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REGIONAL WOOD ENERGY DEVELOPMENT PROGRAMME IN ASIA
GCP/RAS/154/NET

WOODFUEL FLOWS IN THE DRY ZONE OF MYANMAR

A CASE STUDY

in collaboration with
The Pilot Integrated Watershed
Development for
the Kinda Dam Project (MYA/81/003)
Ministry of Forestry

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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FOREWORD

Improving the woodfuel distribution systems in its member countries is one of the important objectives of the Regional Wood Energy Development Programme in Asia. Understanding the conditions that determine the flow of woodfuels from producer to consumer is a first step towards developing policies and programmes for sustainable use and affordable access to this renewable source of energy.

While many woodfuel consumption surveys have been carried out over the past 15 years, the structure of wood fuel flows from dispersed sources to centrally located markets has received little attention so far. This, along with the effect of government policies on pricing of woodfuel and alternatives determine however to a large extent which fuels are available at what price to urban consumers and other users purchasing woodfuel.

In order to plan any development intervention assistance which may be required, it is essential to assess the current market situation and marketing systems for its strengths and weaknesses, and for possible opportunities and threats in the future. For this purpose, RWEDP initiated a series of micro level studies on the trade and marketing systems of woodfuel in several places in Asia. The present study is part of this series and focuses on wood fuel flows to two urban centres in the dry zone of Myanmar.

Mr. U. Saw Thun Khiang presents here the consolidated outcome of two surveys carried out in different seasons. It provides an insight in the market mechanism, consumption patterns and the socio-economic status of fuelwood gatherers and traders. It confirms the important role the fuelwood trade plays in providing (additional) income to poor and often landless rural people.

This project wishes to express its sincere thanks to the author for his very significant contribution to the understanding of the problems and potential of woodfuel use in Myanmar. I also wish to thank Dr. Aroon Chomcharn, Wood Energy Conversion Specialist of this project and Mr. A. Koopmans, who provided respectively supervision and assistance in the technical editing of the report. Ms. Pimpa Molkul, Ms. Navaporn Liangchevasoontorn and Ms. Panpicha Issawasopon provided editorial support and text lay out.

It is hoped that this document will be useful to energy and forestry planners in Myanmar and other parts of Asia, when considering various policies and strategies for affordable access to sustainable sources of energy. Any comments and feed back from the readers will be highly appreciated.

Egbert Pelinck
Chief Technical Adviser

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Although all of these people have contributed to the publication of the report, I am solely responsible for any errors, inconsistencies or omissions which may remain.

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EXECUTIVE SUMMARY

Development Background: This report focuses on a particular fuel resource area around Pyinyaung and Yinmabin of Thazi Forest Township, a hilly region bordering Mandalay Division and Shan State. The report provides some information on the socioeconomic status of fuel collectors and traders who are the prime movers of woodfuel (fuelwood, bamboo fuel, charcoal, etc.) from this hilly area to the central plains of the dry zone.

The report is the outcome of the fuelwood diagnostic study conducted by the author on two occasions: the first in December and the second in April 1992, both occasions covering a period of 28 days. The study was sponsored by FAO/Regional Wood Energy Development Programme in Asia, (GCP/RAS/131/NET) based in Bangkok, Thailand in collaboration with the Kinda Dam Watershed Management Pilot Project, (MYA/81/003) of Myanmar.

The study was undertaken to cover three major aspects of the area: socioeconomic status of fuel gatherers and traders, the trade chain from the resource area to the markets, and the amount of biomass energy consumed in two urban centres of the dry zone. The report is based primarily on information gathered randomly from households and individuals of 8 villages in the resource area and 8 market centres in the plains.

Major Findings: The Forest Department, in response to woodfuel requirements of the people in the dry zone, has created local supply reserves in Yinmabin and Pyinyaung areas.

People in the resource area are the prime movers of woodfuel from the supply area to the market centres in the dry zone. They make a living from woodfuel collection on a full time basis or to supplement their incomes from other sources. The income of fuel gatherers from fuel collection is considerable but their socioeconomic status is quite low, mainly due to the increase in the price of essential commodities. Woodfuel traders are much better-off than the collectors but their net income is declining due to the increase in the price of oil and spare parts for transportation.

Due to the imbalance in supply and demand, the woodfuel resource area is overburdened. It was found that two urban centres of Thazi and Meiktila consume from 4 to 12 times more woodfuel than the annual prescribed quota. Bamboo has become an important energy alternative to wood from this area. Besides reducing the pressure on fuelwood, it is preferred by the evaporated milk production industry.

Data on the growing stock of the resource area has been collected by the National Forest Survey and Inventory of Myanmar (NFSIM) of the Forest Department. From the data it is estimated that, with the existing stock, the resource area can survive 16 years in the case of fuelwood and 6 years in the case of bamboo fuel, provided that the current rates of annual cut are maintained. If remedial measures are taken now, the sustainable use of the area can be maintained.

To ease the pressure on woodfuel energy resources, other organizations such as the Myanmar Electric Power Enterprise, the Department of Agricultural Mechanisation, the Kinda Dam Watershed Management Pilot Project and the Forest Research Institute under the Forest Department have become involved in the area providing electric power and promoting fuel saving stoves. However, the electric power provided is still far from sufficient and is not reliable and the

development of fuel saving stoves is still in the initial stages. Kerosene is scarce and too expensive to be used for cooking and other purposes, except for lighting.

Recommendations: The results of the study on woodfuel production in the fuel supply area and end-use in the consumption centres call for a series of recommendations for forestry and energy development programmes in the dry zone of central Myanmar. These can be summarised as follows:

- The fuelwood deficit problem in the central arid zone as well as in other similar areas should be tackled at the national level as it is the root of all economic, social and environmental ills of the country. As such, multi-organizational efforts are called for to solve energy and related problems. The responsibility should not be borne by the Forest Department alone although a major part on the supply side will rest on the Department.

- People would willingly participate in the Department's development activities provided they have sufficient incentives. The woodfuel deficit problem in the dry zone can be solved only if there is a definite fuelwood policy in line with privatization. Based on this concept, the Forest Department should encourage the formation of village, community and/or private groups to manage, control and utilize fuelwood from the reserved forests, unclassified forests or lease the lands to these communities for tree/fuelwood production purposes. The Forest Department should help the local group forming such local bodies, trainings and providing them with material support as well as the transfer of relevant technologies for woodlot establishments and managements. The private and community groups should have the right to dispose of the products from their tree growing activities, with no legal restrictions.

- The Forest Department should revise the expired working plan of Meiktila and revive the existing local supply working circle. At the same time, depleted areas should be rehabilitated, preferably by natural means with effective control and maintenance. For the management of bamboo stocks, the provision of an alternate rest period of 3 years in a specific area or reserve should be sufficient as only dry bamboo culms are extracted for industrial use.

- In order to educate the urban as well as rural population with regard to conservation ethics and the adoption of fuel saving stoves, an action-oriented extension service should be organised by the Forest Department and other departments concerned with energy, agriculture and rural development. This service strategy should also be used to promote a better coordination and understanding among different government organizations as well as the people.

1 INTRODUCTION

Most developing countries in the world depend for a large part on biomass as a source of energy, not only for domestic use but for industrial applications as well. This in particular is true in the case of Myanmar where 84% of the total amount of energy consumed is biomass based, notably fuelwood and charcoal. The remaining 16% consists of commercial sources of energy like oil, gas and electricity.

The heavy reliance on fuelwood and its possible adverse impacts was acknowledged by the authorities as early as the fifties. Several fuelwood supply and demand studies were carried out by the Forest Department of Myanmar (e.g. "The Fuelwood Situation in Burma" a study carried out for the Asia-Pacific Forestry Commission in 1959). In 1968 another study on the fuelwood and charcoal situation was carried out for the Planning Department of the Ministry of Planning and Finance. This study formed part of a country review on energy in Myanmar. Besides, other studies were also carried out by the Forestry Department and the UNDP/World Bank. These studies indicated that woodfuel problems existed. However, all these studies and assessments dealt with the fuelwood situation of Myanmar on a national basis and therefore did not analyze the woodfuel situation in specific areas of the country. In fact, up to now no detailed study for a specific area has ever been carried out.

With 47% of its land area being forested, Myanmar can still be considered fortunate when compared to other Asian countries. However, due to the continued heavy reliance on wood as a source of energy, the woodfuel situation has become critical in several areas. Various surveys and studies on the energy situation in Myanmar have indicated that, out of 14 states and divisions, two states and six divisions can be classified as fuel deficit areas. Out of these fuel deficit areas, the entire Mandalay Division, located in the dry zone of central Myanmar, has been facing an acute scarcity of fuelwood for a long time. In order to meet the demand, fuelwood is transported from the wetter fringe areas to the sparsely forested dry zone.

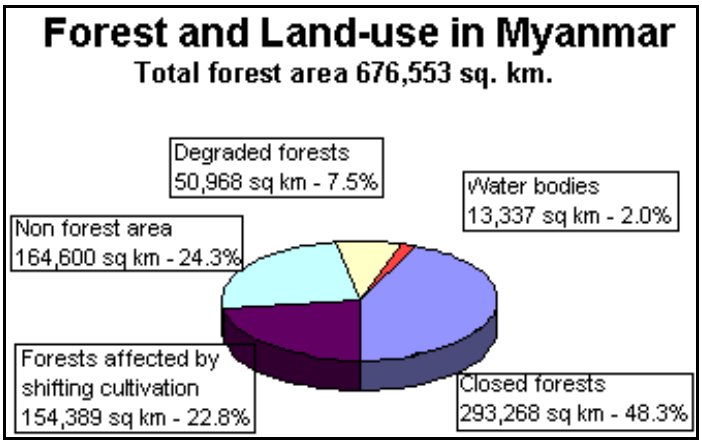


Figure 1.1 Forest cover of Myanmar. Forest Department 1991 (1989 Appraisal)

Along the eastern fringes of the central zone, in the border area of the Mandalay Division and the Shan State, the woodfuel trade has been going on for a long time and is well established. Hundreds of rural people, the majority being women and children, make their living from fuelwood and bamboo fuel collecting and processing. However, very little is known about the trade, trading mechanisms, end-users, on the sustainability of the resource base (in particular for bamboo fuel), etc. For this reason the FAO Regional Wood Energy Development Programme in Asia, in collaboration with the National Pilot Integrated Watershed Development Project for the Kinda Dam, commissioned this study to get a better understanding of all factors involved, from production to end-use. The present report describes the results of this study carried out in the eastern sector, in particular in the Yinmabin and Pyinyaung forest reserves.

2 BACKGROUND INFORMATION ON THE STUDY AREA

2.1 The Study Area

The study area, comprising of the Yinmabin and Pyinyaung reserved forests, is part of the Thazi Forest Township. The latter is one of the four Forest Townships of Meiktila which in its turn is administered by the Mandalay Forest Division. The study area, as shown in figure 1, lies in the eastern part of Thazi, in the border region of Mandalay Division and Shan State. It is about 50 miles by road and rail from Meiktila.

The Thazi Forest Township is one of the 29 administrative units, locally called "townships", of the Mandalay Division. It consists of 13 forest reserves with a total area of 208,058 acres as is shown in table 2.1. Out of the total, 61,500 acres has been designated as woodfuel supply areas. The area designation has not been revised over time to conform with the present establishment of forest townships. Likewise, rules and regulations with regard to the exploitation have also not been changed and are still referred to as "functional management guidelines".

Table 2.1 Reserved forests and designated woodfuel supply areas in Thazi Forest Township

Reserved Forest			Designated woodfuel supply area (acres)
No.	**Name**	**Total area (acres)**	
1.	Yinmabin	6,400	6,400
2.	Pyinyaung	30,593	2,572
3.	Yebokson (N)	3,200	-
4.	Yebokson (W)	4,031	4,031
5.	Yebokson (E)	3,286	2,426
6.	Yupadaung	28,818	28,818
7.	Kubyin	16,227	-
8.	Kubyin Extension I	18,154	-
9.	Kubyin Extension II	8,829	-
10.	Myittha	52,707	-
11.	Kalaw Extension	480	480
12.	Kyatsakan	18,560	-
13.	Sindaung	16,773	16,773
		---	---
	Total	**208,058**	**61,500**

The woodfuel supply areas once covered nearly 5% of the total reserved forests of the country but most of these areas, particularly those located in the plains, are now virtually denuded due to population pressure, coupled with an increased demand for timber, woodfuels, etc. However, the supply areas located in the hills in Yinmabin and Pyinyaung areas, along the eastern fringe of the dry zone, are still fairly well stocked. The areas support the woodfuel needs of Thazi and Meiktila as well as the surrounding areas, both for domestic purposes and for use by small industries.

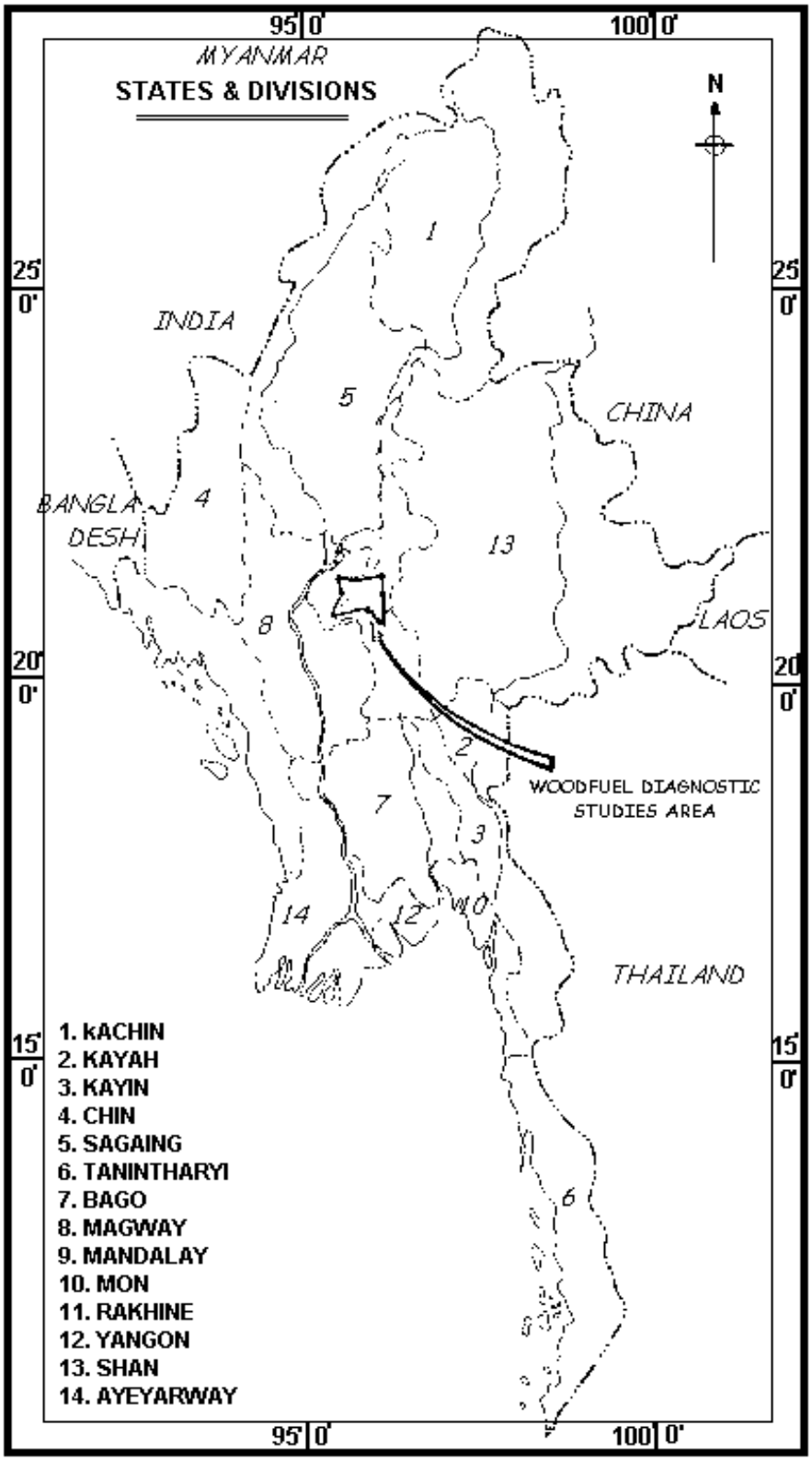


Figure 2.1 Map of Myanmar showing the provinces and the location of the study area

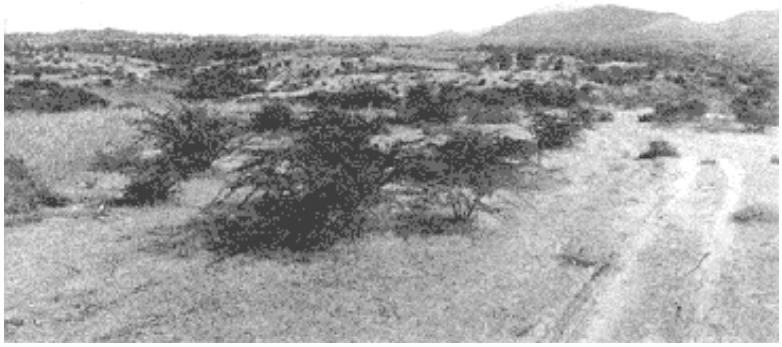


Figure 2.2 A typical scene of the dry zone around Taungtha

2.2 Climate

Like the rest of Myanmar, the dry zone has a monsoonal climate with a rainy season which lasts from May until October. Due to its location in the rain-shadow of the mountain ranges lying near the western coast, the rainfall is considerably lower than in other parts of the country. There are marked differences between the climate at Yinmabin and Pyinyaung and the lower lying core of the dry zone. In the hills, the differences in climate are less marked than those on the plains. Sub-tropical conditions prevail on the Shan Plateau. Rain is common with Pyinyaung receiving on average about 1,450 mm. of rainfall per year while the temperatures are low. Around Meiktila the rainfall is on average only about 750-880 mm. per year

2.3 Principal Vegetation of the Thazi Forest Township

Because of the low amount of rainfall, less than 1,000 mm.per year, the low lying dry zone has a distinct type of vegetation mainly consisting of dry forests. The vegetation consists of thorn forests scattered with thorny exotic tree species such as mesquite (Prosorpis juliflora) and *tazaung* (Euphorbia spp.). This type of vegetation is found everywhere in the dry zone with the exception of the Popa Mountain range. Here better and taller tree species and natural forests are found, consisting of *than* (Terminalia oliveri) and *dahat* (Tectona homiltoniana) as well as man-made fuelwood plantations of exotic species. From Meiktila and Thazi to Yinmabin and Pyinyaung, the elevation increases from 150 to close to 400 meters. The forest type changes with elevation from thorn forests to dry upper mixed deciduous forests (DUMD) and *than* and *dahat* forests and scrub *indaing* forests (Dipterocarp spp.).

The Yupadaung Reserve is covered largely with scrub *indaing* forests. Due to excessive cutting, the reserve is degraded and has been invaded by dry soil type bamboos such as *hmyin* (Dendrocalmus strictus). DUMD forests are found only in patches on the higher lying and more remote parts of the reserve. The Yinmabin Reserve is also covered by scrub *indaing*. Due to the heavy demand for fuel and other forest products by the population of lowland areas, the original stand has become scattered, dwarfed and dry soil bamboo species like *hmyin* are now quite common. Only on the high plateaus some forests with tree species such as *than, dahat* and *sha* (Acacia catechu) are found.

The East Yebokson Reserve is dry and DUMD forests are predominant. For this reason the majority of the area has been designated as a fuel supply area. *Than* and *dahat* are common in this reserve. West Yebokson is dominated by scrub *indaing* and the reserve is now heavily degraded.

Pyinyaung and Kubyin reserves are mostly covered by DUMD forests. As the reserves are fairly well-stocked, only part of the total area has been designated as a fuel supply area. However, dead and dying trees are permitted to be extracted. The remaining part of the Pyinyaung and Kubyin reserves are designated as commercial supply areas and teak and other hardwoods such as *padauk* (Pterocarpus macrocarpus) and *pyinkado* (Xylia dolabriformis) are allowed to be extracted on a commercial basis.

2.4 Population

According to the population census of 1983, the Mandalay Division covers 14,295 sq. miles and consists of 29 administrative units, called "townships". It is one of the most densely populated divisions in the country with a density of 320 persons per sq. mile, about double the national average. The population and household survey data of the area according to the 1983 census and the 1991 projections are shown in table 2.2. The projections are based on an annual population growth rate of 2.24%. Out of 29 townships, the study area covers 8 townships which account for the major share of wood and bamboo fuel derived from the Yinmabin, Pyinyaung, Yebokson and Yupadaung reserves.

Table 2.2 Populations and households in the study area

Name of Township	1983				1991 (projected)			
	Population		Households		Population		Households	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
1. Thazi	18,440	129,210	3,570	23,771	22,015	154,263	4,262	28,380
2. Meiktila	96,496	183,215	17,513	32,641	115,206	218,739	20,908	38,969
3. Pyawbwe	23,857	182,532	4,355	32,342	28,482	217,924	5,199	38,612
4. Wundwin	21,301	157,190	4,340	29,342	25,431	187,668	5,181	35,031
5. Mahlaing	14,717	134,965	2,824	26,196	17,570	161,134	3,371	31,275
6. Taungtha	14,126	194,236	2,735	37,865	16,864	231,897	3,265	45,206
7. Kyaukpadaung	28,718	206,594	5,311	40,686	34,286	246,651	6,340	48,574
8. Myingyan	77,060	183,043	15,505	35,537	92,001	218,534	18,511	42,427
Total	**294,715**	**1,370,985**	**56,153**	**258,380**	**351,855**	**1,636,810**	**67,037**	**308,474**

2.5 Occupation and Land Use

The majority of the people in the dry zone, as elsewhere in Myanmar, are engaged in agricultural activities. Unlike in other parts of the country, cultivation of paddy is impossible without irrigation. Dry cultivation is common in the Meiktila area because the soil is very sandy and there is little rainfall. Cotton, sesame and ground-nut are the main crops but a variety of beans, tomatoes, onions and chilies are grown also. Due to water shortages in the hills, little cultivation takes place.

The villages of Thahtaygon, Kywetatson and Monpinson grow a considerable amount of maize, sesame, sunflower and beans. Yinmabin also grows some maize but also has citrus and promising banana plantations. In Yebokson some paddy is planted but the main crops are maize and bananas. Banana plantations are common in the villages of Yinmabin, Yebokson and Pyinyaung because many banana growers settled here in 1965 after having been evicted from the Popa Mountain range. In Pyinyaung, along the Myittha *chaung* basin, citrus plantations have been promoted by the government in order to ensure sufficient supplies for the tinned fruit factory at Hlaingdet village.

In most cases the cash income from crop growing in the study area is minimal and most people have to rely upon other sources of income. These may consist of jobs in road construction, railway maintenance, in the mines or stone quarries, etc. However, the majority relies on income from forest products such as extracting and/or selling timber, woodfuels including charcoal, bamboos and other minor forest products.

3 TYPES AND NATURE OF WOODFUEL IN THE AREA

In the dry zone, woodfuels are widely used for domestic purposes such as cooking and food processing as well as for small industries. These include evaporated milk factories, sugar factories, jaggery boiling, caustic soda boiling, brick making, lime burning, potteries, black-smithies and weaving factories. Different types of woodfuels are used such as fuelwood, charcoal, bamboo, sawmill off-cuts and sawdust. Besides woodfuels, agricultural residues such as rice husks, ziziphus husks, coconut shells, cotton stalks, pigeon-pea stalks, sesame stalks, paddy stalks, tree leaves and cow dung are also widely used. The bulk of biomass fuels used in the dry zone consists of fuelwood, bamboo and charcoal, both for industrial and domestic energy consumption. Sawmill off-cuts, sawdust and agricultural residues are less important and basically supplement the woodfuels. After the completion of a new road from Payangasu to Pyawbwe in 1990, which shortened the distance from 54 to 16 miles, the latter area has also become a major market for woodfuel, in particular for use by evaporated milk and sugar factories.

3.1 Fuelwood

The Yinmabin area is the main supply source and is covered by DUMD, scrub *indaing*, *than* and *dahat* forests. Due to the growing demand for fuelwood and other timber products the standing stock is gradually decreasing. Natural regeneration is hampered, probably due to soil degradation and erosion and the trees have been replaced by dry bamboo species such as *hmyin* (Dendrocalmus strictus).

Figure 3.1 A dry upper mixed deciduous forest in the Yebokson Reserve, Yinmabin

In order to prevent further forest degradation and soil erosion, the Forest Department has introduced a selective system for fuelwood extraction. They have drawn up a list of fuelwood species in order of suitability. When a permit is issued for fuelwood extraction they mark these species for felling within the overall limit set for a particular area. Within the study area 23 species, shown in Annex 1, have so far been listed for use as fuelwood. The species, most preferred by traders and consumers, in descending order, are: *than*, *dahat*, *kyun-gauk-nwe* (Vitex limonifolia), *bebya* (Crotoxylon neriifolium), *zibyu* (Emblica officinalis), *thitni* (Amoora rohitaka), *te* (Diospros burmanica), *gyo* (Schleichera oleosa) and *pyaukseik* (Holoptelea integrifolia). The preference is not only based on heating and combustion characteristics, but on other factors such as emitting little or no smoke, ease of ignition, ease of splitting, good yield when converted to charcoal, etc.

Besides fuelwood from the forests, a considerable amount is derived from the dry zone itself in the form of stems, branches, uprooted stumps, etc. The mesquite tree (Prosorpis juliflora) which was introduced around 1950 with the objective of rapidly providing a ground cover and a source of fuel, has now become very pervasive on most lands. Although harmful with prickly thorns, it is increasingly used in evaporated milk production units, pottery production, jaggery boiling and yarn dyeing.

3.2 Bamboo

Figure 3.2 Bamboo gathering by young people, many of them women

Out of the 75 species of bamboos found in Myanmar, the species most widely used in the study area is *hmyin* (Dendrocalmus strictus). Yupadaung, Yinmabin and Yebokson reserves

provide the bulk of bamboo used as a source of energy. It is particularly suited for the production of evaporated milk. Owners of evaporated milk-plants prefer bamboo fuel to other biomass fuels because the fire can be started very fast while the amount of heat generated can be controlled at will. It is sometimes compared to a blow-lamp. In addition, by using bamboo as fuel, the colour of the evaporated milk remains whitish which results in a higher price for the product. With other biomass fuels, the colour is often brownish and this lowers the price of the product.

Figure 3.3 Bamboo fuel cut and bundled into the required dimensions

Hmyin is a common bamboo species in upper and lower Myanmar, in particular in dry soil types. Under favourable conditions the culms are 50 feet long and 3-4 inch in diameter. However, in dry locations the size is normally much smaller and the culms are often solid. It is therefore also called "male bamboo". Substitution with other bamboo species does take place but only in areas where *hmyin* is scarce. These generally thick walled species are *thaik* (Bambusa tulda) and *wanwe* (Dinochloa m'clellandi). They are less liked because the heat value of these bamboo species is lower than *hmyin.*

3.3 Charcoal

Charcoal is seldom used for domestic cooking in rural areas but it is an important source of energy for small scale industries such as black-smithies. In urban areas it is used for domestic cooking as well as in restaurants, tea-shops and noodle shops where instant heating is an essential requirement.

Within the study area, charcoal burning is only permitted in Kywetatson village and in fact only two permit holders are listed in Thazi Forest Township. However, as the demand by the urban consumers is increasing, additional charcoal is also produced west of Meiktila (apparently without a permit). The species most often used for charcoal making are *than*, *dahat* and *sha*.

3.4 Mill Off-cuts

Around 100 tons of mill off-cuts are produced each month by the three sawmills of Yinmabin. All off-cuts are taken to the 11 and 27 re-cutting mills in Thazi and Meiktila, respectively. These re-cutting mills process the off-cuts into smaller pieces and bundle them for sale as fuelwood. Of the two centres, Thazi is the main distributor of fuelwood made from mill off-cuts. Users like this type of fuelwood as it is dry, easy to use and has a high heating value. Therefore users are willing to pay a higher price for it than for other woodfuels.

3.5 Saw-dust

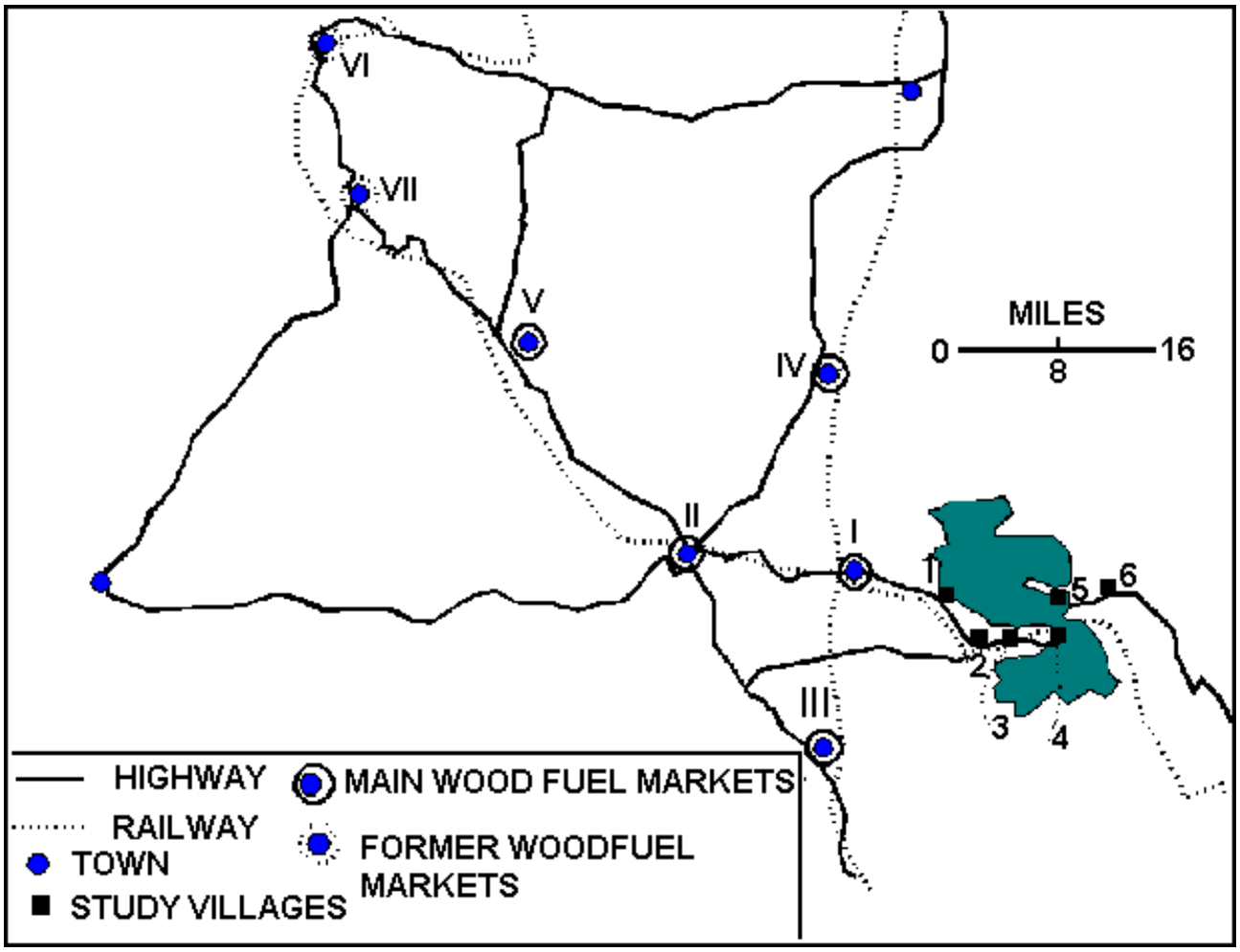
The same sawmills in Yinmabin produce also around 60 tons of sawdust per month. Sawdust is sold locally or to consumers, mainly smithies, in Meiktila and as far away as Yenanchaung. Sawdust is also increasingly used for institutional cooking but hardly for domestic purposes because of its inconsistent supply and it is difficult to burn and control the fire in the stoves commonly used by the households.

3.6 Agricultural Residues

Agricultural residues are obtained from agro-processing centres in the vicinity of urban centres in the dry zone. An exception are rice-husks, paddy stalks and coconut shells which are transported from the southern fringe areas. However, agricultural residues have also other competing uses such as for fodder, organic fertilizer, building material, etc. It is not possible to discuss the pros and cons due to a lack of sufficient data.

4 VILLAGES AND PEOPLE INVOLVED IN THE WOODFUEL TRADE

As mentioned earlier, most of the woodfuel supplies of Meiktila and Thazi come mainly from the eastern sector of the dry zone. There are basically four main supply areas consisting of the Pyinyaung, Yinmabin, Yebokson and Yupadaung reserves of Thazi Forest Township. Some of these main centres get part of their supplies from neighbouring areas as is shown in the following map (figure 4.1).



1. Hlaingdet	I Thazi
2. Thahtaygon	II Meiktila
2. Thahtaygon	II Meiktila
3. Kywetatson	III Pyawbwe
4. Yinmabin	IV Wundwin
5. Yebokson	V Mahlaing
6. Pyinyaung	VI Myingyan
	VII Taungtha

Figure 4.1 Woodfuel study area with main supply and market centres

Within the four main supply areas there are 6 six main villages and five nearby villages, from where labour is drawn, which can be considered as woodfuel supply centres. The population size and the number of households as well as the number of people engaged in woodfuel gatherering and trading, etc. in these villages, are shown in table 4.1. Most of the people in the 11 villages, engaged in fuel collection and trade, are primarily farmers. However, for generations they have been supplementing their income, in particular during the off-farm season, by extracting forest products.

Table 4.1 Villages engaged in woodfuel collection and trade in the study area.

Village/ Sub-village	No. of Households	Population size	No. of people regularly engaged in		
			Trade	Collection	Total
Hlaingdet	1,408	7,044	13	100	113
Thahtaygon	77	511	2	40	42
Kywetatson	197	1,063	3	110	113
Yinmabin	768	4,097	10	176	186
- Madan	90	572	n.a.	n.a.	n.a.
- Monpinson	150	976	n.a.	n.a.	n.a.
Yebokson	229	1,195	6	130	136
- Kubyin	21	79	n.a.	n.a.	n.a.
- Monpin	51	225	n.a.	n.a.	n.a.
- Oakkyin	59	322	n.a.	n.a.	n.a.
Pyinyaung	313	1,376	17	91	108
Total	**3,363**	**17,460**	**51**	**647**	**698**

As shown in figure 4.1, the woodfuel resource areas lie along the highway and the railway line that connect the Central Dry Zone and the Shan State. The six main collection and supply centres are all located along these transport ways between Pyinyaung and Meiktila. Both the highway and the railway are used to transport woodfuels to Meiktila which lies at a distance of about 50 miles from the supply area.

4.1 The Main Collection and Trade Centres

4.1.1 Hlaingdet Village

Hlaingdet is the largest trade and collection centre in the area. It is located about 7 miles from Thazi and 21 miles from Meiktila. The centre specializes in bamboo and there are about 100 regular fuel gatherers who work for the 13 traders. Bamboo is collected from the Yupadaung Reserve which is located about 3 miles from the village. Since 1970 the village has been supplying bamboo for use as fuel to the evaporated milk industries in Thazi, Meiktila, Pyawbwe and Wundwin. In fact, Hlaingdet can be considered as the pioneer in promoting the use of bamboo as a substitute source of energy for the production of evaporated milk in the dry zone.

Although rural in character, Hlaingdet is a prospering village in comparison with the other supply centres. A government owned canned fruit factory as well as an agricultural seed production centre are located near the village. Although grid electricity is available and used in these two facilities, the village proper is still without electricity.

4.1.2 Thahtaygon Village

Thahtaygon lies 14 miles from Thazi and is also a bamboo fuel collection and trade centre. There are about 40 regular bamboo gatherers who work for the two middlemen. Besides buying bamboo on their own account the middlemen also supply bamboo bundles to the traders in Hlaingdet for which they are paid a commission of 100-150 kyats per truck. The main occupation of the people is farming (dry cultivation). As a secondary source of income they rely on bamboo fuel collection and quarrying. Bamboo is collected from unclassed and reserved forests adjoining Thazi and Pyawbwe, about 7 to 8 miles from the village. Grid electricity is available at the government owned quarry near the village of Payangasu, about one mile away from Thahtaygon. However, similar to Hlaingdet, the surrounding villages are still without electricity. Water is also in short supply and villagers have to carry water from the nearby river. Thahtaygon is the poorest community among the fuel supply centres of the study area.

4.1.3 Kywetatson Village

Kywetatson lies 15 miles from Thazi and is the main charcoal and brick supply centre for the lowland plains. Besides fuelwood from the surrounding area a considerable amount of wood is obtained from the Yinmabin and Yebokson areas (mainly for the brick kilns). The reason for this is that the permits for local woodfuel gathering which allow only the supply of 3,000 tons of fuelwood for brick burning and the production of 2,500 bags of charcoal is insufficient to meet the actual demand.

4.1.4 Yinmabin Village

Yinmabin, which lies at an elevation of 1,200 feet is 21 miles from Thazi. Being the gateway to Shan State means that both road and railway traffic make stops here. Because of this, it has also become a trading centre. There is a hospital, a high school and a police station but it is still treated as a village by the administrative sector. Water is scarce and there is no grid electricity. It is surrounded by forests and as it has three sawmills, which supply mill off-cuts and sawdust to Thazi, Meiktila and Yenanchaung, it has become the major supply point for fuelwood to the dry zone. Most of the people employed as fuelwood gatherers come from the nearby Monpinson and Madan villages.

4.1.5 Yebokson Village

Yebokson (which lies about 25 miles from Thazi) and the surrounding villages of Kubyin, Monpin and Oakkyin were founded by the Forest Department. This was done in order to have sufficient labour during the seasonal forest operations such as tree girdling, felling and plantation establishment. Both wood and bamboo are supplied with most woodfuel gatherers recruited from Yebokson and the nearby villages. Yebokson and Kubyin reserves are the main supply sources but only dry wood from dead and dying trees is allowed to be taken from the Kubyin reserve. The source is about 6-7 miles away from the village.

4.16 Pyinyaung Village

Pyinyaung lies 30 miles from Thazi and consists of two parts, about 3 miles apart. Pyinyaung (Road), which is the largest with a population of 1,062, lies along the road while Pyinyaung (Rail) lies along the railway. Both sections are engaged in the extraction of major as well as minor forest products including woodfuel. Pyinyaung (Road), in general, supplies large sized woodfuel as well as lime to the dry zone plains while Pyinyaung (Rail) supplies woodfuel in the form of round billets, small sized bundles, bamboo and thatch for domestic use. The round billets are cut and transported by rail to Myingyan. Small sized fuelwood is collected and bundled by casual fuel gatherers from Thazi. The Thazi railway station is used as an informal market centre for these young fuel gatherers who use the trains, which run between Thazi and Shan State as their mode of transport.

4.2 Woodfuel Gatherers and Traders

4.2.1 Woodfuel Gatherers

Figure 4.2 Felling a marked *dahat* tree (Tectona hamiltoniana) for fuelwood

Woodfuel gathering and selling is normally considered as a secondary source of income, particularly during the off-farm season. It is in general hard and laborious work. Most of the people involved with woodfuel are young. In Monpinson village near Yinmabin the age of the woodfuel gatherers ranges between 12-25 while in Thahtaygon, Hlaingdet and Yebokson villages older people are also involved in wood as well as in bamboo fuel gathering.

The Forest Department at Thazi issues identity cards for genuine woodfuel gatherers. Traders are expected to use only registered woodfuel gatherers and they should keep a list of those gatherers under their control. Only those gatherers who are registered and appear on the list are allowed to enter the area for which an extraction permit has been granted to the traders. The same relationship exists between gatherers and middlemen, who are often employed by traders on a per truck or piece-rate basis.

Most woodfuel gatherers work for the woodfuel traders and/or middlemen from their own villages. The relationship between them is simple and based on trust and legal contracts between them do not exist. The traders and/or the middlemen normally pay a certain amount of money in advance to the gatherers. The gatherers deliver woodfuel to the woodfuel yard or depot of the trader. The amount

delivered is measured using local volumetric measurements such as *pone, lan, htwa, taung* or, in the case of bamboo, bundles. The local measurement units are based on the dimensions of the hand or arm. Annex II shows the details of the local measurements used as well as how these relate to international measurement norms. Based on the volume delivered, payments are made by the trader or middlemen, normally on a five-day market basis, using mutually agreed prices whereby the money paid in advance is deducted.

The income from woodfuel gathering varies from place to place but, judging from the available data, it seems that in general the income generated is considerable. However, although the income may be considerable, the majority of the people involved are not well-off. This is basically caused by the high and increasing cost of essential commodities such as rice and cooking oil which they have to buy. Another reason is the large family size and the perennial shortage of water needed for rice growing and other agricultural crops. The average income from woodfuel as well as from other sources and the household expenditure for woodfuel traders and gatherers in the different village centres is shown in table 4.2 while the details are presented in Annex III. The income earned from woodfuels has been calculated assuming that woodfuel gatherers are fully occupied on their farms for 4 months with the remaining 8 month spent on woodfuel gathering.

Table 4.2 Average income and expenditure of woodfuel traders and gatherers

Occupation	Income in Kyats/year			Expenditures Kyats/year	Surplus
	Woodfuels	Others	Total		
Hlaingdet					
Trader BF	42,400	85,700	128,100	64,176	63,924
Gatherer BF	21,960	1,773	23,733	24,060	(327)
Thataygon					
Middleman BF	11,370	6,000	17,370	16,044	1,326
Gatherer BF	15,840	3,800	19,640	17,740	1,900
Yinmabin					
Middleman BF	21,600	48,000	69,600	64,500	5,100
Gatherer BF	36,400	9,100	45,500	41,820	3,680
Trader FW	48,000	47,640	95,640	77,640	18,000
Gatherer FW	36,000	8,800	44,800	44,580	220
Yebokson					
Trader FW	14,720	26,833	41,553	39,513	2,040
Gatherer FW	35,360	--	35,360	33,100	2,260
Kywetatson					
Charcoal Prod.	5,500	20,200	25,700	26,020	(520)

Note: BF denotes bamboo fuel while FW denotes fuelwood

Woodfuel gatherers need some equipment as otherwise the work becomes impracticable due to the weight and the distances over which woodfuels have to be transported from the resource area to the woodfuel depots. The investments to be made by woodfuel gatherers is normally not very high. Of all the items required, the largest investment to be made is in a pair of bullocks and a cart which could cost up to 25,000 kyats. However, the bullock cart can also be used for other purposes and can be resold if required. The equipment required and the costs involved, which vary from area to area, are shown in table 4.3.

Table 4.3 Equipments and tools required and costs involved for woodfuel gathering (kyats)

Equipment required	Yebokson/Yinmabin			Thahtaygon/Hlaingdet		
	Amount	Price	Total	Amount	Price	Total
Bullock	2	10,000	20,000	2	10,000	20,000
Bullock cart	1	5,000	5,000	1	4,000	4,000
Two-men hand saw	1	500	500	-	-	-
Chain (12 ft)	1	1,500	1,500	-	-	-
Axe	2	70	140	-	-	-
Machete	1	70	70	2	70	140
File	1	150	150	-	-	-
Total	**9**	**-**	**27,360**	**5**	**-**	**24,140**

4.2.2 Woodfuel Traders

Out of the almost 700 people regularly involved with the woodfuel trade, 51 are listed as traders. Nearly half of them are engaged in the trade of bamboo fuels as it is a more lucrative business when compared to fuelwood or charcoal. Traders prefer bamboo fuel for several reasons: a) bamboo fuel does not require an extraction permit in advance as is the case for fuelwood and charcoal, b) extraction levies only have to be paid to the Forest Department after the amount has been checked at the control station in Thazi and c) the recruitment of workers is easy as even youngsters can be employed in cutting and transporting the culms.

Because there is a regular demand for bamboo fuel, all a trader needs is labour and a guaranteed supply of bamboo. One trader in Yinmabin has, with the authority's consent, made his own motorable road in the Yinmabin Reserve and now monopolizes the collection of bamboo fuel from the area.

Most of the bamboo fuel traders are, in general, financially better-off than the average villager or trader engaged in other businesses. For instance, in Hlaingdet there are 13 bamboo fuel traders. Half of them own trucks to transport the bamboo with some of them having been engaged in the trade for nearly 20 years. However, even though there is a regular demand, it appears that the profit margin is now lower than during the last 10 years. At present a bamboo fuel trader sells on average 10-15 truck loads per month on which he makes a profit of about 250-300 kyats per truck load. If the trader owns the truck he may make additional income from passengers joining along the way.

The same is more or less valid for fuelwood traders with profit margins declining. Most traders with their own trucks are now also becoming involved with general transport, but even here the profit margin is becoming marginal because petrol, oil, spare parts and maintenance are becoming increasingly more expensive.

Besides, the woodfuel traders have realized that, although there is a regular demand for woodfuels, the woodfuel resources are dwindling and receding. As a result, gathering requires more time and consequently woodfuels delivered to their depots are becoming more expensive. The increase in price has resulted in a tendency for consumers to switch over to less expensive alternatives such as rice husks and mesquite wood. This, in its, turn, has resulted in many woodfuel traders switching to other trades, mainly in transportation services along the Yangon to Mandalay highways. That the woodfuel trade is becoming less lucrative is also evident from table 4.2 which shows that the income from other sources is considerably higher than that of the woodfuel trade. The general feeling among woodfuel traders and gatherer at present is that the real beneficiaries of their efforts are the end-users such as the owners of cottage industries, etc.

5 WOODFUEL DISTRIBUTION SYSTEM AND PRICING

5.1 Woodfuel Distribution and Prices at the Supply Centres

The main actors in the woodfuel distribution system are the traders who have their business bases in the villages of the woodfuel resource areas. The traders are the holders of the permits issued by the Thazi Forest Township. Traders organize the supply by hiring woodfuel gatherers and at the same time keeping regular contacts with the end-users/buyers as well as with the authorities concerned with their trade.

Figure 5.1 A bamboo fuel depot in Yebokson

There are 6 woodfuel distribution centres in the study area but only 4 are of major importance in the distribution chain. The Yinmabin and Yebokson centres supply both fuelwood and bamboo fuel while the Thahtaygon and Hlaingdet centres supply mainly bamboo fuel. From Pyinyaung, the road-side centre mainly supplies fuelwood to the local lime burning units while the rail-side centre, supplies a considerable and growing quantity of unrecorded fuelwood along the Pyinyaung- Thazi rail line. This informal fuelwood trade is prepared in small bundles. Kywetatson is the main supply centre for charcoal. However, there is also unrecorded charcoal production elsewhere which is not accounted for.

In order to facilitate the collection, distribution and the checking of woodfuel by the traders, 4 fuelwood collection depots have been established with the permission of the Forest Department, one in Yebokson village and the other 3 in the Yebokson, Yinmabin and Yupadaung reserves.

Woodfuel is transported from these depots directly to the regular customers in the market such as small industries and retail shops near and in urban centres as there is no formal wholesaler in the urban markets dealing in woodfuel trade. This is mainly due to the fact that the capital investment required is high while the profit margin is low. Besides, if wholesalers existed, they would have to be registered and subjected to business taxation also.

Previously, there were 10 main woodfuel market centres, the farthest being Myingyan and Yenanchaung which are located at a distance of over 100 miles from Pyinyaung and Yinmabin areas by road or rail (see map in fig 4.1, p. 11). However, due to the increase in transportation costs, which was mainly because of rising petrol prices, these far away market places have become less important. At present, most of the woodfuel goes to Thazi, Meiktila, Pyawbwe, Wundwin and Mahlaing. Due to the high price of woodfuel and the supply shortage, some consumers have begun using local substitutes such as mesquite (thorny) fuelwood and agri-residues, whenever feasible.

Figure 5.2 Informal fuelwood collection and transport to the village centre by bullock carts.

Besides woodfuel coming from the main supply centres, at present some woodfuel supplies (fuelwood and bamboo) from the upper reaches of the inundated area of the Kinda Dam are also finding their long way down the hill to the markets. Most of the fuelwood transported by rail from Pyinyaung to Myingyan is destined for the military barracks as well as for brick burning in Taungtha. The domestic woodfuel supplies for Myingyan and the western part of the dry zone is partly supplied via the Ayeyarwady river which has its origin in the Chindwin river basin of the upper part of the country. The main woodfuel supply and market centres are presented in table 5.1 below.

Table 5.1 Main woodfuel supply and distribution channels

Supply centre	Pyinyaung		Yebokson		Yinmabin		Kywetatson		Hlaingdet		Thahtaygon	
Market centre	Type	Dist.	Type	Dist.	Type	Dist.	Type	Dist.	Type	Dist.	Type	Dist.
Kywetatson	W	10	W	10	W	6	-	-	-		-	
Thazi	W	30	WB	25	WBMC	21	C	15	B	7	B	14
Meiktila	-		WB	39	WBMCS	35	C	29	B	21	B	28
Pyawbwe	-		WB	28	WBMC	24	C	18	B	22	B	17
Wundwin	-		WB	59	WBC	55	-		B	41	B	48
Mahlaing	-		WB	63	WB	59	-		B	45	B	52
Taungtha	-		WB	82	WB	78	-		-		-	
Myingan	W	102	WB	97	B	93	-		-		-	
Kyaukpadaung	-		B	99	B	95	-		-		-	
Yenanyaung	-		-		B	133	-		-		-	

Note: Type denotes the type of woodfuel supplied. W = Fuelwood, B = Bamboo fuel, M = Mill off-cuts, C = Charcoal and S = Sawdust.
Distances given are in miles

The prices of different types of woodfuel, vary very little among the different supply centres, basically because they are competing with each other. However, the prices of woodfuel at these centres have been increasing largely due to its scarcity in which, it has increased the collection distance from the villages and the access from the roadside. They have also resulted in a natural increase in the labor cost. Woodfuel prices, valid for 1991, at the different supply centres are shown in table 5.2.

From table 5.2, the price of fuelwood varies from 104-185 kyats/stacked ton. (This stacked ton or hoppus ton is actually equivalent to 50 cubic feet in volume and not equivalent to a metric ton of 1,000 kg.). The price difference is due to the quality classification adopted both by traders and consumers. The lower price is valid for inferior species which are normally used for brick making, for example for fuelwood at 104 kyats/stacked ton. The higher side price of 185 kyats/stacked ton is valid for fuelwood used by the domestic sector which requires quality species, split and dried wood. The price of fuelwood bundles also varies due to the differences in quality and size of the bundles, although a bundle size is normally about 1.5 feet in circumference and 1.5 feet long.

In contrast, the price of bamboo fuel appears to be uniform because of its uniform quality as previously discussed. A small price variation is basically caused by the difference in transport distance covered by the gatherers from the bamboo source to the roadside collection point. Bamboo fuel is normally sold in bundles measuring about 5-6 inches in diameter and 1 foot long.

Table 5.2 Woodfuel prices (1991) at different fuel supply centres

Woodfuel type and sales unit		Pyinyaung	Yebokson	Yinmabin	Kywetatson
- Fuelwood	Stacked ton (50 cubic)	104 - 185	104 - 185	104 - 185	-
	Bundle	2.0 - 2.5	1.6 - 2.0	1.9 - 2.0	-
- Bamboo	Bundle	-	0.45 - 0.50	0.45 - 0.50	-
- Mill off-cuts	Stacked ton	-	-	500	-
- Charcoal	Bag (90 lbs)	-	-	75	75
- Sawdust	Truck (3-stacked tons)	-	-	500	-

5.2 Royalties Levied by the Forest Department

The woodfuel trade in Myanmar is controlled by the Forest Department. In the study area the Thazi Forest Township has the authority to issue the extraction permits on the Department's behalf, to check woodfuel delivery from the supply areas to the market centres as well as to collect the royalties.

The annual allowable cut (AAC) of fuelwood, bamboo and charcoal is set by the Directorate of Forests in Yangon. The Mandalay Forest Division and the Meiktila Forest Townships Group oversee the actual management and control which are implemented by the Thazi Forest Township. Permits for woodfuels and charcoal are issued in accordance with the targeted quota set. Permit holders for fuelwood are only allowed to fell those trees that have been marked, under the selective system, by forestry staff. Permit fees for the collection of woodfuel and charcoal have to be paid in advance. As a security, each permit holder has to deposit 3,000 kyats with Thazi Forest Township Office.

Woodfuel gatherers recruited by the permit holders(traders) have to be registered and identity cards are issued by the local Forest Office in order to differentiate between legal and illegal gatherers. Even though forest rangers and lower level staff are assigned to administer the extraction centres at Hlaingdet, Kywetatson, Yinmabin, Yebokson and Pyinyaung, a considerable, but unknown, quantity of informal trade in woodfuel persists along the railway line with woodfuel ending up in Thazi mostly by rail(see fig. 10).

Every truckload or cartload of fuelwood or charcoal is checked and recorded at Thazi. There are two reasons for this: One is to calculate and collect the royalty and the other is to ensure that the quantity extracted does not exceed the level allowed under the permit. However, a permit is not required for bamboo fuel and upon arrival at the check-point the transported quantity is checked and the royalty collected. If woodfuels are to be transported beyond Thazi Township removal-pass fees are also levied. The royalty rates are laid down in the "Forest Rules" and are adjusted from time to time. During the study period, the following royalty rates applied:

(a) Fuelwood: 5 kyats per stacked ton. A truckload of fuelwood is presumed to contain 8 stacked tons by volume.
(b) Bamboo fuel: 20 kyats per 1,000 culms or 40 kyats per truckload containing 5,000 bundles which is equivalent to 2,000 culms (2.5 bundles/culm).
(c) Charcoal: 2 kyats per 90 lbs bag.
(d) Other forest products, not described in the Forest Rules: A royalty of 12.5% of the *ad valorem* value.
(e) Removal Pass: 30 kyats per truckload of fuelwood or bamboo fuel and 3 kyats per 90 lbs. bag of charcoal.

Figure 5.3 Selling of fuelwood by informal trader along a major route.

5.3 Transport Cost and Woodfuel Prices at the Market Centres

Most of the fuelwood is transported by truck from the resource area to the main market centres and only a small amount, from Pyinyaung Reserve, destined for military use in Myingan, is transported by rail. Truck transport costs vary, depending on the distance involved. Table 5.3 shows the standard transport costs of woodfuels from the supply area to the different market centres per truck. It has been assumed that a truck can hold about 8 stacked tons (400 cft) of fuelwood or 5,000 bundles of bamboo fuel. Rail transport to Myingyan is quoted per van of about 2,000 cft capacity or 40 stacked tons. Besides the transport costs, the labour costs for loading and unloading are also given. The woodfuel prices in all market centres have been increasing due to the higher prices for collection and transport. In comparison with the price level in 1988, it is found that fuelwood prices have increased by about 29 %, bamboo fuel by 50 % and petrol prices by 58 %. The irregular supply and the rise in petrol price are felt by the traders, the truckers and the end-users. As mentioned earlier some end-users such as the cottage industries have switched to poorer grade substitutes, especially the thorny mesquite wood and agri-residues. While the price

of woodfuel has been rising, the demand is still strong and hence has lead to the flowing in of fuelwood, bamboo fuel and charcoal from the western, northern and southern sectors of Meiktila, filling and/or competing with woodfuel supply from the study area. Table 5.4 gives an overview of the prevailing woodfuel prices in 1991 at the 10 main market centres.

Figure 5.4 Bamboo fuel transported by truck

Table 5.3 Transport and labour charges for moving woodfuel to the market centres

Market centres	Distance in miles	Transport cost	Labour cost	Remarks
Kywetatson	10	1,000	120-200	per truck load
Thazi	21	2,000	120-200	"
Pyawbwe	24	2,000	120-200	"
Meiktila	35	3,200	120-200	"
Wundwin	55	4,000	120-200	"
Mahlaing	59	4,000	120-200	"
Thaungtha	78	6,000	120-200	"
Kyaukpadaung	95	8,000	120-200	"
Yenangyaung	133	8,500	200	"
Myingyan	102	2,600	500-600	per rail van

Figure 5.5 Charcoal bag transported by bullock cart

Table 5.4 Woodfuel prices at the main market centres in 1991.

Market centres	Fuelwood		Mill off-cuts		Bamboo fuel	Charcoal	Sawdust
	Kyats/ton	Kyats/bundle	Kyats/ton	Kyats/bundle	Kyats/bundle	Kyats/bag	Kyats/ton
Kywetatson	262	---	---	---	---	75	---
Thazi	625	1-5	1,400	6	0.80	90	---
Pyawbwe	625	2-5	---	---	0.80	90	---
Meiktila	812	2-5	---	---	0.90	110	800
Wundwin	950	2-5	---	---	1.00	115	---
Mahlaing	1,100	2-5	---	---	1.00	115	---
Thaungtha	1,300	2-5	---	---	1.10	120	---
Kyaukpadaung	1,500	2-5	---	---	1.25	120	---
Yenangyaung	---	---	---	---	---	---	1,500
Myingyan	1,500	2-4	---	---	1.15	120	---

Ton = stacked ton of 50 cubic feet.

6 WOODFUEL END-USER GROUPS

Woodfuels are used extensively by both the domestic and industrial sectors. However, there have been substantial changes in the past, due to the shift in the availability of other fuels. Before 1970, when kerosene was available both in urban and rural areas, the government through the Industrial Development Corporation (IDC), introduced the kerosene stove which was widely used because of its low cost and convenience. However, in the mid-seventies, kerosene supplies became unavailable and the kerosene stove had to be abandoned. Later, the government tried to introduce gas stoves but, again because of the supply problem, the fuel could not be relied upon for daily use. At present, both domestic and cottage industries depend largely on biomass energy, especially woodfuel in the form of fuelwood, bamboo fuel and charcoal. In urban centres where electricity is available, electric stoves are also used. But due to the erratic electricity supply these cannot be relied upon.

Many of the government departments concerned with energy, such as the industry, agriculture, rural development, energy, and forestry departments etc. are now taking a very keen interest in introducing fuel efficient biomass burning stoves and furnaces. However, only a limited number of these improved devices have been in actual use or made available on a commercial basis; the rest are largely still in the research and development stages.

6.1 Domestic and Institutional Users

Most people in rural areas still use three-stone fires for cooking. Although the thermal efficiency of these fires is low (in the order of only 10-15%) compared with the total energy delivered by the fuel, there are a number of additional benefits associated with their use: part of the heat and/or smoke emitted can be used for the preservation of food and roof structures, as a mosquito repellent, and often for warmth in colder areas. Attempts at introducing improved domestic fuelwood and residue burning cookstoves, therefore, have been made by a number of organizations.

Figure 6.1 One stick stove in a kitchen of FRI worker

The Forest Department through the Forest Research Institute (FRI) based in Yezin developed a firewood saving stove during 1986-7, locally known as "one stick stove". A number of stoves using this design was produced and sold on a pilot basis for 50 kyats. While the fuelwood saving feature was amply demonstrated, the local stove producers did not desire to produce the new designs commercially due to the complicated production steps and its heavy weight.

After a field assessment of user needs, the Integrated Pilot Watershed Management for the Kinda Dam Project (IPWM) in 1987-90, in cooperation with FAO/RWEDP, Bangkok, introduced an improved ceramic woodstove (previously developed in Thailand) for use in the project area where all the households used three-stone fires (see fig 6.2). With a strong initial reception of about 10 stoves, some 70 units more (produced on a pilot basis at FRI at the cost of about 50 kyats each) were distributed to interested villagers, who requested them, with very positive results. Even though the users have expressed their willingness to purchase such an improved model, local production has not yet been established to cope with the increased demand inside the project area or in many urban areas of the dry zone which could potentially be markets for the stoves.

The Department of Agricultural Mechanization (DAM), in collaboration with UNICEF, has introduced an improved mud-built chimneyed stove developed in India, the so-called "Jetan Chula". This stove, however, has to be built in-situ by the users themselves. To ensure that the critical dimensions are adhered to, the Department has prepared metal moulds and made them available at field stations for villager use free of charge (see fig 6.3). Since this stove design is primarily made out of clay, the only cost incurred is for one's own labor for clay collection, preparation and construction. However, for proper construction, some training is required. Some villagers around Meiktila have become interested in this stove type.

Restaurants and teashops are also large consumers of woodfuel. Teashops, which often sell various kinds of food and snacks, generally serve plain tea to their customers free of charge. They normally use various types of charcoal stoves, especially metal and stone-carved models. However, these stoves are energy inefficient and often not very safe

Figure 6.2 Thai pottery stove introduced in the IPWM project area (fired with twigs from home garden)

Figure 6.3 A set of moulds used for the construction of improved mud stoves

during use. In order to improve the situation and at the same time to get boiling water for tea, many tea-shops have lately developed a boiler- type charcoal stove (see fig. 6.4). The stove has a hot water jacket around the stove's combustion chambers. The model produced by private enterprises in Yangon and Mandalay costs some 3,000 kyats/unit using iron sheet material. Though the initial investment is very high, these teashop owners found it more energy efficient, safer and cleaner to use and requiring less fire attendance. Another in-situ built model is the chimneyed wood and agri-residue stove. It is widely used in the Meiktila area where food has to be prepared for a large number of people such as in restaurants, training institutes, prisons, army barracks, etc. The stove model, with some variation in design can burn fuel-wood, bamboo, twigs, sawdust as well as rice husks. Besides institu-tional cooking, it is also used by evaporated milk producers.

Figure 6.4 A boiler-type charcoal stoves used in teashop

Figure 6.5 A traditional stove used by restaurants in Meiktila

The stove is made out of bricks and cement, usually by skilled artisans. The total cost of the stove is about 7,500 kyats depending on the size, material used and the location. Energy efficiency, fuel flexibility and convenience are important features of this stove model. For these reasons it has found very good acceptance even though the initial investment is high.

6.2 Cottage and Village Industries

There are many types of cottage and village industries around Thazi and Meiktila. Industries that use large amounts of woodfuel include sugar factories, evaporated milk plants, brick and lime kilns, caustic soda extraction units and weaving factories. Other industries, eg. bakeries, food processing industries, etc use less woodfuel per unit but due to the large number of them the total quantity used is considerable. Cottage and village industries and major food processing units like large restaurants, normally obtain their supplies directly from the woodfuel traders from the resource area. However, most of the smaller users such as teashops and the domestic sector obtain their supplies of charcoal and fuelwood through informal trade channels and/or retailers. In the following sections, selected woodfuel using industries are briefly described:

6.2.1 Sugar Factories

Sugar factories started operating in Meiktila about 10 years ago with a few units. They have since increased in number after the government lifted the production ceiling in order to satisfy the demand of evaporated milk industries. At present, there are 10 factories in Meiktila, which on average produce altogether about 350-500 viss (570-815 kg.) per day. The main raw materials for sugar production are jaggery from the toddy palm and cane sugar slabs. However, sometimes extracts of the juice from the toddy palm and sugar cane are also used. The traditional method of processing refined sugar primarily involves boiling. The cost of the raw material, if in the form of sugar cane slabs, is about 22 kyats per viss.

Figure 6.6 A sugar factory using fuelwood as a main source of energy

Fuelwood is normally in the form of bondos (big round logs with a diameter of 8-12 inches). The average fuelwood consumption per month is two truckloads at a cost of about 12,000 kyats. The fuelwood input per viss of sugar produced, which sells for about 50 kyats, is only 0.8 kyats or 1.6% of the refined sugar output value. Even though the fuelwood share in the production cost is low, many manufacturers are looking for local alternative sources of energy, eg. coconut shells etc.

6.2.2 Evaporated Milk Plants

There are, at present, 77 evaporated milk plants in Thazi, Meiktila, Pyawbwe, Mahlaing and Wundwin. The raw material, fresh milk, is readily available here within the dry zone. The evaporated milk, besides for local consumption, finds its main markets in Yangon and Taunggyi. The production of evaporated milk started because the imported variety became very expensive. The local product is well accepted and is popularly known in tea- shop jargon as "ordinary" in contrast to "shai" which means a cup with imported condensed milk.

The production capacity of evaporated milk plants in the area varies from 80-200 viss (130-325 kg.) of evaporated milk per day. The main source of energy used is bamboo fuel (about 70% of the total) with requirements ranging from 300-1,500 bundles of bamboo fuel per day per factory. To produce a viss of evaporated milk, which fetches a price of 90 kyats, about 3 viss of the main ingredient, fresh milk, at the cost of about 20 kyats/viss is required, besides sugar. The cost of bamboo fuel is about 6 kyats per viss of the output or about 7% of the selling price.

Figure 6.7 Bamboo-fired furnace in a milk evaporation plant

Producers consider this woodfuel cost high and they are looking for alternatives although they know that the quality of evaporated milk prepared with bamboo fuel is better. A variety of other possible sources of energy may include rice husks and local mesquite wood collected from live-fences, fallow and wastelands. The cost of these alternative sources is estimated to be about 2.40 kyats (rice husks) to 3 kyats (mesquite) per viss produced. Time will tell whether these alternative fuels will be widely accepted considering the quality standard of the product.

Figure 6.8 A typical evaporated milk plant with a series of evaporators operated mostly by young boys

6.2.3 Weaving Factories

Weaving, with mechanical and hand looms, is an important cottage and village industry not only in the dry zone but also in many other parts, of the country. Most of the *longyi* (man's lower garment, like a sarong) are produced in this area as well as some ladies sarongs. There are over 300 factories in Meiktila and nearly 3,000 in Wundwin. While electricity is used to power the mechanical looms, woodfuel is the sole energy source used for yarn dyeing. In Meiktila seven large factories are engaged in yarn dyeing and weaving with the remaining factories performing only weaving using processed yarns from the other factories.

Figure 6.9 Wood-fired stoves for yarn dyeing

An average factory with a production capacity of 3,000 *longyi* per month will require on average about one truckload of woodfuel per month for dyeing. The cost of woodfuel in yarn dyeing is about 2.5 kyats per piece of *longyi* which sells for about 100 kyats, ie. the share of the woodfuel cost is about 2.5% of the selling price. Woodfuel from the Yinmabin area is becoming expensive due to the increase in transport costs and some users are also using locally available mesquite wood and fuelwood coming from the inundated areas of the Kinda Dam.

6.2.4 Brick Kilns

Brick production is a booming business as construction in the urban centres is expanding both in the study area and else-where. There are many small brick kilns located in and around the dry zone which all use woodfuel for burning the bricks. The largest factory has a production capacity of about 1 million bricks per year. However, bricks are only produced in the dry season which lasts about 5 months. Most of the woodfuel comes from Yinmabin and the consumption has been estimated at 450 *lans* or 2,000 stacked tons per year. Fuelwood used for firing a piece of brick costs about 0.26 kyats while bricks sell at about 1 kyat per piece.

Figure 6.10 A medium sized brick production center using a Bull's trench kiln fired with fuelwood

Besides brick factories, there are also 17 lime kilns in the study area about which little is known except that their number has increased considerably during the last 5 years, especially near the woodfuel resource area on the hills. Both brick and lime-kilns do not require a particular type of fuelwood but most owners prefer fuelwood which gives soft but long lasting flames.

7 WOODFUEL CONSUMPTION AND THE SUPPLY POTENTIAL

As pointed out earlier, the dry zone has been well recognized as the woodfuel deficit area of the country. Although Thazi and Meiktila are close to the forest resource area on the hills, woodfuel shortages have been felt for a long time. The increasing trend of population growth, coupled with the prosperous development of cottage industries, can only make the woodfuel situation worse, unless other additional woodfuel resources can be found or substitution made with other fuels. In addition, being located at the centre of the trade between lowland users and upland suppliers, the demand for woodfuel from this resource supply area will become unsustainable unless an effective management plan and control, acceptable to the villagers/woodfuel gatherers, can be implemented.

The Thazi Forest Township Office is keeping records of woodfuel movements from the Yinmabin area which have to pass through Thazi on their way to the consumers in the plains. An overview of the actual woodfuel flows and the targets set for by Thazi Forest Township, based on very old forest working plans of the fifties, is shown in Table 7.1.

Table 7.1 Woodfuel flows through Thazi from the Yinmabin area(1986/87-1990/91)

Year	Woodfuel (stacked ton)		Bamboo fuel (,000 culms)	
	Target	Actual	Target	Actual
1986-87	10,612	9,008	2,100	1,772
1987-88	10,159	13,199	1,700	2,380
1988-89	14,855	9,243	2,500	2,277
1989-90	20,000	13,666	4,000	4,444
1990-91	10,001	4,796	1,670	5,611
Total	**65,627**	**49,912**	**11,970**	**17,484**
Average	**13,125**	**9,982**	**2,394**	**3,497**

From table 7.1, actual supplies of fuelwood, except in 1987-88, are considerably lower than the target quotas, indicating strict control against over-extraction by the permit holders. In contrast, for bamboo fuel, which does not require extraction permits, sharp annual increases can be observed. However, when comparing these average figures for the last 5 years with the amount formally moved through Thazi in the year 1991-1992, shown in table 7.2, it becomes evident that the amounts of fuelwood and bamboo fuel have dropped drastically for some reason. A plausible explanation may be that, because a new short-cut road from Payangasu to Pyawbwe has been completed, woodfuel transports may have been diverted to the new route, by-passing Thazi. This reason is supported by records which show that in 1990-91 about 1,365 stacked tons of fuelwood and 165 stacked tons of bamboo fuel passed through Pyawbwe from the eastern sector.

Figure 7.1 Processing of bamboo fuel by a villager in Thahtaygon

Table 7.2 Woodfuel flows through Thazi from the Yinmabin area to six main market centres in 1991-92

Market Centre	Amount distributed		% distribution	
	Fuelwood (stacked ton)	Bamboo fuel (,000 culms)	Fuelwood	Bamboo fuel
Thazi	96	104	3.0	4.4
Meiktila	2,808	1,888	88.9	80.8
Wundwin	152	8	4.8	0.3
Mahlaing	40	324	1.3	13.9
Taungtha	48	8	1.5	0.3
Pyawbwe	16	6	0.5	0.3
Total	**3,160**	**2,338**	**100.0**	**100.0**

Out of the 6 main market centres shown in table 7.2, Meiktila is by far the largest consumer of both fuelwood and bamboo fuel. This is because Meiktila has a large population as well as many cottage industries.

7.1 Woodfuel Consumption in Thazi and Meiktila

The data shown in tables 7.1 and 7.2 are the records of the formal woodfuel trade. However, there also exist informal, non-recorded trade channels that cater to small users and are believed to deal in a considerable quantity of trade. In order to have some indications of the amounts involved, the woodfuel consumption in Thazi and Meiktila has been estimated as shown in table 7.3. The woodfuel consumption by the domestic sector was derived from the number of urban households and the fuelwood consumption per household as obtained from a short survey of only 10 households each from Thazi and Meiktila. The number of households was obtained from the projection of the 1983 census data (see table 2.2). The woodfuel consumption by the cottage industries and food processing sector (food stalls, restaurants etc.) was based on the consumption as recorded during this survey. The data on woodfuel consumption and the household expenditures for woodfuel purchases are shown in Annex V along with other data.

Figure 7.2 A roadside charcoal retailer in Meiktila

An analysis of the data presented in table 7.3 reveals a very large difference between the per household (HH) consumption in Thazi with 2.7 stacked tons/HH, and Meiktila where the average was found to be 6.1 stacked tons/HH per year. While these consumption figures for the two centers should be verified, preferably with a larger sample size, in the meantime they tentatively indicate that the amount consumed by a household is far higher than the norm of 1.4 stacked tons/HH, which is used by the Forest Department to set the extraction limits.

By comparing these consumption figures for the two urban centres with the average annual targets for Thazi Forest Township, as shown in table 7.1, it appears that the woodfuel consumption estimate of 139,814 tons in Meiktila is about 12 times higher than the average target of 13,125 stacked tons from the Yinmabin area. The combined quantity of the targets set for the two urban

areas is close to 50,000 stacked tons (35,000 tons for domestic use and 15,000 tons for the other sectors), giving the ratio of the current estimated consumption to the target of about 4:1. This analysis shows that there exist large discrepancies between the official fuelwood extraction quotas and the consumption estimates. In fact, the woodfuel used per household for domestic sector can be 2-4 times higher than the Forest Department norm.

In the case of bamboo fuel, the consumption estimate appears to be close to the target quota of 2.394 million culms, assuming that 2.5 bundles can be made from 1 culm.

Table 7.3 Estimated woodfuel consumption in two urban centres in 1991

Consumer	Meiktila		Thazi		Total	
	Woodfuel (ton)	Bamboo fuel (bundles)	Woodfuel (ton)	Bamboo fuel (bundles)	Woodfuel (ton)	Bamboo fuel (bundles)
1.Cottage industries	4,128	4,968,000	792	1,080,000	4,920	6,048,000
2.Foodstalls	8,148	-	1,590	-	9,738	-
3.Households(urban)						
20,908 x 6.1	127,538	-	-	-	127,538	-
4,262 x 2.7	-	-	11,507	-	11,507	-
Total	139,814	4,968,000	13,889	1,080,000	153,703	6,048,000

Figure 7.3 An example of very inefficient fuelwood use in restaurant cooking in Thazi

It can be concluded from this study that the actual consumption of woodfuel by various consumers, both households and industries, is much higher than the norm set by the Forest Department. As the Forest Department will normally not allow the extraction or transport of woodfuel over the limits set in the given permits, it appears that the difference is made up by other means (but from the same area), especially through informal trade channels, over which very little control can be exerted. Other sources of woodfuel such as from the southern, northern and western sectors are also used and supplies come from the surrounding areas (eg. fuelwood from farms, villages, homesteads and waste lands).

7.2 Supply Potential of the Study Area

The Forest Department is the principal agency responsible for the regulation, management, control and development of woodfuel in Myanmar. Although the Department has long recognized the role of woodfuel as the principal source of energy for the country, not a great deal has been done towards managing the woodfuel resources on a sustainable basis.

Around 1960, attempts were made for the sustainable management of woodfuel and other products in the study areas through the application of a standard coppice system. It was designed to provide fuelwood and other wood products to nearby villages and towns. However, as the demand outstripped the supply, the sustainable management ceased to function. This has resulted in the supply sources, particularly in the plains, being over-exploited, and nowadays the area is virtually denuded.

Figure 7.4 Commercial charcoal stoves produced in Pathein of Ayeyarwady Delta

In 1983-84 the National Forest Survey and Inventory of Myanmar (NFSIM) carried out an inventory of 7 forest reserves which are also designated as woodfuel supply areas. The inventory covered an area of 99,964 acres. In total, 123 different tree species and 7 bamboo species were recorded in the area. The groups of the different tree species recorded in the survey are given in Annex VI while the standing stock of trees and bamboos in the area are shown in tables 7.4 and 7.5. However, not all of the species are used as woodfuel as already pointed out in chapter 3 (with a list of fuelwood species shown in Annex 1). The same is valid for bamboo where only 3 out of the 7 specie; *hmyin, thaik* and *wanwe* are used as fuel, mainly for evaporated milk production.

Table 7.4 Growing stock of trees in the study area.

Group	Girth (GBH) classes (in feet and inches)					
	2'-2' 11"	3' and over	Total	2'-2' 11"	3' and over	Total
	Number of trees			Quantity in stacked tons		
0	91,675	89,316	180,991	22,716	49,210	71,926
1	450,613	545,448	996,061	81,852	245,973	327,825
2	419,041	440,513	859,554	89,028	192,678	281,706
3	114,140	186,432	300,572	22,135	77,006	99,141
4	32,354	84,106	116,460	6,360	55,409	71,769
5	34,150	33,814	67,964	6,768	17,107	23,875
6	318,375	403,188	784,563	69,620	194,654	264,274
	1,523,348	1,782,817	3,306,165	298,479	832,037	1,130,516

On an area of close to 100,000 acres, the total standing stock was over 3.3 million trees with diameters of over 2 feet. The total volume was about 1.13 million stacked tons. Out of this, close to 1 million trees (or equivalent to 0.35 million stacked tons) consisted of fuelwood species. The density of trees identified as fuelwood species with diameters of over 2 feet, would then be about 10 trees per acre with a weighted volume of about 3.5 stacked tons.

For the total area classified as woodfuel reserve in the study area which covers about 61,500 acres (see table 2.1),the total amount of standing stock of fuelwood species would then be about 61,500 acres x 3.5 stacked tons or 215,250 stacked tons. This is equivalent to about 16.5 times higher than the average annual extraction target, of 13,125 stacked tons, over the last 5 years. However, fuelwood trees with diameters below 2 feet, have been excluded.

Table 7.5 Growing stock of bamboos in the study area.

Local name	Scientific name	Number of culms (,000)			
		1 yr.old	2 yr.old	3 yr.old	Total
Hmyin	Dendrocalamus strictus		1,926.70	774.55	4,831.27
Thaik	Bambusa tulda	2,130.02	329.19	338.87	939.15
Wa-myin	Bambusa griffithiana		67.77	96.82	203.32
Wanwe	Dinochloa m'clellandi	271.09	435.69	319.50	997.24
Thana-wa	Thyrostachys oliveri		1,278.01	1,394.20	4,037.36
Tin-wa	Cephalostachyum	38.73	38.73	38.73	96.82
Kyathaung	pergracile		4,163.22	4,579.54	12,044.29
	Bambusa polymorpha	242.05			
		1,365.15			
		19.36			
		3,301.53			
	Total	7,367.93	8,239.31	7,542.21	23,149.45

In the case of bamboo, the density of *hmyin, thaik* and *wanwe* culms worked out to be about 68 culms per acre. As bamboo is allowed to be cut without permit, the total area of forest reserves of 208,058 acres can be taken as the supply area which would have a standing stock of over 14 million culms of these three species. This would be sufficient to cover the supplies for the next 6 years. In this case young bamboos have not been taken into account.

In both cases of fuelwood and bamboo fuel, the supplies from unclassified forests(non-reserved forests) have also not been taken into account. Although no definite conclusion can be drawn, it appears that effective management and control measures as well as rehabilitation measures should be implemented for the areas concerned in order to maintain a sustainable supply of woodfuel, especially fuelwood, bamboo fuel and charcoal in the future.

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

(a) Adverse climatic conditions coupled with population pressure have resulted in the indiscriminate cutting of the forest cover of central Myanmar, transforming it into the resource poor zone. The situation is further aggravated by the existence of an expanding cottage industrial sector which depends, to a large extent, on woodfuels such as fuelwood, bamboo fuel, charcoal, sawdust, mill off-cuts etc., as well as agricultural residues, as sources of energy.

(b) To satisfy the demand for woodfuels and partly to deter further degradation of the arid zone, the Forest Department established village forests around the rural communities in the plains. At the same time it earmarked woodfuel supplies in the Yinmabin and Pyinyaung areas.

(c) Although grid electricity for domestic and industrial use is available, the supply is erratic and insufficient to satisfy the demand.

(d) The forest resource area of Yinmabin, produces a variety of biomass energy sources of which the most important are fuelwood, bamboo fuel and charcoal.

(e) The present woodfuel situation indicates that the demand exceeds the supply. This causes over-cutting beyond sustainable levels. Coupled with the low regeneration rates this, if left unchecked, may have a serious effect on the environment, the consumers and rural industrial development. Besides, the local economy may suffer due to the lack of alternatives for income generation and employment.

(f) Unless the Forest Department is assisted by all concerned sectors, in particular the agricultural, energy and industrial sectors, to cope with both the supply and demand mangement, it will face serious difficulties in preventing an irreversible degradation of the resource in the dry zone area.

(g) The income generated through woodfuel gathering is relatively high. And many young boys and girls are able to supplement their income from dry farming, quite substantially.

(h) The woodfuel traders, based in the villages of the supply centres, in general are much better-off than the woodfuel gatherers. However, income from the woodfuel trade is diminishing and, as a result, many have switched to other businesses.

(i) The increase in the petrol and related transportation prices has a negative influence on the woodfuel price. During the last five years, fuelwood prices increased by 29 percent and bamboo fuel prices increased by 50 percent, but the price of petrol increased by 58 percent.

(j) Based on the growing stock data collected by NFSIM, the present existing stock of fuelwood species is sufficient to satisfy the demand for another 16 years. In the case of bamboo, the stock is sufficient for 6 years. These figures are based on the assumptions that a) the present annual rates of cut are maintained, b) no regeneration nor regrowth and c) smaller diameter trees have been excluded.

(k) In order to reduce the demand on woodfuel more efficient fuel-saving stoves both for domestic cooking and for industrial applications have been or are being introduced by several concerned departments. However, the impact is still small.

8.2 Recommendations

The management activities, currently carried out by the Forest Department of Thazi Forest Township, in controlling a sustainable flow of woodfuel from the resource area can be considered satisfactory and systematic. Nevertheless, some improvements are necessary to ensure an even better management of the country's valuable forest and tree resources:

(a) The woodfuel deficit problem of central Myanmar should not be treated as a local problem but as a national problem because it has much broader development implications. As such, it should not be the responsibility of a single department. The Forest Department can not solve all the problems but needs more assistance and support from concerned sectors. A multi-agency approach involving the Myanmar Agriculture Service (MAS), the Department of Agriculture Mechanization (DAM), the Department of Energy Planning (DEP), the Myanmar Electric Power Enterprise (MEPE), etc. is considered vital to solving to the woodfuel and energy problems for the dry zone.

(b) Popular participation in forestry development should be encouraged wherever possible. The Forest Department, in order to ease the pressure on the resource area, should promote and develop community, village and private forestries in the vicinity of rural communities.

(c) Prior to entering in joint natural forest management schemes and/or developing community, village and private forests, a clear and well-defined policy with regard to forest- and tree products as well as privatization of the forest products and woodfuel trade needs to be drawn up. Available land should be leased to the community as well as to individuals who are interested and capable of carrying out local forestry development activities and woodfuel trade. Such a lease period should not be less than 20 years.

(d) The Forest Department should take initiatives and support the formation of local organizations at the village and community level to perform participatory forestry development activities. Besides the transfer of technology and material support (such as seeds and seedlings), trainings in participatory forestry are essential.

(e) The Forest Department should establish permanent forest nurseries in every township of the dry zone for the supply of seeds and seedlings at cost (no profit).

(f) People involved in such woodfuel/tree growing activities should be free to choose the species, manage the trees and plantations, harvest and/or dispose of the wood products without any restrictions.

(g) The Forest Department should, with a view to consolidating effective and systematic natural forest management, revise the expired working plan of Meiktila while the local supply working circle should also be reviewed. A re-assessment of the local supply reserves should be made by ground checking. The unproductive areas should be classified and be rehabilitated through artificial or controlled natural regeneration systems. Natural regeneration is preferable in areas where the performance of regrowth is satisfactory. For artificial regeneration, indigenous or fast growing exotic species with vigorous coppicing should be selected.

(h) *Hmyin*, a dry-soil type bamboo, is an important source of energy for cottage industries, in particular for the evaporated milk producers. The use of bamboo lessens to a certain extent the pressure on fuelwood use. As the rotation of bamboo is much shorter than tree species, and because only dried culms are collected, the management of bamboo is far easier. Providing a rest period of three years in a harvested-over area should be sufficient for its recuperation.

(i) In order to curb the demand for woodfuels, the introduction and dissemination of fuel efficient stoves, ovens, kilns, dryers and other more efficient energy conversion devices should be encouraged, promoted and strengthened. If needed, different models both for domestic and industrial use should be developed to suit different strata of end-users.

(j) There is only a limited amount of information and studies available with regard to woodfuel supply and demand for a particular area, a particular town or particular industries, etc. The lack of such critical information has made the development planning difficult. Therefore, more detailed studies of fuel deficit States and Divisions should be undertaken as soon as possible in order to develop a suitable approach to determine the fuelwood situation of the whole country.

(k) To promote energy conservation ethics and efficient use of scarcer woodfuel resources, there should be an action-oriented extension service in the Forest Department in collaboration with concerned departments to promote and coordinate the necessary work as well as to develop better linkages among different agencies concerned with the land based resource management and rural development.

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Annex I Selected fuelwood species in the Yinmabin and Pyinyaung areas

Fuel species		Average weight at 12% (m.c.)		
Local name	**Bolanical name**	**Kg/m^3**	**lbs/cft**	**Main use**
Than	*Terminalia oliveri* Brandis	895	56	Fw/Ch
Dahat	*Tectona hamiltoniana* Wall	879	55	Fw/Ch
Gyo	*Schleichera oleosa* (lour.) Merr.	1,087	68	
Kyun-gauk-nwe	*Vitex limonifolia* Wall.	991	62	
Thanbe	*Stereospermum neuranthum* Kurz.	655	41	Fw
Bebya	*Crotoxylon neriifolium* Kurz.	863	54	Fw/Ch
Te	*Diospros burmanica* Kurz.	1,119	70	Fw/Ch
Pyaukseik	*Holoptelea integrifolia Planch.*	639	40	Fw
Yinzat	*Dalbergia fusca*	--	--	Fw
Kuthan	*Hymenodictyon excelsum* Wall.	543	34	
Thitpalwe	*Balanites triflora* Van Tiegh	767	48	Fw
Zibyu	*Emblica officinalis* Gaertn.	831	52	Fw/Ch
Thitsanwin	*Dalbergia paniculata* Roxb.	639	40	Fw
Thitni	*Amoora rohitaka* W. & A.	639	40	Fw
Nibase	*Morinda tinctoria* Roxb.	--	--	Fw
Kazaw	*Myrsine semiserrata* Wall.	815	51	Fw
Chinyok	*Garuga pinata*	639	40	Fw
Nabe	*Lannea grandis* Engler.	559	35	Fw
Taung-gwe	*Eriolobus indica* Schn.	415	26	Fw
Kathit	*Erythrina suberosa* Roxb.	320	20	Fw
Bonmeza	*Albizia chinensis* (Osbeck.) Merr.	415	26	Fw
Didu	*Salmalia insignis* Schoot. & Endl.	495	31	Fw
Aukchinsa	*Diospros ehretioides* Wall.	703	44	Fw

Note: Fw = Fuelwood, Ch = Charcoal.

Annex II Measurements used in Myanmar and their international equivalents

Woodfuels are normally collected and sold by volume (stacked). Dimensions of the hand and arm are normally used. Units such as "*htwa", "taung"* and *"lan"* are the basic units accepted among the local fuel trading communities.

A *htwa* is the stretched-out length between the tips of the thumb and the middle finger.
A *taung* is the length between the tips of the elbow and the middle finger.
A *lan* is the length between the tips of the middle fingers when both arms are horizontally out-stretched.
A *pone* is a measure of 4 *taungs* in width, height and 1 *'taung'* in length (4*4*1 *taungs*).
A *lan pone* measures 1 *lan* in width, height and length (1*1*1 *lan*).

Myanmar measurements and their international equivalents

Type of fuel	Units (Myanmar)	Units (British)	Remarks
	Width x Height x Length	Width x Height x Length	
(A) Fuelwood			
1. Round billets or bondos	4 x 4 x 1 taung = 1 pone	6' x 6' x 1.5' = 54 cft or 1.08 tons (stacked volume)	Wood must be dry and 8"-12" diameter at the larger end of the billet. Mainly used in sugar houses, weaving factories, bakeries, lime burning and restaurants.
	8 x 4 x 2 taung = 1 lan	12' x 6' x 3' = 216 cft or 4.32 tons (stacked volume)	A three-ton truck has the capacity of 432 cft (2 lan) or roughly 8 tons (stacked volume). A six-ton truck holds 3 lan or roughly 12 tons (stacked volume). A large railway van can hold 9 lan or roughly 40 tons (stacked volume).
2. Round billets	8 x 2 x 2 taung = 1/2 lan	12' x 3' x 3' = 108 cft or 2.16 tons (stacked volume)	Used mainly in brick kilns. Billets are 3 feet long and at least 3 inch in diameter at the small end. May include assorted fuel species and the wood does not have to be dry.
3. Split billets and mill off-cuts	3 x 3 htwa in mid-girth and length	1.5' x 1.5' = 0.21 cft	Wood must be dry, consisting of 4-5 pieces per bundle. Used in household cooking, restaurants and tea-shops. A three-ton truck has the capacity of 300 bundles of split billets.
(B) Others			
1. Charcoal	3 baskets or 1 bag	90 lbs.	Used in household cooking, restaurants and tea-shops.
2. Saw-dust	1 basket	30 lbs.	Used in domestic cooking, blacksmithies and in institutions. Large sawmills sell sawdust on a truck-load basis. A three-ton truck has the capacity of 400 baskets.
3. Bamboo fuel	2 x 2 htwa in mid-girth x length	1.0' x 1.0'	Only thick-walled bamboos, consisting of 4-5 pieces per bundle. Mainly used in evaporated milk plants. A three-ton truck has the capacity of 5,000 bundles of bamboo fuel.
(C) Fuelwood and bamboo fuel	stacked ton	50 cft	

Annex III Socioeconomic status of biofuel gatherers and traders in the study area

HH NO.	Family size	Financial status												Remarks
		Income in kyats per year from			Expenditure in kyats per year on								Surplus + or deficit-(k)	
		Fuel trade	Others	Total	Food	Clothing	Health	Education	Social	Fuel	Others	Total		
(1) Hlaingdet Village:														
1	8	36000	180000	216000	79560	3600	1200	1800	1200	3240	1200	91800	+ 124200	Bamboo fuel traders
2	4	76200	72000	148200	48600	2400	2400	2400	1200	840	1200	80640	+ 67560	Bamboo fuel trader
3	3	15000	5100	20100	17448	1800	600	-	240	-	-	20088	+ 12	Bamboo fuel middle man
Average 5		42400	85700	12810	48536	2600	1400	8600	880	1360	800	64176	+ 63924	
1	7	27000	1000	28000	24420	600	1200	-	120	120	240	26700	+ 1300	Bamboo fuel gatherer
2	8	17280	4320	21600	22200	600	600	60	300	120	-	23880	- 2280	Bamboo fuel gatherer
3	2	21600	-	21600	20880	600	120	-	-	-	-	21600	-	Bamboo fuel gatherer
Average 5.6		21960	1773	23733	22500	600	640	20	140	80	80	24060	- 327	
(2) Thahtaygon Village:														
1	5	9180	3600	12780	10368	240	300	-	300	120	360	11688	+ 1092	Bamboo fuel middle man
2	6	13560	8400	21960	18000	600	600	240	600	120	240	20400	+ 1560	Bamboo fuel middle man
Average 5.5		11370	6000	17370	14184	420	450	120	450	120	300	16044	+ 1326	
1	6	2360	1200	24960	17280	600	120	360	600	240	360	1960	+ 5400	Bamboo fuel gatherer
2	6	11880	4800	16680	18000	240	1800	240	240	360	120	21000	- 4320	Bamboo fuel gatherer
3	4	11880	5400	17280	9900	600	1200	360	120	360	120	12660	+ 4620	Bamboo fuel gatherer
Average 5.3		15840	3800	19640	15060	480	1040	320	320	320	200	17740	+ 1900	

(continued Annex III)

HH NO.	Family size	Financial status												Remarks
		Income in kyats per year from			Expenditure in kyats per year on								Surplus + or deficit-(k)	
		Fuel trade	Others	Total	Food	Clothing	Health	Education	Social	Fuel	Others	Total		
(3) Yinmabin Village:														
1	9	48000	47640	95640	59400	6000	3600	1440	2400	3600	1200	77640	+ 18000	Fuelwood trader
2	10	21600	48000	69600	52800	6000	1200	420	600	2880	600	64500	+ 5100	Bamboo fuel middle man
Average 8.5		34800	47820	82620	56100	6000	2400	930	1500	3240	900	71070	+ 11550	
1	7	36000	6000	42000	37400	3600	60	-	600	600	-	42300	- 300	Fuelwood gatherer
2	8	36000	1200	37200	35040	1200	1200	720	600	600	-	39360	- 2160	Fuelwood gatherer
3	12	36000	19200	55200	45360	4800	240	360	720	600	-	52080	+ 3120	Fuelwood gatherer
Average 9		36000	8800	44800	39280	3200	500	360	640	600	-	44580	+ 220	
4	7	43200	20000	63200	48000	4800	300	120	600	600	-	54420	+ 8780	Bamboo fuel gatherer
5	2	18000	-	18000	14400	600	120	-	360	360	-	15840	+ 2160	Bamboo fuel gatherer
6	12	48000	7300	55300	4800	4800	1200	-	600	600	-	55200	+ 100	Bamboo fuel gatherer
Average 7		36400	9100	45500	36800	3400	540	40	520	520	-	41820	+ 3680	

(continued Annex III)

HH NO.	Family size	Financial status												Remarks
		Income in kyats per year from			Expenditure in kyats per year on								Surplus + or deficit-(k)	
		Fuel trade	Others	Total	Food	Clothing	Health	Education	Social	Fuel	Others	Total		
(4) Yebokson Village:														
1	6	17520	15700	33220	24400	3600	1200	720	1200	1200	-	32320	+ 900	Woodfuel trader
2	6	3840	46800	50640	38400	1200	3600	1200	1200	3600	-	49200	+ 1440	Woodfuel trader
3	8	22800	18000	40800	33000	720	300	2400	600	-	-	37020	+ 3780	Woodfuel trader
Average 6.6		14720	26833	41553	31933	1840	1700	1440	100	2400	-	39513	+ 2040	
1	3	17280	-	17280	1440	600	600	-	600	1200	-	17400	- 120	Woodfuel gatherer
2	9	45600	-	45600	37500	720	600	360	600	600	-	40380	+ 5220	Woodfuel gatherer
3	9	43200	-	43200	36600	1200	1200	720	600	1200	-	41520	+ 1680	Woodfuel gatherer
Average 7		35360	-	35360	25180	840	800	360	600	1000	-	33100	+ 2260	
(5) Kywetatson Village:														
1	5	6000	31200	37200	30000	600	600	600	1200	1200	600	34800	+ 2400	Charcoal producer
2	3	5000	9200	14200	15600	600	240	360	120	120	200	17240	- 3040	Charcoal producer
Average 4		5500	20200	25700	22800	600	420	480	660	660	400	26020	- 320	

Annex IV Woodfuel consumption in cottage industries and foodstalls in two urban centres

Type of cottage industry or foodstall	Meiktila					Thazi				
	Number	Fuel type used	Average consumption unit/month	Total consumption		Number	Fuel type used	Average Consumption unit/month	Total consumption	
				Per month	Per year				Per month	Per year
(A) Cottage industries										
1. Evaporated milk plants	23	Bamboo fuel	18,000 bundles	414,000	4,968,000	5	Bamboo fuel bundles	18,000	90,000	1,080,000
						5	Fuelwood	10	50	600
	10	Fuelwood	24 tons	240	2,880	-	-	-	-	-
2. Sugar-houses	7	Fuelwood	8 tons	56	672	-	-	-	-	-
3. Weaving factories	12	Fuelwood	2 tons	24	288	4	Fuelwood	2 tons	8	96
4. Bakeries/sweet factories	6	Fuelwood	4 tons	24	288	2	Fuelwwood	4 tons	8	96
5. Noodle-houses										
Total (A)	35	Fuelwood	Tons	344	4,128	11	Fuelwood	tons	66	792
	23	Bamboo fuel	Bundles	414,000	4,968,000	5	Bamboo fuel	bundles	90,000	1,086,000
(B) Food-stalls										
1. Restaurants	103	Fuelwood	3 tons	309	3,708	17	Fuelwood	3 tons	51	612
2. Noodle-shops	50	Charcoal	2 tons	100	1,200	15	Charcoal	2 tons	30	360
		Fuelwood	0.5 ton	25	300		Fuelwood	0.5 ton	7.5	90
3. Tea-shops	70	Charcoal	2 tons	140	1,680	14	Charcoal	2 tons	28	336
		Fuelwood	0.5 ton	35	420		Fuelwood	0.5 ton	7	84
4. Fried food-stalls	70	Fuelwood	1 ton	70	840	9	Fuelwood	1 ton	9	108
Total (B)	293	Fuelwood & Charcoal	Tons	679	8,148	55	Fuelwood & Charcoal	tons	132.5	1,590
Total (A)+(B)	328	Woodfuel	Tons	1,023	12,276	66	Woodfuel	Tons	198.5	2,382
	23	Bamboo fuel	Bundles	414,000	4,968,000	5	Bamboo fuel	Bundles	90,000	1,080,000

Annex V Percentage share of the annual cost of woodfuel in the expenditure of urban households of Meiktila and Thazi

HH NO:	Family size	Expenditure in kyats per year on								Fuel consumed		Remarks
		Food	Clothing	Health	Education	Social	Woodfuel	Others	Total	Quantity (stacked ton)	% of total expenditure	
I. Meiktila												
1	6	21000	3600	3600	1344	600	1800	360	32304	5.8	5.6	Charcoal & electricity user
2	7	48000	1200	2400	1200	600	4260	600	58260	5.4	7.3	Woodfuel (bundles) & charcoal user
3	4	15324	2400	600	1200	480	528	200	20732	1.5	2.5	Saw-dust/mill offcuts user
4	7	45000	3600	360	2400	600	3120	250	55330	5.6	5.6	Woodfuel (bundles) user
5	4	9600	600	240	240	120	-	240	11040	1.5	-	Mesquite-fuel user
6	6	31200	3600	600	18000	1200	3360	1260	59220	7.7	5.7	Charcoal user
7	12	55680	4800	4200	24000	2400	4320	1200	96600	15.4	4.5	Charcoal user
8	5	31080	2400	2400	6000	1200	3900	720	47700	9.6	8.2	Charcoal user
9	4	20400	3000	840	1200	600	1369	360	27769	1.8	4.9	Woodfuel (bundles) user
10	4	27252	3600	2400	6000	1800	1980	600	43632	5.8	4.5	Charcoal user
Average	5.9	30454	2880	1764	6158	960	2463	579	45258	6.1	4.8	

(continued Annex V)

HH NO:	Family size	Expenditure in kyats per year on								Woodfuel consumed		Remarks
		Food	Clothing	Health	Education	Social	Woodfuel	Others	Total	Quantity (stacked ton)	Share cost in % of total expenditure	
II. Thazi												
1	9	39600	600	240	600	360	2400	600	44400	7.7	5.4	Charcoal user
2	3	15000	600	600		120		360	16680	1.0	-	Woodfuel collector
3	10	53100	1200	600	600	600	3600	600	60300	3.5	6.0	Woodfuel user (bundles)
4	6	22600	1200	600	650	600	2400	600	28650	1.9	8.4	Charcoal electricity user
5	9	33600	2400	600	1200	600	2280	600	41280	1.9	5.5	Charcoal Electricity user
6	5	42400	1200	1200	-	600	3600	600	49600	3.5	7.3	Woodfuel user (bundles)
7	3	12480	600	600	1200	240	1140	240	16500	1.9	6.9	Charcoal electricity user
8	7	26040	1200	600	1200	240	1080	240	30600	1.4	3.5	Woodfuel bundles & electricity user
9	8	22776	1200	600	3600	600	1800	450	31026	2.1	5.8	Woodfuel (bundles) user
10	8	54660	3600	4000	1200	1200	-	1200	65860	2.1	-	Woodfuel (bundles) user & recutting mill owner
Average	6.8	32225	1380	964	1025	516	1830	549	38489	2.7	4.8	

Annex VI Tree species and groups recorded by the National Forest Survey and Inventory of Myanmar (1983 - 84)

Group no. and no. of species		Species	
		Local name	Botanical name
0	1	*Kyun*	*Tectona grandis*
I	5	*Pyinkado*	*Xylia dolabriformis*
		Ingyin	*Pantacme siamensis*
		Padauk	*Pterocarpus macrocarpus*
		Tamalan	*Dalbergia oliveri*
		Thitya	*Shorea oblongifolia*
II	12	*Binga*	*Mitragyna rotundifolis*
		Hnaw	*Adina cordifolia*
		In	*Dipterocarpus tuberculatus*
		Kokko	*Albizzia lebbek*
		Sagawa	*Michelia champaca*
		Thadi	*Protium sarrata*
		Thinwin	*Milletia pendula*
		Thit-magyi	*Albizzia odoratissima*
		Thitsi	*Melanorrhoea usitata*
		Yemane	*Gmelina arborea*
		Yindaik	*Dalbergia cultrata*
		Yinma	*Chukrasia tabularis*
III	13	*Panga*	*Terminalia chebula*
		Pyinma	*Lagerstromia speciosa*
		Sandawa	*Cordia fragrantissima*
		Taukkyan	*Terminalia alata*
		Taukkyan	*Terminalia tomentosa*
		Taukkyan-ywet they	*Terminalia crenulata*
		Taung-thayet	*Swintonia floribunda*
		Taw-thayet	*Mangifera caloneura*
		Thabye	*Eugenia spp.*
		Tharapi	*Calophyllum kunstleri*
		Thit-e	*Castanopsis spp.*
		Yingat-gyi	*Gardenia coronaria*
		Yon	*Anogeissus acuminata*
IV	7	*Baing*	*Tetrameles nudiflora*
		Chinyok	*Garuga pinnata*
		Didu	*Salmalia insignis*
		Gwe	*Spondias pinnata*
		Letpan	*Salmalia malabarica*
		Nabe	*Lennea grandis*
		Wetshaw	*Firmiana colorata*

(continued Annex VI)

Group no. and no. of species		Species	
		Local name	Botanical name
V	6	*Kuthan*	*Hymenodictyon excelsum*
		Kyunbo	*Premna pyramidata*
		Leza	*Lagerstroemia tomentisa*
		Myaukchaw	*Homalium tomentosum*
		Pyaukseik	*Holoptelea integrifolia*
		Tayaw	*Grewia tiliaefolia*
VI	78	*Aukchinsa*	*Diospros ehretioides*
		Bambwe	*Careya arborea*
		Bebya	*Cratoxylon neriifolium*
		Bwegyin	*Bauhinia variegata*
		Chinbyit	*Bauhinia malabarica*
		Dahat	*Tectona hamiltoniana*
		Daukyat-gyi	*Helicia erratica*
		Gyo	*Scleichera oleosa*
		Gyok	*Diospros montana*
		H maik	*Cordia grandis*
		Kabaung	*Strychnos nuxblanda*
		Kathit	*Erythrina suberosa*
		Kyaung-dauk	*Pajanelia rheedii*
		Kyetyo	*Vitex pubescens*
		Kyun-gauk-nwe	*Vitex limonifolia*
		Kyun-nalin	*Premna latifolia*
		Laukya	*Schima wallichii*
		Lein	*Terminalia pyrifolia*
		Lettok-gyi	*Holarrena antidysenterica*
		Lettok. thein	*Wrightia tomentosa*
		Lezo-byu	*Lagerstroemia calyculata*
		Linyaw	*Dillenia parviflora*
		Lumbo	*Buchanania lanzan*
		Madama	*Dalbergia ovata*
		Ma-hlwa	*Markhamca stipulata*
		Momaka	*Salix tetrasperma*
		Mondaing-bin	*Lophopetalum wallichii*
		Myasein	*Parkinsonia*
		Myauk-okschit	*Michocarpus pentapetalus*
		Nagye	*Pterospermum semi-sagittum*
		Naywe	*Flacourtia catahracta*
		Ngu	*Cassia fistula*
		Nibase	*Morinda tinctoria*
		Nyaung	*Ficus spp.*
		Okshit	*Aegle marmelos*
		Palan	*Bauhinia racemosa*

(continued Annex VI)

Group no. and no. of species	Species	
	Local name	Botanical name
	Peinne	*Artocarpus heterophyllus*
	Pet-wun	*Berrya spp.*
	Petthan	*Haplophragma ade. nophyllum*
	Pin-tayaw	*Grewia elatostemoides*
	Seikchi	*Bridelia retusa*
	Sha	*Acacia catechu*
	Shaw	*Sterculia spp.*
	Sin-kozi	*Helicia terminalis*
	Taw-thabut	*Polyalthia simiarum*
	Te	*Diospros burmanica*
	Tein	*Mitragyna purvifolia*
	Thabut-gyi	*Miliusa velutina*
	Than	*Terminalia oliveri*
	Than that	*Albizzia luccida*
	Thanat	*Cordia dichotoma*
	Thanatka	*Linonia acidissima*
	Thanbe	*Stereospermum neuranthum*
	Thande	*Storeospermum personatum*
	Thapan	*Ficus glomerata*
	Thayet	*Mangifera indica*
	Thetyin-gyi	*Croton oblongifolius*
	Thinwin-bo	*Millettia pubinervis*
	Thinwin-pyu	*Pongamia pinnata*
	Thit-pagan	*Millettia brandisiana*
	Thit-palwe	*Balanites triflora*
	Thit-payaung	*Neonauclea excelsa*
	Thitkya	*Juglans regia*
	Thitmin	*Podocarpus wallichianus*
	Thitni	*Amoora rokituka*
	Thit pok	*Dalbergia kurzii*
	Thitsanwin	*Dalbergia paniculata*
	Thitsein	*Terminalia belerica*
	Titswele	*Schrebera swietenoides*
	Yingu-akyi	*Quercus helferiana*
	Yingu-athe	*Quercus mespilifolia*
	Yinzat	*Dalbergia fusca*
	Ywe-gyi	*Adananthera pavonia*
	Zaungbale-ywet-gyi	*Lagerstromia venusta*
	Zaung-gyan	*Osyris wightiana*
	Zaungbale	*Lagerstroemia villosa*
	Zibyu	*Emblica officinalis*
	Zinbyun	*Dillenia pentagnya*
123	*Others*	