening, pickers begin bringing the day's kam to be counted. The processing of the leaves is carried out by the family starting from 5:00 p.m. to 11:00 p.m. This is done immediately after all the harvests have been done for the day as this is their only free time and the leaves can not be kept more than one day which affects the quality of the taste. The processing is done in a separate roof or house just beside the owner's house. The stove used for miang processing or the "hai"[1] consists of a fine pit about two meters or more in length by a half a meter wide and deep. At one end, a large iron broiler rests on two iron bars placed across the pit. The fire is lit under the broiler, and the firewood lengths pushed under as they burn. The kam are packed tightly into a wooden barrel also called hai (1 hai = 120 kam) with a base of bamboo mesh called laeo (1 laeo = 60 kam). It is placed over the iron broiler and the top is covered with a banana leaf or packing, to keep in the steam. Approximately after one hour, the barrel is removed and the kam are tipped out on the floor of the processing house.

The number of kam to be boiled per night depends on the number harvested for the day. During the low season, only one hai can be boiled per night but for the high season, a maximum of 10 hai is attainable which may even start at 3:00 p.m. The average

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1 This term is applied to the whole apparatus from the fire pit to the wooden steamer.

number of hai per night is three hai which contains about 360 kam.

For the average miang processor, the first boil needs the maximum number of pieces of firewood which is about 10 while the second boil takes about 30 minutes needing four pieces of firewood. Details on the amount of firewood used per household for miang processing is discussed in section 6.2.1. During the observation, it was found out that the large miang garden owners use more firewood (15-16/night) as they have a lot of kam harvested from their lands.

There are 14 households who own miang stoves. Two villagers producing miang who do not have miang stoves rent from stove owners. About one-third of the total number of tea leaves collected are paid as rent. In addition, those who rent such stoves bring their own sets of firewood.

2.4.1.5 **Packing**

After the wooden barrel is removed, the kam are untied, resorted, usually into slightly smaller bundles and tied again with a pure white tok (bamboo strip) about two cm. wide. Great care is taken to protect these tok so that they do not become discolored, as this reduces the attractiveness of the product. The kam are then carefully packed in large bamboo baskets or tang (1 tang = 200-240 kam) specially made for the purpose, and the top and bottom is closed with banana leaf. Each tang, prior to the

filling, will be painted with animal waste in order to protect the tang from decaying. Once packed, they are left to ferment for an indefinite period (4 mos. to 1 year), usually governed by the time it takes to accumulate a load for transport to market. Packing is done by the family. Sometimes, exchange labor is employed when the number of kam collected are too many especially during the second season.

Miang leaves is steamed and packed within the same night. Farmers will not have enough time to do packaging on the next day because they have to go collect the leaves before they are going to be ripe. The ripened leaves are not marketable.

Manufacturing accessory objects for the miang industry, narrow packing tok, wide-packing tok and the tang, is an activity which provides money-earning employment for numbers of people in both upland and lowland villages. The only requirement is a steady supply of bamboo. Young boys cut the bamboo into the appropriate lengths with their machettes, and bring it home to the elderly men and women, who sit all day to slice up a thousand tok which the miang growers will buy for 6 Baht. The tang, which an experienced person can make in one day, brings 12 Baht each. There is a regular market for these goods, as very few miang households are able to produce their own. The reason for this seems to be that much of the picking is still within the capabilities of the elderly folk in miang villages, so that their time is already occupied. Children in the villages spend part of their time gathering the wild banana leaf which is used for packing.

2.4.1.6 Transporting

The transport of tang of miang from Ban Kui Tuai to the market is by pick-ups owned by four miang garden owners. A pick-up can carry about 17 to 18 tang per trip. The transportation fee per tang is 40 Baht. The tang of fermented tea are sent to the markets for sale at least three to four times a month or every week. Sometimes, it also depends on the amount of tea leaves harvested especially during the last season which has the smallest amount of leaves.

2.4.1.7 Marketing

Another role of the miang merchants is they act as wholesalers. They control the market outlets because they have the transportation. They buy from the independent growers at 2.00 Baht per kam, as well as taking delivery of the miang produced by themselves and the small tea farmers and the landless tea farmers. The fermented tea are sold at three to four Baht per kam at different markets in the districts of Lampang, Lamphun and Jomtong.

The price system shows little if any variation. The market price, total volume and sales of miang for the last five years are shown in Table 20.

Table 20. Market price, total volume and sales of miang for the last five years (1985-1989)*

Total	Year				
	1985	1986	1987	1988	1989
Price of miang (Baht/kam)	2.50	2.50	3.00	3.00	3.00
Volume (kam)	100000	100000	100000	100000	105520
Sales (Baht)	250000	250000	300000	300000	316560

* Based on estimates of miang farmers in Ban Kui Tuai

2.4.2 Other Aspects of Miang Production

2.4.2.1 Cultivation

In recent years, a few villagers are beginning to augment their "wild" trees with plantings or transplanted from the forest. From the interview with the farmers, six households plant tea using seeds for the past few years. This means that they are extending their miang gardens but in small scale like planting at the back of their houses and in some other parts of miang gardens. Tea plants are planted during the rainy season. There are about 95-100 tea trees per rai with irregular spacing (Preechapanya, *et al.* 1985). For large owners, tea plants are just maintained by weeding which is done by hired laborers. No inputs are needed. In the case of small tea producers and the landless, they use the livestock to graze around the garden instead of weeding. No labor is used in this case.

2.4.2.2 Consumption of Miang

A survey was done about the consumption of miang for every household in the village. Table 21 shows the results. Of the 99 villagers, 34 or 34.34% like miang while 59 or 59.59% do not like miang. For those who like miang, four reasons were stated: "tastes good", "like gum", "maintains the teeth", and "substitute for tobacco". Only adults are the ones who consume miang. Only one reason was given by 55 villagers who do not like miang which is

Table 21. Results of the survey from all 99 villagers on their perception towards miang in Ban Kui Tuai

Reason	Frequency	%
Like miang		
good taste	18	18.18
like gum	9	9.09
maintains teeth	3	3.03
tobacco substitute	4	4.04
	34	34.34
Dislike miang		
bad taste	59	59.60
Not applicable	6	6.06
Total	99	100.00

Table 22. Survey results from 26 households on the present trend of miang consumption in Ban Kui Tuai

	Trend			Total	Reason					Total
	decreasing	stable	increasing		A1	A2	A3	A4	A5	
No.	11	10	5	26	11	8	3	2	2	26
%	42.31	38.46	19.23	100	42.31	30.77	11.54	7.69	7.69	100

Note: Five reason were given: A1 - most adults consume miang; A2 - taste good; A3 - consumer is stable; A4 - can be sold every year; and A5 - consumers less than the past.

"bad taste".

The present trend of demand for miang is shown in Table 22. This shows that 11 or 42.31% stated decreasing, 10 or 38.46% for stable, and five or 19.23% supply for increasing. Five reasons were stated on why the villagers said such trend. Of the 26 households, 11 or 42.31% stated that most adults consume miang and 2 or 7.69% stated that there are less consumers in the past for "decreasing". For those who stated "stable", reasons which were given were "consumer is stable" (3 or 11.54%) and "miang can be sold every year" (2 or 7.69%). One reason was stated for "increasing" which is "miang tastes good" (8 or 30.77%).

The villagers were also asked about their observations on the supply of miang leaves. Results are shown in Table 23. There are 16 or 61.54% households who stated that the present trend of supply of tea leaves is "stable" while 10 or 38.46% stated "increasing". None of the villagers stated "decreasing". These figures indicate that the supply of leaves is stable. The villagers have been working on their tea gardens since they arrived at the village. The planting of tea plants just started a few years ago which are not still ready for picking tea leaves. Other respondents have answered that there is an increasing supply of tea leaves because of the presence of old trees which produces new seedlings from its seeds.

The issue on the prospect of miang market was also included in the survey. Table 24 shows 13 or 50% households stated "decreasing", 12 or 46.15% for "stable" and 1 or 3.84% for "increasing". This indicates that the market for miang is

Table 23. Survey results from 26 households on the present trend of supply of tea leaves in Ban Kui Tuai

	Trend			Total
	stable	increasing	decreasing	
No.	16	10	0	26
%	61.54	38.46	0.00	100

Table 24. Survey results from 26 households on the prospect of total market demand of miang in Ban Kui Tuai

	Trend			Total
	decreasing	stable	increasing	
No.	13	12	1	26
%	50.00	46.15	3.85	100

decreasing to stable.

2.5 Major Components and their Interrelationships Existing in the Forest-Tea Production System

2.5.1 Income

Table 25A, 25B, & 25C show the annual family income (AFI) of the large tea farmers, small tea farmers and the landless tea farmers from each resource in Ban Kui Tuai.

In Table 25A, the four large tea farmers have a total annual family income of 185,050 Baht or 41.79% of the total annual family income of the village which is 442,745 Baht. The average AFI is 46,262.50 Baht. About 148,250 Baht or 80.11% of the total income of the large farmers comes from selling, transporting and leasing land for miang. The rest of the 19.89% comes from selling cattle (6.48%), pigs (2.97%), fruits (3.02%), Chinese tea (0.21%) and vegetables (0.16%). There are two households who earn income from mini-stores with a total income of 13,000 Baht or 7.02% of the total income of the group.

For the small tea farmers including those without tea gardens, their AFI comes mostly from selling miang which is 74.45% of the group's total income. Other income are derived from wage labor and selling cattle, pigs, fruits, vegetables and Chinese tea which makes up only 15.28%. The average income is 11,574.5 Baht (Table 25B).

The largest group, the landless, has a total AFI of

Table 25A. Annual family income of large tea farmers from each resource in Ban Kui Tuai

HHNo.	Miang selling	Miang transporting	Miang leasing land	Total	Cattle*	Pig	Fruit Trees	Chinese tea	Chilli	Mini-store	Annual Family Income
2	40000	2000	5000	47000	12000	3500	4000	200		8000	74700
8	27500	3000		30500		2000	1600	200			34300
12	35000	2000		37000					300		37300
24	31250	2500		33750						5000	38750
Total	133750	9500	5000	148250	12000	5500	5600	400	300	13000	185050
%	90.22	6.41	3.37	80.11	6.48	2.97	3.03	0.22	0.16	7.03	100
Average	33437.5	2375	5000	37062.5	12000	2750	2800	200	300	6500	46262.5

* For sale or for rent
HHNo. - Household number

Table 25B. Annual family income of small tea farmers from each resource in Ban Kui Tuai

HHNo.	Miang selling	Cattle*	Pig	Fruit Trees	Chinese tea	Taro	Family Income Monthly (wage 1.)	Family Income Annual
1	16750	9000						25750
6	8750							8750
7	12750		500					13250
9	9500							9500
10	11000							11000
22	6500	4000			200			10700
23	10500							10500
25	10425							10425
4*						170	660	6770
5*			500	2000			660	9100
Total	86175	13000	1000	2000	200	170	1320	115745
%	74.45	11.23	0.86	1.73	0.17	0.15	1.14	100
Average	10771.8	6500	500	2000	200	170	660	11574.5

* These households do not own any tea garden but small areas of paddy fields and orchards.
* For sale or for rent
HHNo. - Household number

Table 25C. Annual family income of landless tea farmers from each resource in Ban Kui Tuai

HHNo.	Miang selling	Cattle*	Pig	Cutting firewood	Chinese tea	Family Income Monthly	Family Income Annual
3	8750		500			660	15850
11	7000					1320	20200
13				3000		580	8800
14				3000		330	6300
15				3000		300	6000
16	7250		1000			500	13250
17	6750	4000				630	17050
18	5500	4000				420	13700
19		6000				300	9000
20	6500				200	400	10700
21		4000				330	7300
26			500	3000	200	375	7450
Total	41750	18000	2000	12000	400	6145	135600
%	27.23	11.74	1.30	7.83	0.26	-	100
Average	6958.3	4500	666.7	2400	200	512.1	11300

* For sale or for rent
HHNo. - Household number

5D. Summary of annual family income from each resource in Ban Kui Tuai

nd	Miang			Total	Cattle	Pig	Fruit Trees	Cut-ting fire-wood	Chinese tea	Chilli	Taro	Mini-store	Wage labor	Annual Family Income
	selling	trans-porting	leasing land											
	261675	9500	5000	276175	43000	8500	7600	12000	1000	300	170	13000	74650	436395
	94.75	3.44	1.81	63.29	9.85	1.95	1.74	2.75	0.23	0.07	0.04	2.98	17.11	100
average	13772.3	2375	5000	-	6142.9	1214.2	2533.333	3000	200	300	170	6500	5332.142	43639.5

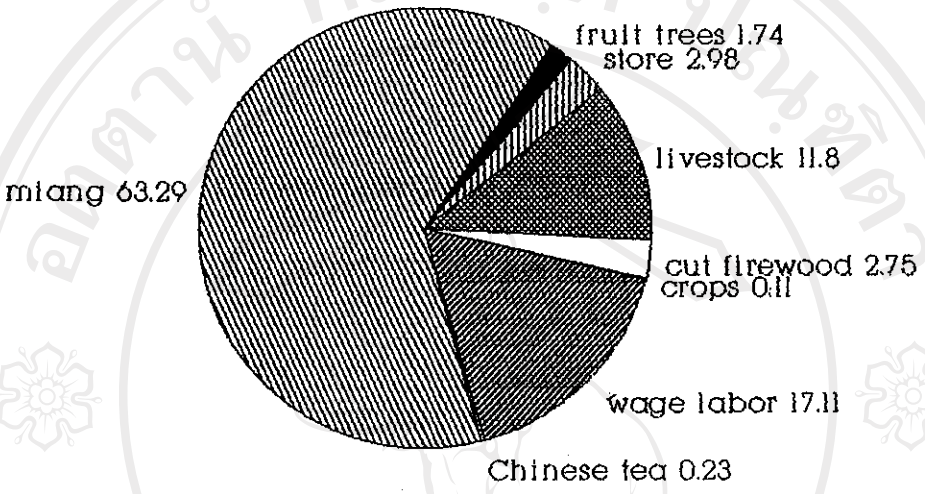

Fig. 15 Percentage of annual family income in Ban Kui Tuai

135,600 Baht or 31.07% from 12 households. About six households earn a total of 41,750 Baht from selling miang. The group has also the highest sales of cattle with 18,000 Baht or 11.74% in the village. Other sources of income include selling pigs (1.3%) and Chinese tea (0.26%) and cutting firewood (7.83%). Each household in this group are wage laborers doing weeding, picking tea leaves, planting rice and cutting firewood.

Table 25D shows the total AFI for each resource and the grand AFI of the village. The grand total AFI is 436,395 Baht where miang contributes the highest which is almost 60% of the total income followed by cattle (9.85%), mini-store (2.98%), pig (1.95%), fruit trees (1.74%), wage labor (17.11%), Chinese tea (0.23%), cutting firewood (0.13%) and vegetables (0.10%).

The statistics indicate that the villagers of Ban Kui Tuai depend mainly on miang production. The income earned comes from the selling and transporting of miang, leasing tea gardens and wage labor. The large and small tea farmers and the landless derive most of their income from miang production. These large and small farmers who get their income from producing miang provide income to the landless by working as hired laborers.

Another source of income is selling or leasing cattle. Since most cattle are owned by the landless farmers, they more or less get enough income from it.

There are times when some villagers particularly the poor families run out of money and here, the role of money lenders who are the large tea farmers themselves, comes in. Usually the

young married couples lend money. When the borrowers are heavily in debt, they are invited to work for them in exchange for their debt such as in picking many leaves.

All that the large tea garden owners produce goes directly to them while the laborers get advances of rice and almost nothing else. The poor people can even receive a little less than the basic producer's price of miang. The reason for buying the debtor's miang at below the normal price is said to be that the large owners must pay all cash outlays himself as his tenants will not usually have cash. He must therefore allow for the expense of getting the miang to market. However, the combination of low prices, high interest and high prices for advances of rice and other essentials, make it extremely difficult to get out of debt.

2.5.2 **Land Tenure and Labor**

In Ban Kui Tuai, the gap between the rich and the poor can be clearly seen when investigating the problem of land tenure and labor. Of the 26 households, there are only 12 households or nearly 50% (Table 11B) who do not own any land and have to rely for their living on miang picking. Their existence depends on their labor. The relationship is thus maintained and never appears to change (Pitackwong 1988). Even a small miang garden owner finds it difficult to expand his holding because no one is willing to sell miang gardens to him.

Only a few rich ones own both miang gardens and terrace fields; newcomers do not own any piece of land but rely for their living on wages. The land owning class in Kui Tuai, therefore, is already well-off and also facing the problem of scarcity of family labor. Hence, they do not feel the urge for additional investment in field crops. The size of the miang gardens can probably explain the fact well. Landowners own between 2 to 61 rai. The large owners can live quite comfortably without the need to adapt their system.

Labor for picking comes from the family of husband, wife, and older children, augmented by laborers who live in the village. As pointed out several times, there are several families in this miang village who have no access to a garden and are entirely dependent on day labor.

Most of the households both rich and medium hire laborers as tea leaf pickers. A tea leaf picker is paid one Baht per kam. A tea leaf picker can get an average of 50 kam/day which is equal to 50 Baht/day.

For a firewood gatherer, he receives 70 setang for cutting the tree but if he also delivers them, he can earn one Baht per ton. Normally, the laborers earn between 60 and 200 Baht depending on the number of firewood collected.

Aside from these labor-needing operations, weeding and clearing bushes are also done to facilitate movement and to ensure that they do not compete with tea. Again, the poor villagers can

earn income from landowners although they are not paid in cash but in kind - free lunch and supper. In some cases, there are a few households with many family members who can do weeding in their miang gardens by themselves (family labor) which is done once a month before every picking of tea leaves.

The large miang garden owners are also facing labor shortage particularly in the harvesting of miang leaves since they own big areas of miang gardens. Even hired labor is not enough for them because most wage laborers also work for other miang garden owners. Sometimes, they hire tea leaf pickers from a nearby village such as Pang Khum with a huge population of 634 people (100 households).

2.5.3 Role of Livestock in the Traditional Forest-Tea Agroforestry System

Cattle plays an important role in the traditional forest-tea agroforestry system. When not in use, they are grazed among the tea trees and the forest on the native grasses which thrive in the sunlight let in by removal of the forest. The animals help to keep the land clear as well as supporting themselves, and they are permitted to roam freely on any person's land. Their presence even helps the villagers do less weeding which must be frequently done during the miang season.

In other words, cattle helps control soil erosion. Besides due to frequent trampling by farmers who in a single year collect tea leaves up to 200 times (Preechapanya 1985), they also

help in compacting the soil since cattle are grazed in tea gardens full of grasses.

Concerning land conservation, there was little soil erosion in tea gardens because the water could not take away the top soil in its flow as the soil was hard. At the same time, weeding prevents a fire hazard and competition of bush growth with young trees and tea trees. According to Preechapanya, *et al.* (1985), if shade is available for the cows, it will help reduce tension and helps in the growth process.

In favor of livestock grazing in forests is the fact that it reduces the costs of clearing the bush, and the savings can offset some of the costs of planting and managing the trees.

The use of livestock, particularly cattle, under the forest-tea agroforestry system to control grass and bush regrowth has been practiced by the livestock owners. Limited maintenance is needed for the system because of their presence. The grasses present in the area are being eaten by the cows while cows provide manure for the plantation. Lazier, *et al.* (1981) found out that animals rapidly recycle nutrients throught the production of faeces, and there may be an increase in soil fertility.

Cattle is also grazed in paddy fields and orchards. Table 26 shows the number of cattle in the village. A total of 180 cows owned by 12 or 46.15% out of 26 households, are present in the village. There are 11 households who use cattle for home

Table 26. Livestock Ownership

	Cattle						Water buffalo					
	Total	Owners	Non-owners	No. of HHs	Home consumption	For sale	Total	Owners	Non-owners	No. of HHs	Home consumption	For sale
No.	180	12	14	26	11	3	13	2	24	26	2	0
%	100	46.15	53.85	100	-		100	7.69	92.31	100	-	-

consumption and three for sale. The owners include one large tea farmer, seven small tea farmers and four landless tea farmers.

For water buffaloes, only two (1 large tea farmer & 1 landless) out of 24 own them which are all for home consumption. These animals are used for plowing the field and sometimes, for grazing purposes.

2.6 The Villagers' Tree Cutting Practice

2.6.1 Firewood Acquisition

As in many tropical and subtropical countries, rapid deforestation has occurred over the past twenty years. This deforestation is caused by many factors, but perhaps, one of the most important causes besides pressure from population growth, the need of increased agricultural land and expansion of commercial logging, is rural fuelwood consumption. While the consequences of deforestation will be felt directly or indirectly by many different segments of the population, those rural villagers who have long depended on trees and forested areas to meet many of their basic necessities are likely to be the ones most directly and most seriously affected by reduced availability of and access to forest resources.

Rural villagers in the highlands of northern Thailand began to experience a shortage of fuelwood as a consequence of increased deforestation several decades ago. Certainly not all

areas have been equally affected as some villages like Ban Kui Tuai still contain forested areas of substantial size.

2.6.1.1 **Who Acquires the Firewood?**

Although the collection of firewood includes people from all socio-economic classes in the village, most firewood gatherers appear to be members of the poor households consisting of thlandless people and who work as wage laborers. They are the ones hired by large tea garden owners and merchants who top the list of large users of firewood (Table 16A). This means that the few wealthier rural households appear to be presently indirectly involved in collecting firewood as they are the ones ordering the hired laborers on the amount of firewood needed to be cut for a particular time of miang processing.

The wage of the firewood gatherer depends on the number of pieces of firewood he collects for miang processing per day. The cost of hired labor for collecting one piece of firewood is between 70 setang and one Baht depending on the kind of deal he gets. For example, if a villager is told to cut trees, chop into pieces of firewood and leave them in the tea, garden, 70 setang is paid for ton. If the laborer is told to cut and bring the collected firewood to his house, an additional 30 setang is added which totals to one Baht. In case the source of firewood is far from the village and a pick-up is needed, the change is about 30 to 40 Baht per 100 ton for one trip. A firewood collector can

average about 50 ton per day.

The RRA findings strongly suggest that although there are at present few "full-time" firewood gatherers (number about two households), many households are heavily engaged in collecting firewood at certain times of the year to supplement the firewood requirements needed especially for miang processing and cooking. Although various household members may be involved in acquiring fuelwood, different members often do so at different times and indifferent ways. Children of school age may go off in small groups to a nearby forest to gather wild foods and may also bring back bundles of small pieces of firewood for cooking. With the feeling that wood sources are getting scarce, it appears that all family members, including small children and old people, have a sense of responsibility to gather wood anytime the opportunity arises. Some families who have trees in their own fields but are short of labor may invite neighbors to fell some of them, the wood being divided. Frequently, husbands and wives working in the fields bring home bundles of fuelwood gathered from their tea gardens. Big trunks and big branches, however, are carried by men.

2.6.1.2 **Sources of Firewood**

At present, the villagers obtain wood primarily from "privately" owned or claimed lands and from the public forest lands. These sources include tea gardens, the forest and along the roads. For those tea garden owners, they usually cut trees for

firewood at the peak of tea gardens. Other owners even allow other firewood gatherers to cut from their tea gardens in the condition that they will be given a share for it.

From the researcher's interview with the villager's agricultural extension officer, the reason why the villagers cut within or at the peak of tea gardens is to prevent them from cutting trees from the surrounding forest. This idea was brought up by the villagers with the suggestions from the Royal ForestDepartment through the UN/Thai Sam Mun Highland Development Project. It would also help them in creating boundaries for tea gardens. However, since most of the trees especially the matured and preferred species have already been cut in their miang gardens, the villagers tend to cut at the surrounding forest and along the roads without permission from the RFD. The villagers even collect firewood for miang from the forest as far as three to five kms. away from the village. This is the time the pick-up vehicles of the merchants are hired by the villagers for transporting many pieces of ton from the collecting area to the village. The use of pick-up indicates a longer distance for collecting firewood and the need to collect larger quantities which will last for a longer period at anytime. If the wood source is within or near the village, the villagers carry fuelwood back to the village on their shoulders.

The reserved forest have long been an important source of firewood used for miang processing, cooking, house and fence construction. Landless households and those who possess very small

landholdings such as tea gardens are particularly reliant upon these areas for wood.

Until now, there are still some landless villagers who have long depended on wood from the large miang owners. Since they are aware of cutting trees within the tea garden but they have no gardens to cut from, they ask permission from the miang landowners to cut some trees for firewood used for miang processing.

2.6.1.3 **Species of Trees Preferred**

Interviews with the villagers indicate that there are about nine species of trees used for all wood uses in Ban Kui Tuai especially for miang processing and cooking. Among the tree species, Mai Kor specifically, Kor Mue Doi (*Lithocarpus calathiformis*) is the most preferred by 19 out of 26 households because according to them, besides of the abundance of this species in the area, it is easy to burn and has a long duration of emitting fire which helps lessens the use of more firewood in the miang processing. Another preferred species is Mai Talo (*Schima wallichii*) which is used by 11 households. Table 27 shows the list of tree species used by the villagers as well as species of bamboos used as raw materials for making *tang* and bundle strips used in packing miang.

The villagers rely upon the types of wood that are available and their priority in obtaining wood is usually size other than type. Obviously, the firewood gatherers prefer big

Table 27. Tree species used for firewood and bamboo species used as raw materials

	Local Name	Scientific Name	No. of HHs using each species
	Trees		
1.	Kor Mue Doi	*Lithocarpus calathiformis*	19
2.	Mai Talo	*Schima wallichii*	11
3.	Kor Daeng	*Lithocarpus trachycarpus*	7
4.	Mai Miat	*Litsea garretti*	2
5.	Mai San	*Dillenia obovata*	2
6.	Mai Khaw	*Tristania rufescens*	2
7.	Kor Duay	*Castanopsis acuminatissima*	1
8.	Mai Sor	*Gmelina arborea*	1
9.	Champee	*Paramichellia baillonii*	1
	Bamboo		
1.	Phai Par	*Bambusa arundinaeca*	
2.	Phai Fong	*Bambusa tulda*	
3.	Phai Rai	*Gyantoehloa albeiliata*	
4.	Phai Sang	*Dendroealamus strietus*	

Note: A household can use one or more tree species.

sizes which can produce more volume of firewood. The current priority on large size wood is encouraged, in part, by the villagers' interest in producing a lot of firewood in a short period of time. This is what the few large miang landowners in the village adopt since they have the largest production of miang compared with the small landowners and the landless who prefer any type of species. However, firewood gatherers recognize that different species of wood make different qualities of firewood.

Hardwood of good size is almost always chosen over smaller branches. On the otherhand, softwood is considered inferior - it burns too fast and produces too much smoke and seldom used.

Based on interviews from the agricultural extension officer and on the questionnaire survey, the large tea farmers prefer those matured and big-sized trees for firewood used for miang processing while small tea farmers and some landless farmers prefer any size or type of tree.

2.6.1.4 **Time of collecting firewood?**

The villagers primarily gather wood for firewood in large quantities during the months from December to March immediately preceding the start of the miang season and some agricultural activities such as the planting of upland and wet rice and chilli. They seek to obtain enough wood because it is no longer appropriate to collect during the rainy season. Quantities

and frequencies of firewood gathering vary a little bit from household to household. The volume of firewood used for each use is discussed more in the next section. Nevertheless, the villagers have relatively large amounts of firewood grouped for miang processing and cooking which are kept under the houses or shades for these firewood for many months until the last season of miang which is October and November. For a few cases, firewood for cooking is collected whenever the opportunity arises which can be anytime of the year.

The firewood collection usually starts at around 8:00 a.m. and ends between 4:00 p.m. and 5:00 p.m.

2.6.2 **Firewood Usage**

Firewood collection is a major activity of the miang production which is time-consuming and expensive in terms of labor requirements because it involves gathering large quantities of big-sized firewood for miang and small-sized firewood for cooking. Other usages of firewood are for house construction and fencing which need only small amounts of firewood because these activities seldom occur.

2.6.2.1 **Usage of Firewood for Boiling Miang**

Miang production consumes the most number of volume of firewood in the village. The normal size of one piece of firewood

or *ton* measures about 1.5 to 2 meters long with an average volume of 0.0172 m^3 [1]. The average number of pieces of firewood used per day is about 9.11 (0.246 m^3) or 911.11 pieces (24.6 m^3) per year which is equivalent to 16.27 trees cut per household. The minimum number of pieces per day and year and the number of trees cut per year are 6 (0.162 m^3), 600 (16.2 m^3) and 10.714, respectively while its maximum number are 15 (0.405 m^3), 1,500 (40.5 m^3) and 26.786, respectively. For the village's firewood consumption for miang processing, the total number of pieces per day and per year are 164 (4.428 m^3) and 16,400 (442.8 m^3), respectively. The total number of trees cut per year is approximately 292.587. Table 28[1] shows the amount and volume of firewood used per household.

The results indicate that the households with the most volume of firewood consumed are the large tea garden owners with 15 to 16 pieces used per day. Those households whose firewood consumption ranges from eight to 10 pieces are the small tea farmers and the landless tea farmers.

2.6.2.2 Usage of Fuelwood for Cooking

The most common and frequent usage of fuelwood is in cooking which normally occurs twice a day. One piece of firewood measures about one foot long with a volume of 0.0007 m3. The average number of pieces used per household is about 15 per day or

[1] Sizes of firewood for miang processing and cooking were measured from samples of 10 households to determine the standard size and volume data is shown in Appendix D .

Table 28. Number of trees cut, number of pieces & volume of firewood used per year for miang processing by 18 households

HHNo.	NP per		NTC per		m^3/ year	NTC/ year
	day	year	yr	day		
1	8	800	14.286	0.22	21.60	14.286
2*	15	1500	26.786	0.41	40.50	26.786
3	8	800	14.286	0.22	21.60	14.286
4	8	800	14.286	0.22	21.60	14.286
5	8	800	14.286	0.22	21.60	14.286
6	13	1300	23.214	0.35	35.10	23.214
7	10	1000	17.857	0.27	27.00	17.857
8*	8	800	14.286	0.22	21.60	14.286
9	6	600	10.714	0.16	16.20	10.714
10	13	1300	23.214	0.35	35.10	23.214
11	8	800	14.286	0.22	21.60	14.286
12	8	800	14.286	0.22	21.60	14.286
13*	6	600	10.714	0.16	16.20	10.714
14	7	700	12.500	0.19	18.90	12.500
15	8	800	14.286	0.22	21.60	14.286
16	8	800	14.286	0.22	21.60	14.286
17	14	1400	25.000	0.38	37.80	25.000
18	8	800	14.286	0.22	21.60	14.286
Total	164	16400	292.857	4.428	442.800	292.857
Mean	9.11	911.11	16.270	0.246	24.600	16.270
Min	6	600	10.714	0.162	16.200	10.714
Max	15	1500	26.786	0.405	40.500	26.786

* Households who do not have miang stoves but rent from others.

HHNo. - Household number
NP/day - Number of pieces per day
NTC/yr - Number of trees cut per year
The researcher's calculations are shown in Appendix E.

0.010 m^3 per day and 4,922.88 pieces or 3.446 m^3 per year. The minimum number of pieces used per household is 10 while the maximum is 20. Of the 26 households, there are five who uses a maximum of 20 pieces of firewood per day. They include the four large tea garden owners and a household with a big family. For the total consumption of firewood for cooking, 371 pieces or 0.260 m^3 per day or 127,995 pieces or 89.596 m^3 per year are utilized. These results are shown in Table 29[1]. Most of the firewood used for cooking are cut from small or big-sized left-over branches and other parts of trees not used for miang processing.

2.6.2.3 **Other Uses of Firewood**

As the interviews became more thorough, the researcher found out that although miang processing is the most demanding fuelwood using activity followed by the most common and regular activity, cooking, there are many other uses, some of which consume as much if not more firewood. Principal among the other uses that consume firewood are house construction and fencing and cremation. Although these activities are not as common or as firewood demanding (per household per year) as many of the uses mentioned above, they nevertheless create high demands for fuelwood when they occur.

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1 See Appendix E for calculations.

Table 29. Amount of firewood used for cooking per year by 26 households (1989)

HHNo.	NP per		m^3 per	
	day	year	day	year
1	14	4830	0.010	3.381
2	20	6900	0.014	4.830
3	12	4140	0.008	2.898
4	12	4140	0.008	2.898
5	14	4830	0.010	3.381
6	14	4830	0.010	3.381
7	12	4140	0.008	2.898
8	20	6900	0.014	4.830
9	14	4830	0.010	3.381
10	12	4140	0.008	2.898
11	12	4140	0.008	2.898
12	20	6900	0.014	4.830
13	12	4140	0.008	2.898
14	12	4140	0.008	2.898
15	12	4140	0.008	2.898
16	12	4140	0.008	2.898
17	14	4830	0.010	3.381
18	20	6900	0.014	4.830
19	12	4140	0.008	2.898
20	12	4140	0.008	2.898
21	14	4830	0.010	3.381
22	18	6210	0.013	4.347
23	12	4140	0.008	2.898
24	20	6900	0.014	4.830
25	15	5175	0.011	3.623
26	10	3450	0.007	2.415
Total	371	127995	0.260	89.597
Mean	14.27	4922.88	0.010	3.446
Min	10	3450	0.007	2.415
Max	20	6900	0.014	4.830

For house construction, there are about 20 to 30 pieces of wood used which measures about 2 meters long and is a little bit bigger than the ton for miang processing. Wood for fences do not need high quality wood.

Cremation of the dead according to Buddhism is another traditional practice with high fuelwood demand. The practice is carried out in a forested area designated by villagers as the village funeral ground. Wood is cut from trees in the funeral ground itself. It is believed that fuelwood stored at the house must not be used for this purpose. Few trees remain in the funeral ground and the host has to provide most of the fuelwood from his fields. In places where the host has difficulty finding enough fuelwood, guests help provide wood.

2.6.3 **Decision-Making in Firewood Collection**

The decision-making in collecting firewood is different for the large, small and the landless tea farmers. Based from the RRA interviews, large tea farmers can either choose to cut trees from his tea garden or others using hired labor or to hire villagers to cut for them in the forest. This decision is usually determined by the presence of matured or high quality trees. If there are still matured trees in his or other´s tea garden, these are cut for miang production and cooking. Who collects firewood

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1 See Appendix F for calculations.

production and cooking. Who collects firewood depends, in turn, upon whether the large tea farmer has available labor. If so, the farmer proceeds with the collection. The large tea farmers usually "share crop" with poorer households in the village or else hire poor and landless households to collect firewood for them. It was also found out that the poor families have more access to wood sources than better-off families because the former can always afford their own labor. Poor families often approach the wealthy for offering to fell trees and to cut wood for them to get a share of firewood for their miang processing.

For small tea farmers or poor rural households, decision-making in firewood collection is different. Because these households have small amount of cash, they usually depend upon miang (either from their tea garden or those belonging to others) and firewood is collected in the reserved forest if there are no more matured trees available in the tea garden. In such cases, these households try to collect firewood by choosing even small-sized firewood in order to be not being caught up by the rainy season. If wood is not available from their own land (or if they are landless), they try to obtain wood from the lands of others in the village by asking permission to collect wood or by proposing a "share cropping" arrangement. If wood is not available locally, they collect firewood in the reserved forest. In addition, these households usually have little or no choice in terms of size and species of firewood and people use whatever shapes, sizes and species they can find.

2.6.4 Attitude of the Villagers Towards Tree Cutting

The villagers have heard about fuelwood shortages in other villages and realize that this village may eventually face similar problems although they have not felt the need yet to plan for the future. During the formal questionnaire survey, the respondents were asked if they are aware of any forest law against cutting trees. Of the 26 households, 22 answered "yes" and 4 answered "no". Four reasons were given by all respondents on why they cut trees. Table 30 shows the result of the respondent's answers including their response on the impacts of tree cutting.

There were 12 respondents who cut trees because "It's necessary". This implies that whether there is a law or not against tree cutting , they still have to cut trees since the villagers fully depend on miang production which consumes a lot of firewood. The second response was "They live in my garden" stated by 10 households. The third was "They're my trees". Both responses means that it is their right to cut trees because the trees they cut are within their tea garden that is why they claim that they own the trees. The last response has its same implication as the second and third response in which they can cut trees because they bought the land before. Three households responded the fourth statement. There were also two respondents who stated "no impact" because they think that there are lots of trees in the forest.

From the response of the villagers concerning the impacts of tree cutting, four comments were stated. There were

Table 30. Villagers' awareness on the impacts of tree cutting

Aware of forest law?		If yes, why still cut trees?			Impacts of cutting trees		
yes	no	Comments	Frequency	%	Comments	Frequency	%
22	4	It's necessary.	12	46.15	firewood shortage	17	65.38
		They live in my garden.	10	38.46	no water, no rain	8	30.77
		They're my trees.	3	11.54	soil erosion	7	26.92
		I bought them before.	3	11.54	no impact	2	7.69
					don't know	2	7.69

Table 31. Response of the villagers on the idea of of solving the problem of tree cutting

Comments	Frequency	%
Plant new trees.	15	57.69
Select trees to cut or cut less.	6	23.08
Don't cut trees.	2	7.69
Don't know.	1	3.85

17 households who said that tree cutting will cause firewood shortage; eight stated "no water" or "no rain"; seven stated the "overflow of soil" or "bad roads" and two do not know its impacts. All of these statements indicate that the villagers are somewhat aware of the consequences of tree cutting.

The respondents who cited the impacts of tree cutting were asked a follow-up question on the idea of how to solve this problem. Table 31 shows their responses to this question.

The idea of planting new trees was stated by 15 households followed by "select trees to cut or cut less" which was stated by six households. Two responded not to cut trees and one family answered "don´t know". The table indicates that most of the villagers are somehow interested in substituting the trees cut with new ones. From an interview with the assistant village headman, the villagers were longing to plant trees although they do not have the seeds or tree seedlings to plant.

2.6.5 Roles of Development Projects in Ban Kui Tuai

As mentioned earlier, in spite of the continuous and increase use of firewood, the villagers in Ban Kui Tuai are cognizant on the effects of cutting trees. They are even knowledgeable about the importance of fast-growing species as alternative sources of firewood and this is clearly indicated in section 2.7.1 wherein the villagers have a positive attitude

towards this idea.

Note that Ban Kui Tuai has been under active operations of several development schemes, especially the community forestry extension and the Royal Forest Department's intervention. This made the villagers concerned and well-articulated on various issues on the mismanagement of forest and their positive attitude towards tree growing. In fact, the planting of fast-growing species used to be introduced in Ban Kui Tuai in the past but for a short period of time. The presence of the agroforestry extension officer who stay and work with the villagers is another factor the people's awareness on tree planting.

In addition, the Research Management and Development Project which collaborates with the UN-Thai Sam Mun Highland Development Project, is implementing a social forestry pilot project in this village to find ways in solving poverty and resource use and at the same time, involves the participation of the villagers themselves.

The presence of these development projects in Ban Kui Tuai confirms that their intervention plays a big role in stimulating the process of revitalization of the forest and the firewood supply management in the future.

2.7 The Role of Fast-Growing Species as Alternate Sources of Firewood

2.7.1 The Villagers' Perception Towards Fast-Growing Species

Table 32 shows the results of the formal survey on the attitude of the villagers towards fast-growing species. Of the 26 households, 22 know about fast-growing species particularly *Eucalyptus camaldulensis* and *Melia azedarach*. Two benefits were stated: 23 for "firewood" and 4 for "easy to grow". For those who are willing to plant fast-growing species, 15 households agree while 11 do not because some villagers stated that there are many trees for firewood now and no land for growing trees. Available lands which are located in and outside the village totalled to 29 rai are owned by 15 households.

2.7.2 Introduction of *Eucalyptus camaldulensis* and Melia azedarach as Sources of Firewood in Ban Kui Tuai

Based from the survey on the villagers' attitude towards firewood use, a clear indicator is that the people are aware of the reduced availability of firewood that they will be facing in the future if no alternative measures are worked out. A number of villagers even realize the consequences that they will meet. As a result, they are amenable with the idea of applying such alternative measures to cope up with the demands of firewood particularly for miang processing and cooking, and one of the plans which most of the villagers longed for was to plant new

Table 32. Villagers' attitude towards fast-growing species in Ban Kui Tuai

	Heard of fast-growing species?		Total no. of HHs	Tree species you know		Benefits for firewood	Benefits easy to grow	Willing to plant fgs?		Total no. of HHs	Any land available?		Total no. of HHs	Available total area (rai)
	yes	no		Eucal	Melia			yes	no		yes	no		
No.	22	4	26	22	14	23	4	15	11	26	15	11	26	29
%	84.62	15.38	100	84.62	53.85	88.46	15.38	57.69	42.31	100	57.69	42.31	100	-

Note: fgs - fast-growing species

trees. Survey results also revealed their willingness to plant fairly fast- growing species such as *Eucalyptus camaldulensis* and *Melia azedarach* with the condition that they will be supplied with its seedlings. These species were also chosen based on its popularity and characteristics mentioned on the next two sections.

2.7.2.1 **Characteristics:**

2.7.2.1.1 ***Eucalyptus camaldulensis***

Among the promising fast-growing species recommended by Thai forestry experts, *Eucalyptus camaldulensis* has become the dominant reforestation species. Based from conclusions of scientific research, both Thai and international, *Eucalyptus*, like *Acacia* and a number of other tree crops, reduces the water table and affects neighboring crops, where moisture and nutrients are in short supply (Bangkok Post 1990). *Eucalyptus* is not recommended for protection of watersheds, for regulation of water flows, or as a crop for good soil. It is suitable for degraded areas; it should be planted in small plots, blocked by other species. In addition, it serves as wind breaks and does not damage crops. It helps in soil erosion (Preechapanya, *et al.* 1985).

2.7.2.1.2 ***Melia azedarach***

Melia azedarach is also considered one of the recommended fast-growing species for firewood. The species can be

maintained easily which saves time. It grows quickly under weather conditions similar to natural forest conditions. According to Khamyong (1990), Melia thrives well in the Hill evergreen Forest.

2.7.2.2 *Eucalyptus camaldulensis* and *Melia azedarach* as Two of the Fast-Growing Species promoted in the 6th National Economic & Social Development Plan

For the Sixth National Economic and Social Development Plan (1986-1991), three main programs related to tree planting have been adopted, including planting fast-growing species, economic trees and the establishment of community forests. Two of the fast-growing species, Eucalyptus and Melia, are on the top list of fast-growing species promoted in the present plan. These two species were categorized in one of the four main groups of promising trees called "Fuelwood Group", under the community forestry program.

In general, in the planting program in Thailand, four main planting activities can be grouped, including industrial plantations, environmental plantations, farm woodlots, and planting multipurpose trees. The list of 99 native and exotic tree species planted in various forms in Thailand is shown in Appendix G. Most of these trees have been planted by RFD and other state organizations in various parts of the country (Bhumibhamon 1986).

At present, there are 21 Regional Forest Offices of RFD who are responsible for tree planting in all provinces of Thailand. Eucalyptus and Melia were among the top seven out of 42

fast-growing species chosen for planting (by rank) by most regional offices (Appendix H). The choice of tree species were also recommended by various organizations such as the Regional Forest Offices, District Forest Offices, Provincial Forest Companies and State organizations (Appendix I). There was also a study on a group of tree farmers who have established 80% of the tree farmers, intend to grow fast-growing species. The tree species selected by these tree farmers is limited in number including *Eucalyptus* and *Melia*.

2.8 Production Function Estimation of *Eucalyptus camaldulensis* and *Melia azedarach*

From the 15-year growth data of *Eucalyptus camaldulensis* and *Melia azedarach* (Table 33), the total volume per rai of *Eucalyptus* is 51.536 m^3 and 56.418 m^3 for *Melia*. The average volume per rai per year for *Eucalyptus* is 3.436 m^3 and 3.761 m^3 for *Melia*.

The production model for *Eucalyptus* and *Melia* was estimated using the general Cobb-Douglas form:

$y_i = A_i x^{bi}$ where y_1 = volume (m^3) of *Eucalyptus*,

y_2 = volume (m^3)of *Melia*,

for i = 1,2 x = year (age), and

A_i, b_i = parameters

The results of the estimation using ordinary least squares are presented in Table 34. For *Eucalyptus camaldulensis*, the

Table 33. Growth data of *Eucalyptus camaldulensis Dehnh* and *Melia azedarach Linn*

Year	Volume (m3)/rai			
	Eucalyptus camaldulensis	AP/ yr	*Melia azedarach*	AP/ yr
1	0.511	0.511	0.356	0.356
2	1.059	0.530	3.140	1.570
3	3.014	1.005	4.349	1.450
4	4.476	1.119	5.869	1.467
5	6.834	1.367	8.032	1.606
6	9.386	1.564	11.559	1.927
7	12.420	1.774	14.988	2.141
8	15.867	1.983	18.747	2.343
9	19.726	2.192	22.911	2.546
10	23.997	2.400	27.481	2.748
11	28.681	2.607	32.457	2.951
12	33.776	2.815	37.838	3.153
13	39.284	3.022	43.626	3.356
14	45.204	3.229	49.819	3.559
15	51.536	3.436	56.418	3.761

AP/yr - Average product per year
Source: Forest Industry Organization (1986)

Table 34. Results of estimating the production models for Eucalyptus & Melia using ordinary least squares

Dependent Variable	Ci = lnAi		lnx		R2	Adjusted R2	F-Statistic (1, 13)	No. of Obs.	Standard Error of Regression
	Estimated Coefficient	Standard Error	Estimated Coefficient	Standard Error					
y1	-.896404	.711090E-01	1.76846	.140329	.9948	.9944	2492.65	15	0.103638
y2	-.587539	.354213E-01	1.70644	.699015E-01	.9787	.9970	595.95	15	0.204523

Note: Representation are as follows: ci = constant; x = age of tree; y1 and y2 are volume data (m3/rai) of Eucalyptus & Melia , respectively.

estimated function is $y = e^{-.896404} \times^{1.76846}$ with the R- squared value of .9948. The F-value of 2492.65 indicates that the coefficient of the function is significantly different from zero at a one percent level of significance.

For *Melia azedarach*, the estimated function is $y_1 = e^{-.587539} \times^{1.70644}$ with the R-squared of .9787. Its F-value is 595.951 which reveals that the coefficient of the function is significantly different from zero at a one percent level of significance. These results revealed that the production functions for both species derived are very significant. The R-squared and t-values are remarkable high. This means that the relationship between age and volume are highly correlated for both species.

Thus, the regression from the ordinary least squares produces the production function curves according to age for *Eucalyptus* and *Melia* which are shown in Figure 16 & 17. The scatterplots of the original growth data are also displayed in the same figures.

In Figure 16, the scatterplot shows that the curve is almost smooth in which at the 15th year attains a total volume of 51.536 m^3 per rai while the production function curve represents an exact smooth curve in which at 15th year attains a total volume of 48.981 m^3 per rai which is 2.55 lower than the ordinary curve.

Figure 17 shows also the same trend in which the scatterplot shows a slightly rough curve (shown in year 2 & 3) attaining a total volume of 56.418 m^3 per rai at the 15th year while the production function curve represents a very smooth curve

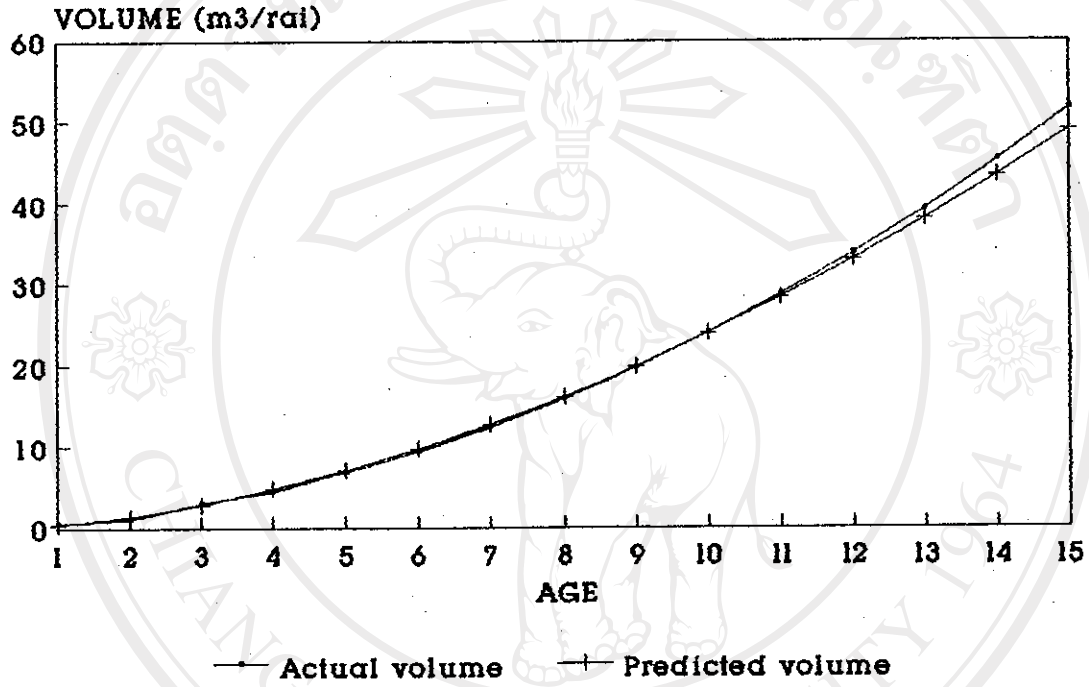

Fig. 16 Actual and predicted volumes of Eucalyptus camaldulensis

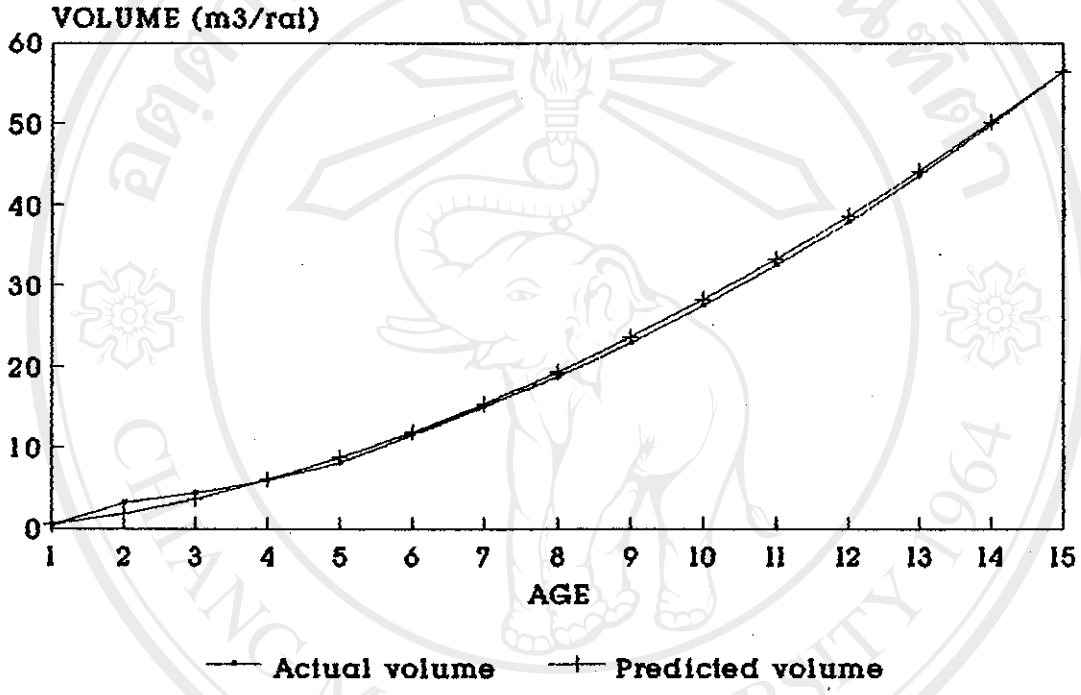

Fig. 17 Actual and predicted volumes of Melia azedarach

in which at 15th year attained a total volume of 56.396 m^3 per rai which is .022 higher than the scatterplot.

Based from these production function curves, the optimum level of trees cut (the maximum average volume per unit of time). Both Eucalyptus and Melia can be cut at the 15th year because they have attained the maximum average volume which are 48.981 m^3 and 56.396 m^3, respectively.

2.9 Estimation on the Supply of Firewood in Meeting its Future Demand in Ban Kui Tuai

2.9.1 Present & Future Demand of Firewood

In section 2.6.2, it was mentioned that the total consumption of firewood of the entire village in 1989 is 532.4 m^3 while the average volume used per household is 20.48 m^3 per year. To estimate the future demand of firewood, the villagers were asked on the amount of firewood used for the past five years. Most of the villagers including the assistant village headman said that they use the same amount of firewood every year. The agricultural extension officer of the village said that some people do not count the number of firewood. This is the reason why some respondents had a difficult time recalling the amount of firewood used. Generally, the rate of firewood use is more or less the same for the whole village for the past five years. With these, it

can be assumed that the rate of firewood use per year for the next 15 years is around 532 m^3. This rate is used to determine the overall supply of firewood for 15 years.

There are reasons on why the rate of use is stable every year. One reason is the low population growth of the village because of the present family planning program being extended in the highlands by the Thai Government. In case of Ban Kui Tuai, the UN\Thai SMHDP is the one responsible for looking into this. Another reason is the stable supply of tea leaves (discussed in section 2.4.2.2). Moreover, the owners can no longer extend their tea gardens because of labor shortage. In section 2.5.2, it was said that labor shortage is one problem in miang production because the tea leaf pickers are not enough for collecting from the present large areas of tea gardens. Besides, few villagers have just started planting seedlings of tea a few years ago.

There has been no migration in the village for the past three years. With the same number of households, the same supply of firewood used every year can be assumed.

2.9.2 Present & Future Supply of Firewood

Based from Table 35, the total volume of firewood used by the village in 1989 is 532.4 m^3. Estimates were made on the number of trees cut in the village . A tree bole of *Lithocarpus calathiformis* measuring 13 meters long can produce an average of 0.512 m^3. In this case, the total number of trees cut by the village is approximately 292 trees per year.

As mentioned in section 2.8, the volumes per rai at 15th year of the fast-growing species, *Eucalyptus camaldulensis* and *Melia azedarach*, are 51.536 m^3 and 56.418 m^3 , respectively.

2.9.3 Estimating the Areas Needed for Planting *E. camaldulensis* and *M. azedarach*

In projecting land areas needed for planting *E. camaldulensis* and *M. azedarach*, yearly projections of firewood consumption in Ban Kui Tuai from 1990 to 2049 were initially done. Two growth rates were used to make the projections using the firewood consumption growth rate of two percent from the consumption data between 1988 and 1989 and the projected population growth of 1.6 percent based on Thailand's estimate in 1987.

With the yearly projection of firewood consumption, two sets of estimating land areas were made for every five years and 15 years for planting two fast-growing species, *Eucalyptus*

Table 35. Total volume of firewood used per household per year in Ban Kui Tuai (1989)

HHNo.	Miang Processing (m3)	Cooking (m3)	Total (m3)
1	21.60	3.381	24.98
2	40.50	4.830	45.33
3	21.60	2.898	24.50
4		2.898	2.90
5		3.381	3.38
6	21.60	3.381	24.98
7	21.60	2.898	24.50
8	35.10	4.830	39.93
9	27.00	3.381	30.38
10	21.60	2.898	24.50
11	16.20	4.830	21.03
12	35.10	2.898	38.00
13		2.898	2.90
14		2.898	2.90
15		2.898	2.90
16	21.60	2.898	24.50
17	21.60	3.381	24.98
18	16.20	4.830	21.03
19		2.898	2.90
20	18.90	2.898	21.80
21		3.381	3.38
22	21.60	4.347	25.95
23	21.60	2.898	24.50
24	37.80	4.830	42.63
25	21.60	3.623	25.22
26		2.415	2.42
Total	442.80	89.597	532.40
Mean	24.60	3.446	20.48
Min	16.20	2.415	2.42
Max	40.50	4.830	45.33

camaldulensis and *Melia azedarach*, with growth data available for 15 years. Tables 36 and 42 shows the yearly projection of firewood consumption in Ban Kui Tuai using the two growth rates. The rate of firewood use for miang processing remains constant because of the constant supply of miang while for cooking demonstrates an increasing rate. This results to an increasing rate of total demand of firewood in the village.

The tea farmers need to use firewood every year. They still have to wait for 15 years in order to do the first cutting of the trees if maximum volume should be attained. Nevertheless, the five-year projection was considered so the tea farmers can acquire firewood at the earliest possible time. Thus, the ideal year for cutting the fast-growing trees for firewood which attains reasonable volume of firewood was at the 5th year for both Eucalyptus and Melia. In Ponthat (1986), the ideal cutting of these tree species for firewood are at the 5th, 10th and 15th year.

In determining the actual areas needed for growing the fast-growing species, total accumulated areas were calculated from 5- and 15-year projections each using 2 (growth rate of firewood for cooking) and 1.6 (Thailand's 1987 population growth) percent growth rates.

Using the two percent growth rate, the five-year projection of land areas needed for planting (1990-2019) and cutting (1995-2024) *Eucalyptus* and *Melia* in Ban Kui Tuai, is

Table 36. Yearly projection of firewood consumption in Ban Kui Tuai (1990-2049)

Year	Firewood Use		Total Demand for Firewood (m3) C	Growth Rate (%)
	Miang Processing (m3) A	Cooking* (m3) B		
1989**	442.800	89.597	532.40	
1990	442.800	91.389	534.19	0.003
1991	442.800	93.217	536.02	0.003
1992	442.800	95.081	537.88	0.003
1993	442.800	96.983	539.78	0.004
1994	442.800	98.922	541.72	0.004
1995	442.800	100.901	543.70	0.004
1996	442.800	102.919	545.72	0.004
1997	442.800	104.977	547.78	0.004
1998	442.800	107.077	549.88	0.004
1999	442.800	109.218	552.02	0.004
2000	442.800	111.403	554.20	0.004
2001	442.800	113.631	556.43	0.004
2002	442.800	115.903	558.70	0.004
2003	442.800	118.221	561.02	0.004
2004	442.800	120.586	563.39	0.004
2005	442.800	122.997	565.80	0.004
2006	442.800	125.457	568.26	0.004
2007	442.800	127.967	570.77	0.004
2008	442.800	130.526	573.33	0.004
2009	442.800	133.136	575.94	0.005
2010	442.800	135.799	578.60	0.005
2011	442.800	138.515	581.32	0.005
2012	442.800	141.285	584.09	0.005
2013	442.800	144.111	586.91	0.005
2014	442.800	146.993	589.79	0.005
2015	442.800	149.933	592.73	0.005
2016	442.800	152.932	595.73	0.005
2017	442.800	155.991	598.79	0.005
2018	442.800	159.110	601.91	0.005
2019	442.800	162.293	605.09	0.005
2020	442.800	165.538	608.34	0.005
2021	442.800	168.849	611.65	0.005
2022	442.800	172.226	615.03	0.006
2023	442.800	175.671	618.47	0.006
2024	442.800	179.184	621.98	0.006
2025	442.800	182.768	625.57	0.006
2026	442.800	186.423	629.22	0.006
2027	442.800	190.152	632.95	0.006
2028	442.800	193.955	636.75	0.006
2029	442.800	197.834	640.63	0.006
2030	442.800	201.790	644.59	0.006
2031	442.800	205.826	648.63	0.006
2032	442.800	209.943	652.74	0.006
2033	442.800	214.142	656.94	0.006

Table 36. (Continued)

Year	Firewood Use		Total Demand for Firewood (m3) C	Growth Rate (%)
	Miang Processing (m3) A	Cooking‡ (m3) B		
2034	442.800	218.424	661.22	0.007
2035	442.800	222.793	665.59	0.007
2036	442.800	227.249	670.05	0.007
2037	442.800	231.794	674.59	0.007
2038	442.800	236.430	679.23	0.007
2039	442.800	241.158	683.96	0.007
2040	442.800	245.981	688.78	0.007
2041	442.800	250.901	693.70	0.007
2042	442.800	255.919	698.72	0.007
2043	442.800	261.037	703.84	0.007
2044	442.800	266.258	709.06	0.007
2045	442.800	271.583	714.38	0.008
2046	442.800	277.015	719.81	0.008
2047	442.800	282.555	725.36	0.008
2048	442.800	288.206	731.01	0.008
2049	442.800	293.971	736.77	0.008

‡ Projection was based on the growth rate of firewood of 2% (1988-1989) for cooking in Ban Kui Tuai.

‡‡ Year of firewood consumption in Ban Kui Tuai recorded by the researcher.

Table 42. Yearly projection of firewood consumption in Ban Kui Tuai (1990-2049)

Year	Firewood Use		Total Demand for Firewood (m3) C	Growth Rate (%)
	Miang Processing (m3) A	Cooking* (m3) B		
1989**	442.800	89.597	532.40	
1990	442.800	91.031	533.83	0.003
1991	442.800	92.487	535.29	0.003
1992	442.800	93.967	536.77	0.003
1993	442.800	95.470	538.27	0.003
1994	442.800	96.998	539.80	0.003
1995	442.800	98.550	541.35	0.003
1996	442.800	100.127	542.93	0.003
1997	442.800	101.729	544.53	0.003
1998	442.800	103.356	546.16	0.003
1999	442.800	105.010	547.81	0.003
2000	442.800	106.690	549.49	0.003
2001	442.800	108.397	551.20	0.003
2002	442.800	110.132	552.93	0.003
2003	442.800	111.894	554.69	0.003
2004	442.800	113.684	556.48	0.003
2005	442.800	115.503	558.30	0.003
2006	442.800	117.351	560.15	0.003
2007	442.800	119.229	562.03	0.003
2008	442.800	121.136	563.94	0.003
2009	442.800	123.074	565.87	0.003
2010	442.800	125.044	567.84	0.003
2011	442.800	127.044	569.84	0.004
2012	442.800	129.077	571.88	0.004
2013	442.800	131.142	573.94	0.004
2014	442.800	133.240	576.04	0.004
2015	442.800	135.372	578.17	0.004
2016	442.800	137.538	580.34	0.004
2017	442.800	139.739	582.54	0.004
2018	442.800	141.975	584.77	0.004
2019	442.800	144.246	587.05	0.004
2020	442.800	146.554	589.35	0.004
2021	442.800	148.899	591.70	0.004
2022	442.800	151.282	594.08	0.004
2023	442.800	153.702	596.50	0.004
2024	442.800	156.161	598.96	0.004
2025	442.800	158.660	601.46	0.004
2026	442.800	161.198	604.00	0.004
2027	442.800	163.778	606.58	0.004
2028	442.800	166.398	609.20	0.004
2029	442.800	169.060	611.86	0.004
2030	442.800	171.765	614.57	0.004
2031	442.800	174.514	617.31	0.004
2032	442.800	177.306	620.11	0.005
2033	442.800	180.143	622.94	0.005

Table 42. (Continued)

Year	Firewood Use		Total Demand for Firewood (m3) C	Growth Rate (%)
	Miang Processing (m3) A	Cooking‡ (m3) B		
2034	442.800	183.025	625.82	0.005
2035	442.800	185.953	628.75	0.005
2036	442.800	188.929	631.73	0.005
2037	442.800	191.951	634.75	0.005
2038	442.800	195.023	637.82	0.005
2039	442.800	198.143	640.94	0.005
2040	442.800	201.313	644.11	0.005
2041	442.800	204.534	647.33	0.005
2042	442.800	207.807	650.61	0.005
2043	442.800	211.132	653.93	0.005
2044	442.800	214.510	657.31	0.005
2045	442.800	217.942	660.74	0.005
2046	442.800	221.429	664.23	0.005
2047	442.800	224.972	667.77	0.005
2048	442.800	228.572	671.37	0.005
2049	442.800	232.229	675.03	0.005

‡ Projection was based on Thailand's population growth rate of 1.6% (1987).

‡‡ Year of firewood consumption in Ban Kui Tuai recorded by the researcher.

presented in Table 37. For *Eucalyptus*, the area every five years were calculated by dividing the corresponding total demand for firewood at the 5th year (from Table 36) by the yield of *Eucalyptus* at 5th year which is 6.834 m^3 per rai. For example, for 1990 (planting) to 1995 (cutting), the total demand of firewood which is 543.7 m^3 for 1995 (from Table 36) is divided by 6.834 m^3 per rai producing 79.558 rai. In the case of *Melia*, the yield of 8.032 m^3 at the 5th year is used.

The total accumulated planted land areas are then calculated from the five-year production period for planting (1990-2003) and cutting (1995-2008) both species. In Table 38, the number of rai and trees were projected for each species from 1990 to 2003 using the projected areas from Table 37. Calculations for the number of trees to be planted are based from 40 trees per rai for both species. There are approximately 0.17085 m^3 per tree for *Eucalyptus* and 0.2008 m^3 for *Melia*.

The 15-year projection of planted areas were also made (Table 39). The areas were projected by dividing the total demand of firewood (Table 36) for each year by 51.536 m^3 for *Eucalyptus* and 56.418 m^3 for *Melia* both per rai.

Table 40 shows the total accumulated land areas and number of trees calculated from the 15-year production period for planting (1990-2003) and cutting (1995-2008) *Eucalyptus* and *Melia*. Calculations were done by accumulating the number of rai every 15 years (from Table 39) as what was done for every five years in Table 38. For the number of trees per year, calculations were

Table 37. Five-year projection of land areas needed for planting (1990-2019) and cutting (1995-2024) *E. camaldulensis* and *M. azedarach* in Ban Kui Tuai

Year of		Projection (rai)	
Planting	Cutting	Eucalyptus camaldulensis	Melia azedarach
1990	1995	79.558	67.692
1991	1996	79.854	67.943
1992	1997	80.155	68.200
1993	1998	80.462	68.461
1994	1999	80.776	68.728
1995	2000	81.095	68.999
1996	2001	81.421	69.277
1997	2002	81.753	69.559
1998	2003	82.092	69.848
1999	2004	82.439	70.143
2000	2005	82.792	70.443
2001	2006	83.152	70.750
2002	2007	83.519	71.062
2003	2008	83.894	71.381
2004	2009	84.276	71.706
2005	2010	84.665	72.037
2006	2011	85.063	72.375
2007	2012	85.468	72.720
2008	2013	85.881	73.071
2009	2014	86.302	73.430
2010	2015	86.733	73.796
2011	2016	87.171	74.170
2012	2017	87.619	74.551
2013	2018	88.076	74.939
2014	2019	88.541	75.335
2015	2020	89.017	75.740
2016	2021	89.501	76.152
2017	2022	89.996	76.572
2018	2023	90.499	77.001
2019	2024	91.013	77.438

Note:
1. Projection was based on the growth rate of 2% (1988-1989) for cooking in Ban Kui Tuai.
2. Yield at 5th year of *E. camaldulensis* = 6.834 m3/rai
3. Yield at 5th year of *M. azedarach* = 8.032 m3/rai

Table 38. Total accumulated planted land areas calculated from the five-year production period for planting (1990-2003) and cutting (1995-2008) *E. camaldulensis* and *M. azedarach* in Ban Kui Tuai

Year	Projection			
	E. camaldulensis		*M. azedarach*	
	rai	No. of trees	rai	No. of trees
1990	79.56	3182.40	67.69	2707.60
1991	159.41	6376.47	135.63	5425.40
1992	239.57	9582.67	203.83	8153.39
1993	320.03	12801.17	272.30	10891.83
1994	400.80	16032.19	341.02	13640.94
1995	402.34	16093.65	342.33	13693.23
1996	403.91	16156.34	343.66	13746.56
1997	405.51	16220.25	345.02	13800.95
1998	407.14	16285.46	346.41	13856.42
1999	408.80	16352.00	347.83	13913.05
2000	327.71	13108.22	278.83	11153.09
2001	246.28	9851.39	209.55	8382.02
2002	164.53	6581.27	139.99	5599.65
2003	82.44	3297.57	70.14	2805.73

Note:

1. Projection was based on the growth rate of firewood of 2% (1988-1989) for cooking in Ban Kui Tuai.
2. Yield at 5th year of *E. camaldulensis*
   = 6.834 m3/rai
   = 0.17085 m3/tree
3. Yield at 5th year of *M. azedarach*
   = 8.032 m3/rai
   = 0.2008 m3/tree
4. The calculation is based on 40 trees per rai.
5. The planted area in year 2003 will be cut in January 1, 2004.

Table 39. 15-year projection of planted areas needed for planting (1990-2032) and cutting (2005-2047) *E. camaldulensis* and *M. azedarach* in Ban Kui Tuai

Year of		Projection (rai)	
Planting	Cutting	Eucalyptus camaldulensis	Melia azedarach
1990	2005	10.98	10.03
1991	2006	11.03	10.07
1992	2007	11.08	10.12
1993	2008	11.12	10.16
1994	2009	11.18	10.21
1995	2010	11.23	10.26
1996	2011	11.28	10.30
1997	2012	11.33	10.35
1998	2013	11.39	10.40
1999	2014	11.44	10.45
2000	2015	11.50	10.51
2001	2016	11.56	10.56
2002	2017	11.62	10.61
2003	2018	11.68	10.67
2004	2019	11.74	10.73
2005	2020	11.80	10.78
2006	2021	11.87	10.84
2007	2022	11.93	10.90
2008	2023	12.00	10.96
2009	2024	12.07	11.02
2010	2025	12.14	11.09
2011	2026	12.21	11.15
2012	2027	12.28	11.22
2013	2028	12.36	11.29
2014	2029	12.43	11.36
2015	2030	12.51	11.43
2016	2031	12.59	11.50
2017	2032	12.67	11.57
2018	2033	12.75	11.64
2019	2034	12.83	11.72
2020	2035	12.92	11.80
2021	2036	13.00	11.88
2022	2037	13.09	11.96
2023	2038	13.18	12.04
2024	2039	13.27	12.12
2025	2040	13.37	12.21
2026	2041	13.46	12.30
2027	2042	13.56	12.38
2028	2043	13.66	12.48
2029	2044	13.76	12.57
2030	2045	13.86	12.66
2031	2046	13.97	12.76
2032	2047	14.07	12.86

Table 39. (Continued)

Year of		Projection (rai)	
Planting	Cutting	Eucalyptus camaldulensis	Melia azedarach
2033	2048	14.18	12.96
2034	2049	14.30	13.06

Note: Projection was based on the growth rate of firewood of 2% (1988-1989) for cooking in Ban Kui Tuai.

Table 40. Total accumulated land areas and number of trees calculated from the 5- and 15-year production period for planting and cutting of E. camaldulensis and M. azedarach in Ban Kui Tuai

Year	Projection			
	E.camaldulensis		M. azedarach	
	rai	No. of trees	rai	No. of trees
1990	10.98	439.20	10.03	401.20
1991	22.01	880.21	20.10	804.04
1992	33.08	1323.21	30.22	1208.71
1993	44.21	1768.21	40.38	1615.20
1994	55.38	2215.23	50.59	2023.54
1995	66.61	2664.31	60.84	2433.76
1996	77.89	3115.51	71.15	2845.91
1997	89.22	3568.85	81.50	3260.03
1998	100.61	4024.39	91.90	3676.15
1999	112.05	4482.16	102.36	4094.30
2000	123.56	4942.21	112.86	4514.55
2001	135.11	5404.59	123.42	4936.91
2002	146.73	5869.34	134.04	5361.45
2003	158.41	6336.52	144.71	5788.20
2004	170.15	6806.16	155.43	6217.21
2005	170.98	6839.18	156.18	6247.37
2006	171.82	6872.86	156.95	6278.13
2007	172.68	6907.21	157.74	6309.51
2008	173.56	6942.25	158.54	6341.52
2009	174.45	6977.98	159.35	6374.16
2010	175.36	7014.44	160.19	6407.46
2011	176.29	7051.61	161.04	6441.42
2012	177.24	7089.54	161.90	6476.06
2013	178.21	7128.22	162.78	6511.40
2014	179.19	7167.68	163.69	6547.44
2015	180.20	7207.93	164.61	6584.21
2016	181.22	7248.99	165.54	6621.72
2017	182.27	7290.86	166.50	6659.97
2018	183.34	7333.58	167.47	6698.98
2019	184.43	7377.14	168.47	6738.78
2020	172.62	6904.98	157.69	6307.47
2021	160.76	6430.24	146.85	5873.81
2022	148.82	5952.88	135.94	5437.76
2023	136.82	5472.85	124.98	4999.27
2024	124.75	4990.10	113.96	4558.29
2025	112.61	4504.56	102.87	4114.76
2026	100.40	4016.18	91.72	3668.65
2027	88.12	3524.91	80.50	3219.89
2028	75.77	3030.70	69.21	2768.44
2029	63.34	2533.47	57.86	2314.24
2030	50.83	2033.17	46.43	1857.23
2031	38.24	1529.73	34.93	1397.36
2032	25.58	1023.10	23.36	934.57

Table 40. (Continued)

Year	Projection			
	E.camaldulensis		M. azedarach	
	rai	No. of trees	rai	No. of trees
2033	12.83	513.21	11.72	468.80

Note:
1. Projection was based on the growth rate of firewood of 2% (1988-1989) for cooking in Ban Kui Tuai.
2. Yield at 15th year of E. camaldulensis = 51.536 m3/rai
3. Yield at 15th year of M. azedarach = 56.418 m3/rai

based on 40 trees per rai.

In summary, the total accumulated land areas and the number of trees were calculated from the 5- and 15-year production period of *Eucalyptus* and *Melia* (Table 41). This was done by adding the number of rai and the number of trees per year for each species of Tables 38 and 40. This shows the number of rai and the number of trees needed for planting and cutting in order to cope up with the firewood demand of the village. As shown in Table 41, the maximum requirement of the planted area is in 1999 for both species. A lot of planted areas are needed for the first 14 years but after the number of rai as well as the number of trees decreases until 2033. Two sets of planted areas are needed in the first 15 years with one set to meet the urgent needs of firewood while the second set will be used as stable planted areas.

For the 5- and 15-year projections of land areas and the number of trees planted using 1.6 percent (Thailand's population growth rate), the same procedures were done. Refer to Tables 42 to 47.

According to a forest officer from the Royal Forest Department who is assigned in the village and the author's field observations, there are available lands where the fast-growing species can be planted. Since the forests in Ban Kui Tuai are restricted watershed areas, the trees can be planted in patches of available lands which could be in cleared forest areas, along the roads, at the vacant lots of houses and the temple in the village, and in miang gardens which are abundant in the area.

Table 41. Grand Total accumulated land areas and number of trees calculated from the 5- and 15-year production period for planting and cutting of *E. camaldulensis* and *M. azedarach* in Ban Kui Tuai

Year	Projection			
	E.camaldulensis		M. azedarach	
	rai	No. of trees	rai	No. of trees
1990	90.54	3621.60	77.72	3108.80
1991	181.42	7256.68	155.74	6229.44
1992	272.65	10905.89	234.05	9362.10
1993	364.23	14569.38	312.68	12507.03
1994	456.19	18247.42	391.61	15664.47
1995	468.95	18757.96	403.17	16126.99
1996	481.80	19271.84	414.81	16592.48
1997	494.73	19789.10	426.52	17060.98
1998	507.75	20309.84	438.31	17532.57
1999	520.85	20834.16	450.18	18007.35
2000	451.26	18050.43	391.69	15667.63
2001	381.40	15255.98	332.97	13318.94
2002	311.27	12450.61	274.03	10961.10
2003	240.85	9634.09	214.85	8593.93
2004	170.15	6806.16	155.43	6217.21
2005	170.98	6839.18	156.18	6247.37
2006	171.82	6872.86	156.95	6278.13
2007	172.68	6907.21	157.74	6309.51
2008	173.56	6942.25	158.54	6341.52
2009	174.45	6977.98	159.35	6374.16
2010	175.36	7014.44	160.19	6407.46
2011	176.29	7051.61	161.04	6441.42
2012	177.24	7089.54	161.90	6476.06
2013	178.21	7128.22	162.78	6511.40
2014	179.19	7167.68	163.69	6547.44
2015	180.20	7207.93	164.61	6584.21
2016	181.22	7248.99	165.54	6621.72
2017	182.27	7290.86	166.50	6659.97
2018	183.34	7333.58	167.47	6698.98
2019	184.43	7377.14	168.47	6738.78
2020	172.62	6904.98	157.69	6307.47
2021	160.76	6430.24	146.85	5873.81
2022	148.82	5952.88	135.94	5437.76
2023	136.82	5472.85	124.98	4999.27
2024	124.75	4990.10	113.96	4558.29
2025	112.61	4504.56	102.87	4114.76
2026	100.40	4016.18	91.72	3668.65
2027	88.12	3524.91	80.50	3219.89
2028	75.77	3030.70	69.21	2768.44
2029	63.34	2533.47	57.86	2314.24
2030	50.83	2033.17	46.43	1857.23
2031	38.24	1529.73	34.93	1397.36
2032	25.58	1023.10	23.36	934.57

Table 41. (Continued)

Year	Projection			
	E.camaldulensis		M. azedarach	
	rai	No. of trees	rai	No. of trees
2033	12.83	513.21	11.72	468.80

Note:

1. Projection was based on the growth rate of firewood of 2% (1988-1989) for cooking in Ban Kui Tuai.
2. Yield at 15th year of E. camaldulensis = 51.536 m3/rai
3. Yield at 15th year of M. azedarach = 56.418 m3/rai

Table 43. Five-year projection of land areas needed for planting (1990-2019) and cutting (1995-2024) E. camaldulensis and M. azedarach in Ban Kui Tuai

Year of		Projection (rai)	
Planting	Cutting	Eucalyptus camaldulensis	Melia azedarach
1990	1995	79.214	67.399
1991	1996	79.445	67.596
1992	1997	79.680	67.795
1993	1998	79.918	67.998
1994	1999	80.159	68.203
1995	2000	80.405	68.413
1996	2001	80.656	68.625
1997	2002	80.909	68.841
1998	2003	81.166	69.060
1999	2004	81.428	69.283
2000	2005	81.694	69.509
2001	2006	81.965	69.740
2002	2007	82.240	69.974
2003	2008	82.520	70.212
2004	2009	82.802	70.452
2005	2010	83.090	70.697
2006	2011	83.383	70.946
2007	2012	83.682	71.200
2008	2013	83.983	71.457
2009	2014	84.290	71.718
2010	2015	84.602	71.983
2011	2016	84.920	72.253
2012	2017	85.241	72.527
2013	2018	85.568	72.805
2014	2019	85.901	73.089
2015	2020	86.238	73.375
2016	2021	86.582	73.668
2017	2022	86.930	73.964
2018	2023	87.284	74.265
2019	2024	87.644	74.572

Note:
1. Projection was based on Thailand's population growth rate of 1.6% (1987).
2. Yield at 5th year of E. camaldulensis = 6.834 m3/rai
3. Yield at 5th year of M. azedarach = 8.032 m3/rai

Table 44. Total accumulated planted land areas calculated from the five-year production period for planting (1990-2003) and cutting (1995-2008) *E. camaldulensis* and *M. azedarach* in Ban Kui Tuai

Year	Projection			
	E. camaldulensis		M. azedarach	
	rai	No. of trees	rai	No. of trees
1990	79.21	3168.40	67.40	2695.97
1991	158.66	6346.39	135.00	5399.80
1992	238.34	9533.57	202.79	8111.60
1993	318.26	12730.29	270.79	10831.52
1994	398.42	15936.67	338.99	13559.66
1995	399.61	15984.31	340.00	13600.20
1996	400.82	16032.72	341.03	13641.38
1997	402.05	16081.88	342.08	13683.22
1998	403.30	16131.81	343.14	13725.70
1999	404.56	16182.56	344.22	13768.87
2000	324.16	12966.34	275.81	11032.37
2001	243.50	9740.12	207.18	8287.35
2002	162.59	6503.78	138.34	5533.72
2003	81.43	3257.13	69.28	2771.31

Note:

1. Projection was based on Thailand's population growth rate of 1.6% (1987).
2. Yield at 5th year of *E. camaldulensis*
   = 6.834 m3/rai
   = 0.17085 m3/tree
3. Yield at 5th year of *M. azedarach*
   = 8.032 m3/rai
   = 0.2008 m3/tree
4. The calculation is based on 40 trees per rai.
5. The planted area in year 2003 will be cut in January 1, 2004.

Table 45. 15-year projection of planted areas needed for planting (1990-2032) and cutting (2005-2047) E. camaldulensis and M. azedarach in Ban Kui Tuai

Year of		Projection (rai)	
Planting	Cutting	Eucalyptus camaldulensis	Melia azedarach
1990	2005	10.83	9.90
1991	2006	10.87	9.93
1992	2007	10.91	9.96
1993	2008	10.94	10.00
1994	2009	10.98	10.03
1995	2010	11.02	10.06
1996	2011	11.06	10.10
1997	2012	11.10	10.14
1998	2013	11.14	10.17
1999	2014	11.18	10.21
2000	2015	11.22	10.25
2001	2016	11.26	10.29
2002	2017	11.30	10.33
2003	2018	11.35	10.36
2004	2019	11.39	10.41
2005	2020	11.44	10.45
2006	2021	11.48	10.49
2007	2022	11.53	10.53
2008	2023	11.57	10.57
2009	2024	11.62	10.62
2010	2025	11.67	10.66
2011	2026	11.72	10.71
2012	2027	11.77	10.75
2013	2028	11.82	10.80
2014	2029	11.87	10.85
2015	2030	11.93	10.89
2016	2031	11.98	10.94
2017	2032	12.03	10.99
2018	2033	12.09	11.04
2019	2034	12.14	11.09
2020	2035	12.20	11.14
2021	2036	12.26	11.20
2022	2037	12.32	11.25
2023	2038	12.38	11.31
2024	2039	12.44	11.36
2025	2040	12.50	11.42
2026	2041	12.56	11.47
2027	2042	12.62	11.53
2028	2043	12.69	11.59
2029	2044	12.75	11.65
2030	2045	12.82	11.71
2031	2046	12.89	11.77
2032	2047	12.96	11.84

Table 45. (Continued)

Year of		Projection (rai)	
Planting	Cutting	Eucalyptus camaldulensis	Melia azedarach
2033	2048	13.03	11.90

Note: Projection was based on Thailand's population growth rate of 1.6% (1987).

Table 46. Total accumulated land areas and number of trees calculated from the 5- and 15-year production period for planting and cutting of *E. camaldulensis* and *M. azedarach* in Ban Kui Tuai

Year	Projection			
	E.camaldulensis		M. azedarach	
	rai	No. of trees	rai	No. of trees
1990	10.83	433.20	9.90	396.00
1991	21.70	868.09	19.82	792.97
1992	32.61	1304.32	29.79	1191.45
1993	43.55	1742.02	39.78	1591.28
1994	54.53	2181.22	49.81	1992.48
1995	65.55	2621.96	59.88	2395.07
1996	76.61	3064.24	69.98	2799.09
1997	87.70	3508.11	80.11	3204.54
1998	98.84	3953.58	90.29	3611.46
1999	110.02	4400.68	100.50	4019.87
2000	121.24	4849.43	110.74	4429.79
2001	132.50	5299.86	121.03	4841.25
2002	143.80	5752.00	131.36	5254.27
2003	155.15	6205.88	141.72	5668.86
2004	166.54	6661.52	152.13	6085.08
2005	167.14	6685.62	152.68	6107.09
2006	167.75	6710.11	153.24	6129.46
2007	168.37	6734.98	153.80	6152.19
2008	169.01	6760.25	154.38	6175.27
2009	169.65	6785.94	154.97	6198.73
2010	170.30	6812.03	155.56	6222.57
2011	170.96	6838.54	156.17	6246.79
2012	171.64	6865.48	156.78	6271.39
2013	172.32	6892.84	157.41	6296.39
2014	173.02	6920.65	158.04	6321.78
2015	173.72	6948.90	158.69	6347.59
2016	174.44	6977.59	159.35	6373.80
2017	175.17	7006.75	160.01	6400.44
2018	175.91	7036.38	160.69	6427.50
2019	176.66	7066.47	161.37	6454.99
2020	165.23	6609.04	150.93	6037.14
2021	153.74	6149.79	140.44	5617.63
2022	142.22	5688.69	129.91	5196.43
2023	130.64	5225.71	119.34	4773.52
2024	119.02	4760.83	108.72	4348.86
2025	107.35	4294.00	98.06	3922.43
2026	95.63	3825.20	87.35	3494.20
2027	83.86	3354.40	76.60	3064.14
2028	72.04	2881.57	65.81	2632.22
2029	60.17	2406.67	54.96	2198.41
2030	48.24	1929.66	44.07	1762.69
2031	36.26	1450.54	33.13	1325.02

Table 46. (Continued)

Year	Projection			
	E.camaldulensis		M. azedarach	
	rai	No. of trees	rai	No. of trees
2032	24.23	969.23	22.13	885.36
2033	12.14	485.73	11.09	443.70

Note:

1. Projection was based on Thailand's population growth at 1.6% (1987).
2. Yield at 15th year of E. camaldulensis = 51.536 m3/rai
3. Yield at 15th year of M. azedarach = 56.418 m3/rai

Table 47. Grand Total accumulated land areas and number of trees calculated from the 5- and 15-year production period for planting and cutting of *E. camaldulensis* and *M. azedarach* in Ban Kui Tuai

Year	Projection			
	E.camaldulensis		M. azedarach	
	rai	No. of trees	rai	No. of trees
1990	90.04	3601.60	77.30	3091.97
1991	180.36	7214.48	154.82	6192.77
1992	270.95	10837.88	232.58	9303.05
1993	361.81	14472.31	310.57	12422.80
1994	452.95	18117.89	388.80	15552.14
1995	465.16	18606.27	399.88	15995.27
1996	477.42	19096.96	411.01	16440.47
1997	489.75	19590.00	422.19	16887.76
1998	502.13	20085.39	433.43	17337.16
1999	514.58	20583.23	444.72	17788.75
2000	445.39	17815.77	386.55	15462.16
2001	376.00	15039.98	328.21	13128.60
2002	306.39	12255.78	269.70	10787.98
2003	155.15	6205.88	141.72	5668.86
2004	166.54	6661.52	152.13	6085.08
2005	167.14	6685.62	152.68	6107.09
2006	167.75	6710.11	153.24	6129.46
2007	168.37	6734.98	153.80	6152.19
2008	169.01	6760.25	154.38	6175.27
2009	169.65	6785.94	154.97	6198.73
2010	170.30	6812.03	155.56	6222.57
2011	170.96	6838.54	156.17	6246.79
2012	171.64	6865.48	156.78	6271.39
2013	172.32	6892.84	157.41	6296.39
2014	173.02	6920.65	158.04	6321.78
2015	173.72	6948.90	158.69	6347.59
2016	174.44	6977.59	159.35	6373.80
2017	175.17	7006.75	160.01	6400.44
2018	175.91	7036.38	160.69	6427.50
2019	176.66	7066.47	161.37	6454.99
2020	165.23	6609.04	150.93	6037.14
2021	153.74	6149.79	140.44	5617.63
2022	142.22	5688.69	129.91	5196.43
2023	130.64	5225.71	119.34	4773.52
2024	119.02	4760.83	108.72	4348.86
2025	107.35	4294.00	98.06	3922.43
2026	95.63	3825.20	87.35	3494.20
2027	83.86	3354.40	76.60	3064.14
2028	72.04	2881.57	65.81	2632.22
2029	60.17	2406.67	54.96	2198.41
2030	48.24	1929.66	44.07	1762.69
2031	36.26	1450.54	33.13	1325.02

Table 47. (Continued)

Year	Projection			
	E.camaldulensis		M. azedarach	
	rai	No. of trees	rai	No. of trees
2032	24.23	969.23	22.13	885.36
2033	12.14	485.73	11.09	443.70

Note:

1. Projection was based on Thailand's population growth at 1.6% (1987).
2. Yield at 15th year of E. camaldulensis = 51.536 m3/rai
3. Yield at 15th year of M. azedarach = 56.418 m3/rai