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REPORT

THE NATIONAL TRAINING WORKSHOP ON WOODFUEL TRADE IN MYANMAR

Forest Research Institute, Yezin
27 - 30 November 1996

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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FOREWORD

In 1990, fuelwood accounted for some 80% of total energy consumption in Myanmar, equivalent to about 20,000 tons. Since then, the consumption of fuelwood has increased, and this trend is likely to continue in the coming years. Though the country is known for its vast forest resources, in populated areas scarcities of fuelwood are severe and basic fuel needs are not satisfied, particularly in the Dry Zone. The flow and trade of woodfuels in the country may be a key element of balancing supply and demand.

RWEDP has for many years cooperated with the Forest Department of Myanmar, which in 1992 resulted in a programme for the introduction of improved stoves. In the same period, a study was undertaken on 'Woodfuel Flows in the Dry Zone of Myanmar' (see RWEDP Field Document No. 39, published in 1993). When the government of Myanmar declared 1995 the Year of Fuelwood Substitution, RWEDP contributed to the national effort by giving expert advice on technologies for densification of biomass residues for fuels. Furthermore, throughout the years, delegates from Mynamar have been active contributors to regional workshops and expert consultations on various aspects of wood energy development.

The National Training Workshop on Woodfuel Trade in Myanmar, organized by the Forest Department in 1996 at Yezin, was supported by RWEDP and built on previous experiences as well as presented new studies. The National Workshop also extended the concepts of the Regional Course on Trade in Woodfuel-related Products, organized by RWEDP in 1995 at Peshawar, Pakistan (see RWEDP Report No. 25). More than a hundred participants attended the National Workshop at Yezin, of which the present report gives an account. The report will be of interest not only to the many staff involved in Myanmar itself, but also to experts in other RWEDP member-countries. Thanks are due to the Myanmar Forest Department and to Mr. Tara Bhattarai, Wood Energy Resources Specialist at RWEDP, who assisted in the preparations and overviewed the publication.

The sincere efforts of all those involved may contribute to satisfying the needs of the many rural people who partly or wholly depend on wood energy resources for their livelihoods.

Dr. W. S. Hulscher,
Chief Technical Adviser
FAO/RWEDP

PREFACE

Myanmar has faced woodfuel shortages in some areas of the country since 1950. Initially the scale of the problem was small and generally went unnoticed, even by the country's foresters. However, in recent years the problem has become so acute that unless urgent and appropriate action is taken by the responsible authorities, the country's forest resources will continue to dwindle and may even disappear entirely.

The rural people, who form the majority of Myanmar's population, are partly or wholly dependent on forest resources for their livelihoods. The woodfuel crisis is, therefore, essentially a crisis of the rural poor, and as such cannot be separated from other subsistence related crises, which combine to jeopardise the country's development.

The woodfuel crisis has become too severe to be competently handled by the Forest Department alone, given the available resources allotted to it. The task of restoring the debilitated ecosystem is too enormous a burden to be shouldered by a single agency. Authorities at all levels should realize and be genuinely aware of the depth and gravity of the situation and all ministries concerned should co-ordinate and pool their resources and make a concerted effort to solve the socio-economic and environmental problems that constitute the woodfuel crisis.

Full state support is necessary for the successful rehabilitation and restoration of the debilitated forest resources and ecosystem. Unless, the state and the people as a whole can combine their resources an important part of the country's national heritage will ultimately be lost. Let us be fully aware of the historical evidence that civilizations have become extinct because of the mismanagement of their soil and natural resources. Let all those who are genuinely concerned about this crisis pool their resources, whether from home or abroad, and facilitate full co-ordination of all management efforts pertaining to local assessments, local participation, privatization, and decentralization. A multi-disciplinary approach and a flexible social organization should also be supported and promoted.

The National Training Workshop on Woodfuel Trade in Myanmar organized by the Forest Department in co-operation with the Regional Wood Energy Development Programme was an ideal opportunity for the country's governmental and non-governmental organizations to review the prevailing woodfuel situation of the country and to make recommendations essential for the preparation of an effective future action plan to improve the Wood Energy Development Programme in Myanmar.

Director General
Forest Department
Myanmar

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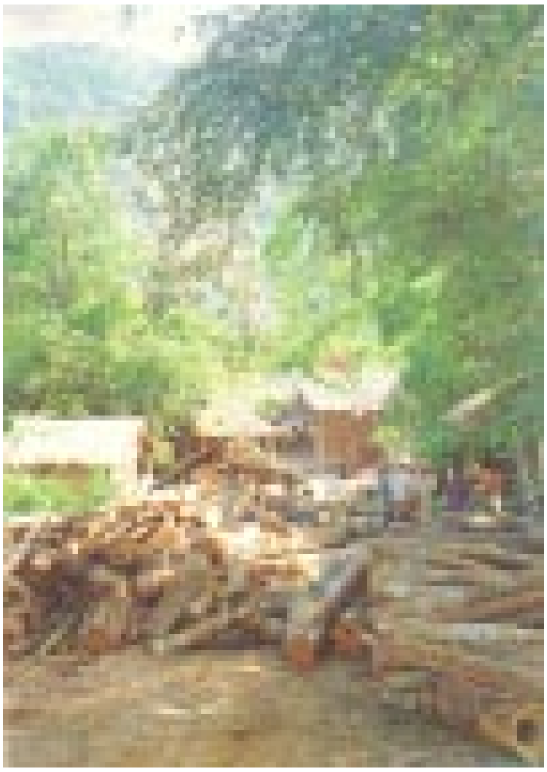

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1. INTRODUCTION

1.1 Background

Woodfuel remains the dominant energy source for the majority of the people in Myanmar. Though more than half of the total land area of the country is covered by forests, the forest cover is generally very sparse in the thickly populated areas where rapid rates of forest degradation and depletion have occurred due to the heavy demand on forest products, including woodfuel, and other causes associated with population pressure. The result is an acute woodfuel shortage problem.

In order to narrow the gap between the demand and supply of woodfuel in the woodfuel deficit areas, the Forest Department is implementing remedial measures such as increasing the annual acreage of woodfuel plantations, encouraging the formation of village owned woodlots and fuelwood plantations, accelerating a nation-wide tree planting programme, and introducing energy saving cookstoves. A woodfuel substitutes programme is also being implemented. The success of these remedial measures requires proper planning for which correct data and up-to-date information are essential.

Although the Forest Department is one of the main agencies responsible for woodfuel production, the co-operation of other governmental and non-governmental organizations and private individuals who are engaged in woodfuel extraction, processing, transportation, marketing and utilization is needed to improve the present woodfuel situation in the country. It must be recognised, however, that the achievement of such concerted efforts will be extremely difficult.

1.2 Objectives

a) To review the present system of woodfuel production, distribution, marketing and utilization in some specific study areas.
b) To exchange information and experiences among the representatives from various parts of the woodfuel deficit areas.
c) To recommend appropriate policies and strategies for the improvement of the woodfuel situation in Myanmar.

1.3 Workshop Implementation

The National Training Workshop on Woodfuel Trade in Myanmar was held from 27 to 30 November, 1996 at the auditorium of the Forest Research Institute, Yezin, Myanmar. The Workshop was attended by 42 participants and 69 observers including Directors-General, Advisors, Rector, Directors, Professors, Deputy Directors, Assistant Directors, Senior and Junior Researchers, and other ranks from the various departments under the Ministry of Forestry, the Ministry of Science and Technology, and various non-governmental organizations.

1.4 Opening Session

The Workshop was inaugurated by U Soe Tint, Director-General, Planning and Statistics Department Ministry of Forestry and by Mr. K. P. Upadhyay, Resident Representative a.i. of FAO. The full texts of their inaugural addresses are contained in Part 3 of this report.

1.5 Technical Session/Case Studies

The technical session (held on the 27th and 28th November) was opened with the paper "A framework for woodfuel flow studies: A study of the marketing and distribution of commercial wood energy" prepared by Mr. Conrado S. Heruela. It was read by U Mehn Ko Ko Gyi, Director of the Forest Department, on behalf of Mr. Heruela who was unable to attend. This paper identifies the most important variables that should be covered in a woodfuel flow study and the data requirements for such a study. An annex to the paper contains a suggested format for the terms of reference for a woodfuel flow study for urban areas.

The technical session continued with the presentation of 7 case study reports. Summaries of these are presented below and the full text of the papers can be found in Part 2 of this report.

1.5.1 Wood Energy in Myanmar

(U Khin Maung Nyunt and U Soe Tint)

During the 14 year period from 1975 to 1987, the actual forest cover of Myanmar degraded (or reduced) at the rate of 0.64% annually, or by a total of 543,600 acres (about 220,000 ha). The rate of degradation of the country's mangrove forests in the Ayeyarwaddy Division was even greater. These covered an area of 1,190,000 acres (481,593 ha) in 1974 and 880,000 acres (356,136 ha) in 1990. This amounts to a loss of 310,000 acres (125,457 ha) of mangrove forests within a period of 16 years with an average anual loss of 19,375 acres (7,841 ha) or 1.63 % per year. Thus, the annual rate of loss of mangrove forest cover was 2.5 times the rate of loss of total forest area in the country. The rapid depletion of the country's forest resources has resulted in considerable hardship for the people of Myanmar, particularly for the women and children who have to spend a large portion of their time gathering fuelwood for domestic use.

The authors undertook a survey of household woodfuel consumption in 7 townships: Yamethin, Meikhtila, Myingyan, Chauk, Magway, Pyay, and Pathein. It was found that an average household of approximately 5 persons consumed 6.27 cu tons of biofuel per year. A rural person on average consumes more than a ton of fuelwood per year. The recorded data on woodfuel consumption by the Forest Department 's Planning and Statistics Division was 19 million cu tons per year for the whole country, with a projected consumption of 20 million cu tons per year in 2000-2001.

The annual fuelwood supply from the country's forest plantations amounts to 0.068 million cu tons, supplies from roadside and perimeter plantations amount to 2.00 million cu tons, while fuelwood supply from tops and lops amounts to 0.21 millions tons, altogether totalling 2.278 millions cu tons. The remaining 17.72 cu tons (20 - 2.28 = 17.72) would have to be provided from the country's natural forests. But the Myanmar Energy Sector Investment and Policy Review Mission (World Bank, 1992) estimated that to remain sustainable, Myanmar's natural forests could produce only 18.47 million ADT or 13.12 million cu tons of fuelwood. Thus, there would be an annual deficit of 4.6 millions cu tons of fuelwood for the country.

To fulfil the annual current deficit of 4.6 millions cu tons of fuelwood, the Forest Department should implement the following measures:

- establish fuelwood plantations on a massive scale so as to be able to supply the fuelwood and charcoal needs of the population

- encourage rural communities to establish their own fuelwood plantations to meet their fuelwood needs. Ideally they should be able to market fuelwood to neighbouring areas. The community forestry approach should be vigorously implemented, aided by both the Forest Department and the state which should recognise the gravity of the woodfuel crisis. Priority should be given to the successful implementation of these operations

- enlarge the Extension Branch of the Forest Department by providing it with sufficient funds to educate the rural and urban populations on the woodfuel crisis and its adverse affect on the socio-economic progress of the whole country. Those who are in a position to influence the development of woodfuel production should be specifically targeted

- endeavor to use alternative energy sources and introduce new conventional and non-conventional energy technologies.

1.5.2 Woodfuel Flow/ Marketing from Pyinmana to Yangon: A Case Study

(U Saw Kelvin Keh)

The study area is approximately 600 square miles or 384,000 acres and consists of the areas along the Pyinmana-Taungdwingyi trunk-road up to Moswe (27 miles from Pyinmana) and the adjoining forest reserves (up to 15 miles from either side of the trunk road) such as Kaing Reserve, Taungnyo Reserve and Ngalaik Reserve.

Over 30 years ago the area under study was fully forested and there was little or no woodfuel marketing from Pyinmana to Yangon. Now in 1996, the area has become degraded due to the excessive extraction of timber and woodfuel. In 1959, a bag of charcoal cost K 4 while in 1985, it was K15. In 1996, it had risen, exorbitantly, to K150.

The price-rise is partly due to inflation, partly due to the woodfuel marketing to Yangon and partly due to the woodfuel scarcity. This of course exerts severe socio-economic stress on the poorer sections of the rural population and has led to the migration of these groups from fuel deficient areas to fuel sufficient areas where their livelihoods can comfortably be sustained. Furthermore, this process of overtaxing the country’s forests or reserves due to excessive marketing of timber and woodfuel to other areas, particularly Yangon, has resulted in a shrinking annual yield and a reduction in the country's total AAC (Annual Allowable Cut) of economic species. If this situation continues unabated the degradation and ultimate denudation of the country’s forests will result.

At present, the woodfuel market from Pyinmana to Yangon is thriving with an annual export to Yangon varying from 11, 311 tons of charcoal to 28, 948 tons based on 1991 to 1996 data. This is, of course, only the recorded data and the figure for the unrecorded data may be as much as ten times that of the recorded data (Hau Saw, 1990). If so, this would amount to 289,480 tons of charcoal and this, it must be stated, is only a very conservative estimate. This export figure excludes the amount consumed by the Pyinmana township which would amount to 193,000 tons of firewood annually, taking into consideration that each person consumes 1 ton of firewood a year and the Pyinmana population is 193,000 (National Academy of Sciences, 1980, 1983). In another 10 or 12 years time Pyinmana township will become a woodfuel crisis area if this trend continues, especially as the number of poor rural people, who are totally dependent on the forest for their livelihoods, is increasing day by day. Charcoal markets to Yangon from other townships are also increasing year by year although the recorded data may show otherwise.

A co-ordinated approach to management including local assessments, local participation and a multi-displinary approach and effective social organization should be vigorously planned and implemented. Extensive planting of *Acacia mangium* is advocated in the high rainfall area as well as in Yangon and its environs. Decentralization in the sense of systematic allotment of forest lands to poor rural people living adjacent to the forest is advocated along with appropriate inputs provided by the government during the first 2/3 years of the development project. Full technical support by the Forest Department should be provided until the rural population involved in the project become self-supporting.

1.5.3 The Dissemination of the A-1 Fuelwood Cookstoves

(U Win Kyi and U Win Oo Naing)

The improved fuelwood cookstove which was recently named the “A-1” was designed and tested at the Forest Research Institute, Yezin in 1991.

To discover the efficiency of these stoves 432 stoves were sold out of 40 villages in the nearby Yezin region. After periods ranging from one to three years, evaluations in the study area indicated that the average saving of fuelwood consumption was about 40 percent compared to the traditional open-fire cookstoves.

The stove gained popularity and the Nine Critical Districts Greening Project, the Community Multipurpose Fuelwood Woodlots Project, the Watershed Management Project and the Township Law and Order Restoration Councils from the Dry Zone and the middle part of Myanmar ordered thousands of A-1 stoves. In response, the FRI tried to initiate a mass production programme. This programme was started in October, 1994 at the FRI and by the end of September, 1996 about 25,000 A-1 stoves had been produced and sold.

To disseminate these stove all over the country, several training sessions on making A-1 stoves were also held at the FRI, Yezin. Based on the techniques learned from the training, some private entrepreneurs from Tetkone, Pyinmana, Thazi, Salin, Taungdwingyi, Chaungoo, Kyaukpadaung, Pathein, Pindaya, Inlay and Na-hto-gyi are now producing these A-1 stoves.

A field study was carried out at the places mentioned above and data were collected on the total number of A-1 stoves produced, the name of the regions to which they were disseminated, and the quality of the stoves.

The total number of stoves disseminated to various regions of Myanmar, up to the end of September, 1996, was found to be about 99,400.

By using 99,400 A-1 stoves, 99,400 households can save nearly half of their money for buying fuelwood or can save nearly half of their time for gathering fuelwood. On the other hand, the Forest Department can save about 5,851 ha of fuelwood plantations.

The greater the number of A-1 stoves used the more the consumption of fuelwood will be reduced, thereby lessening the threat to the country's forests.

1.5.4 Woodfuel Position with Particular Reference to Mangrove Areas in Myanmar

(U Ohn)

About 35% of the world's mangroves are found in the South East Asian countries of Malaysia, Thailand, Myanmar, Indonesia, Singapore, Cambodia and Vietnam. However, due to the absence of sustainable management, it is estimated that 30% - 40% of the region's mangroves have already been lost.

Rapid depletion and degradation of mangroves in South East Asia, particularly in Myanmar, are due to (i) reclamation and conversion of mangroves into industrial and housing complexes, aquaculture and agriculture sites, tourist resorts and beach improvements; (ii) uncontrolled and unsustainable use of mangroves for domestic, agricultural and fishery related uses, and for fuelwood and charcoal; (iii) upstream watershed deforestation and the resulting increase in nutrient and pollutant loads downstream and (iv) reduction of available water to mangroves due to uncontrolled damming and irrigation activities.

The mangrove area is continuing to shrink due chiefly to fuelwood consumption (78.3%) and conversion to charcoal (5.8%) (total woodfuel consumption = 84.1%). The high incidence of woodfuel use indicates a very adverse affect on the growing stocks of mangrove forests, some of which are no longer productive or are now totally depleted. Unless other woodfuel substitutes can be introduced this trend will continue, endangering the country's forests and the environment. The amounts of woodfuel flown to Yangon from the various states and divisions, as estimated by a World Bank Team in 1990, are as follows:

Ayeyarwaddy Div .	1.2 million tons
Rakhine Div	0.1 million tons
Tanintharyi Dif	0.1 million tons
Bago Div	0.2 million tons
Magway Div	0.2 million tons

The 1996 figure for consumption of woodfuel esdimated by the Ministry of National Planning and Economic Development is 32.943 million cubic tons. To replenish the depleting woodfuel stocks from the country's forests, an annual planting of bioenergy plantations amounting to 36,800 acres (14,893 ha) is being carried out, amounting to 40% of the total annual planting area of 92,000 acres (37, 232 ha). There is an urgent need to increase bioenergy planting on a massive scale so as to ensure that the future woodfuel requirement for the whole country can be met.

A concerted effort and co-ordinated programme to restore the potentially renewable and vital mangrove ecosystem should be implemented.

Social forests, community forests and farm forests should be established/ enlarged, to the extent that they can export woodfuel to neighbouring fuel deficient areas.

1.5.5 Output of Fuelwood Species and Some Experimental Findings on Fuelwood Production

(U Sann Lwin, U Khin Maung Oo, U Kyaw Than and U Mya Win)

The paper mainly deals with the output volume of some fuelwood species planted in Pyinmana, Yamethin and Yedashe townships between 1983 and 1990. It also provides some other basic technical information relating to the formation and production of fuelwood plantations based on the experimental research carried out by FRI during the last 15 years.

To prevent the fuelwood shortage reaching crisis proportions the Forest Department launched a large scale village supply fuelwood plantation programme in the fuelwood deficit regions in the early 1970s, and the Forest Research Institute conducted a series of experimental research activities in order to introduce appropriate technologies in the fields of site selection, choice of species, nursery practices, planting techniques, tending operations etc.

The species selected for output volume studies include *Eucalyptus comaldulensis; Leucaena leucocephala; Albizzia lebbek; Albizzia procera; Acacia catechu; Acacia auriculiformis; Acacia senegal; Cassia siamea; Tectona hamiltoniana* and *Acacia holosericea*, which are commonly used in fuelwood plantations in Myanmar. Those species are planted in 3 different townships with 3 different spacing regimes such as 10' x 6' (3m x 1.8m), 8.5' x 8.5' (2.6m x 2.6m) and 12' x 12' (3.7m x 3.7m). The ages of the plantation at the time of volume measurement vary from 6 years to 13 years old. Consequently the solid volume of those species ranges from 14.3 Hoppus ton per acre (63.7 m^3 per hectare) to 85.5 Hoppus ton per acre (380.8 m^3 per hectare) with the mean annual increment (M.A.I.) varying from 1.2 Hoppus ton per acre (5.3 m^3 per hectare) to the highest 9.1 Hoppus ton per acre (40.7 m^3 per hectare). Among the species studied, *Eucalyptus comaldulensis, Leucaena leucocephala, Albizzia lebbek,* and *Albizzia procera* are the most promising ones for the study areas.

Issues and suggestions

The Forest Department has increased its annual planting acreage of village supply forest plantations from about 27,700 acres (11,200 ha) in 1993 to 31,600 acres (12,800 ha) in 1994 and 34,100 acres (13,800 ha) in 1995. In establishing such large scale fuelwood plantations, a proper planning stage is as important as the implementation, monitoring and evaluation stages. There are a few factors which should be thoroughly considered at the planning stage and some of which may require experimental research. As those research findings will be helpful as guidelines, or at least as a reference for the future implementation of programmes, the research should be conducted jointly by researchers and territorial staff.

1. Improve awareness of the direct and indirect benefits of local supply fuelwood plantations.

Extension services are needed to make the local people become convinced of the direct and indirect benefits of local supply fuelwood plantations such as providing fuelwood for daily cooking and heating, small timber, posts and poles for housing and making agricultural implements, job opportunities and additional income for upgrading their living standards, windbreak for protection and improvement of the production of agricultural crops. Cost-benefit analysis of the fuelwood plantations and studies of the impact of the fuelwood plantations on the social problems of the local people may provide results that could help the extension services to gain the active participation and full co-operation of the local people in the implementation of the fuelwood plantation programme.

2. Carefully select the planting site.

There are vast amounts of denuded and degraded forest land, abandoned old *taungya* (shifting cultivation) land and other vacant lands which are to be rehabilitated throughout the country. The sites for the fuelwood plantations should, generally speaking,

a) be in the vicinity of the villages with acute fuelwood storage problems.
b) be accessible to the villagers for their participation, implementation, supervision, protection and harvesting at minimal cost.
c) have soils with at least the minimum quantity of physical and chemical properties required for forest tree growth.

Socio-economic surveys of the local areas and studies of the physical and chemical properties of the soil of the site should be carried out prior to any other activity.

3. Chose fuelwood species according to the characteristics of a given site

It is of prime importance to choose the most suitable species for a given site depending on its annual rainfall, rainfall distribution pattern, temperature, soil conditions etc. Multipurpose species are preferable to provide the local users with additional materials for use in their agricultural and fishery related activities and handicrafts. Site-species matching experimental research should be carried out in different localities and non-commercial tree species should also be improved.

4. Ensure proper nursery practices, planting techniques and tending operations.

The degree of success of any forest plantation partially depends on:

a) availability of good quality seeds.
b) proper seed storage.
c) correct pre-treatment of seeds for improved germination (in terms of both quantity and quality).
d) proper planting techniques to ensure better growth and higher survival rates.
e) timely and efficient tending operations for faster growth and larger output.

In order to improve the degree of success of all aspects of a forest plantation, a proper research programme should be carried out in consultation with the local territorial staff who will be the end users.

5. Apply proper silvicultural systems and economic harvesting techniques with appropriate rotation ages.

Silvicultural systems such as coppice, coppice with standard or agro-forestry system and harvesting techniques such as clear felling, strip felling or felling on coppice with standards should be adopted beforehand depending on the site. The appropriate rotation age should also be fixed based on the objective of the plantation, utilization, species used, site quality, market demand etc. A long-term forestry research plan is needed to improve plantation forestry management.

1.5.6 The Role of Non-forest Areas in Woodfuel Production

(U Soe Myint)

The study area comprised the Dry Zone of Myanmar which is situated in the middle of the country. It covers 27,075 sq miles and its land uses by category are as follows :

Forest land	9,139	square miles	34%
Agricultural land	11,092	"	41%
Marginal land	1,615	"	6%
Other land	5,193	"	19%
Total	27,075	"	100%

It is one of the most densely populated areas of the country with a density of 347 people per square mile -- about triple the national average. The dense population and the meagre forest areas with stunted growth due to the severe adverse climate of the area have created an acute shortage of fuelwood.

It is estimated that the annual current consumption of biomass fuel in the study area is 8.01 million cubic tons, of which 2.16 million cubic tons (27%) are fuelwood from non-forest areas and 2.64 million cubic tons are from crop residues from agriculture lands.

Both reserved and non-reserved forests have been seriously degraded due to over-exploitation for fuelwood and the lack of effective protection and proper management. To compensate for the shortfall in the fuelwood supply numerous plantations have been established with fast growing species since 1963. The total number of plantations in the whole of the Dry Zone up to 1995 amounted to over 300,000, out of which 169,550 are village supply plantations which were established to meet local needs. Most plantations have so far played a relatively minor role in fuelwood supply as they are primarily being maintained to provide amenities and for greening purposes.

Fuelwood from the non-forest areas such as homesteads, farm boundaries, marginal and waste lands, village woodlots etc. contributes about 40% of the current total fuelwood consumption of the study area, i.e. 3.21 million cubic tons. Increasing fuelwood production in non-forest areas appears highly promising, and could be carried out by planting multipurpose trees within an agroforestry system and by emphasizing people’s participation.

The fuelwood harvesting systems of the Dry Zone area are pollarding, coppicing and pruning. The authors recommend that:

- degraded natural forests must be rehabilitated urgently to increase fuelwood production through proper management and the participation of the rural population
- fuelwood production from non-forest acres must be promoted through people's participation by introducing community forestry on a wider scale
- rural inhabitants should be encouraged to get involved in the participatory fuelwood plantation programmes and to make extensive use of energy efficient stoves and devices
- forestry extension service should be strengthened to promote awareness regarding the efficient use of natural resources and the conservation of the country’s forests.

1.5.7 Use of Woodfuel in Cottage Industries in Yamethin District

(U Win Kyi, U Kyaw Win Maung, U Win Oo Naing)

Yamethin District is situated in the middle part of Myanmar in between the road and railway connections of Yangon and Mandalay. Various types of cottage industries using both woodfuel and other biomass fuel are located in this area. The area stretches out from the south beginning with abundant and valuable teak forests, changing to a less dense forest in the middle part and then a sparse, bush-like forest towards the north. It consists of 5 townships namely Lewe, Pyinmana, Tatkone, Yamethin and Pyawbwe. The total area is about 4,200 square miles.

The major woodfuel cottage industries in the area are lime, sugar, condensed milk and alcohol industries which consume about 93 percent of the total woodfuel requirement of all woodfuel consuming cottage industries in the study area. The remaining woodfuels are used by the brick, pottery, cookstove and ceramic industries. The total annual woodfuel consumption by all cottage industries for the year 1996-97 was surveyed and found to be 9,178.46 tons. If woodfuel consumption of state owned sugar mills is included it would amount to 18,418 tons. The woodfuel requirement of the cottage industries in Pyawbwe township, where most of the heavy industries are located, is generally satisfied by the importation of woodfuel from nearby Thazi township which lies outside the study area. The total annual input of this kind is estimated to be not less than 8,500 tons. Cottage industries located in the other townships are self-sufficient in terms of energy in the form of woodfuel or woodfuel supplemented by other kinds of biomass fuel.

Alcohol and sugar industries in Lewe and Pyinmana townships prefer rice-husk for meeting their energy needs due to its cheaper cost. One evaporated milk industry and a sugar mill in Pyawbwe township use bamboo and plum fruit kernel, respectively. The heat supplied by bamboo fuel is said to be easily controllable which is a requirement of the evaporated milk industry. Both bamboo and plum fruit kernel are reported to be cheaper than woodfuel. The total annual cost of woodfuel consumed by cottage industries in the study area is found to be K 11.5 million and the production value is about K 588 million.

Apart from woodfuel consuming cottage industries, state owned sugar mills at Pyinmana consume about 9,240 tons of woodfuel per annum. Therefore, the woodfuel requirement of both state and privately owned industries together can hardly be met by the woodfuel supplied by the district Forest Department whose annual woodfuel production quota is only 19,000 tons. More woodfuel is required for household consumption and for transportation to Yangon. In order to meet the total woodfuel requirement for the district, more than 8,000 acres of fuelwood plantations must be planted annually. The present plantation scheme seems to be erratic and inadequate. At present, unregulated cutting and illegal trade are the prevailing solutions to the timber and woodfuel shortfall with the result that the existing natural forests are being progressively depleted.

Since the woodfuel situation is recognized as a national issue of strategic importance the following recommendations apply to the country as a whole:

- More emphasis should be placed on the establishment of extra-large scale fuelwood plantations and a separate body should be formed to take responsibility for this endeavour.
- Extension activities to initiate community forestry practices for self-sufficiency should be given a high priority.
- As not all stands in the natural forest are marketable, and some even interfere with the growth of valuable tree species, a study on potential woodfuel yields at selected sites in natural forests should be undertaken.
- Research on ways to improve the efficiency of cookstoves and on woodfuel substitutes should be continuously carried out.
- Distribution of fuel efficient cookstoves should be subsidized by the government and issued free to the poorer communities.
- An adequate supply of alternative energy sources such as natural gas should be ensured for the residents of major cities and heavy fuel consuming industries as increases in the urban population accelerate the rate of forest destruction.

1.5.8 Woodfuel Flows in the Dry Zone of Myanmar

(U Saw Tun Khaing)

Research Focus: This paper 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 paper provides some information on the socio-economic 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 study was undertaken to cover three major aspects of the area: socio-economic 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 paper is based primarily on information gathered randomly from households and individuals in 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 either make a full-time living from woodfuel collection or collect to supplement their incomes from other sources. The income of fuel gatherers from fuel collection is considerable but their socio-economic status is quite low because of the relatively high prices of essential commodities. Woodfuel traders are much better-off than the collectors but their net income is declining due to increases in the price of oil and spare parts for the vehicles used to transport the woodfuel.

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 in the 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 area can perhaps be used sustainably.

To ease 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 by providing electric power and promoting fuel saving stoves. However, the supply of electric power is still far from sufficient and is not reliable, and the fuel saving stoves are still in the initial stages of development. Moreover, kerosene is scarce and too expensive to be used for cooking and other purposes, apart from lighting.

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

– As it is the root of all the country’s economic, social and environmental ills, the fuelwood deficit problem (in the central arid zone, as well as in other similar areas) should be addressed at the national level. 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 of the responsibility for the supply side will rest with the Department.

- People would willingly participate in the Department's development activities if they had 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 and unclassified forests or should lease the lands to these communities for tree/fuelwood production purposes. The Forest Department should help the local people form such groups and provide them with training and material support as well as transfer relevant technologies for woodlot establishment and management to the groups. The private and community groups should have the right to dispose of the products from their tree growing activities without 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 and rural population about the importance of conservation and the need to adopt fuel saving stoves, an action-oriented extension service should be organized by the Forest Department and other departments concerned with energy, agriculture and rural development. This service should also be used to promote better coordination and understanding among different government organizations and the people.

1.6 Group Discussion Session

In the afternoon session of the second day, the participants and observers were formed into 3 groups to discuss and identify critical issues pertaining to 3 separate subjects. They were:

Group 1. Woodfuel trade supply and demand.
Group 2. Policies and strategies for the sustainable supply of woodfuel.
Group 3. Possible improvements in existing technology for energy saving and in ensuring the supply of woodfuel substitutes.

After thorough discussions, each group recommended appropriate strategies for the preparation of future national fuelwood action plans. These were later presented in a plenary session and after discussions a summary of recommendations was approved. These are presented in section 1.8.

1.7 Field Trip

A one-day field trip was arranged on the third day, 29 November, for the participants and observers to study biomass fuel consumption at some cottage industries in Pyinmana, Yamethin and Pyawbwe townships. Altogether 48 participants and observers, including the Director General of the Planning and Statistics Department, went on the trip and contributed to a number of interesting discussions with the hosts at each site. The cottage industries surveyed included condensed milk, sugar mills, evaporated milk, alcohol distillery and lime kilns. A fuelwood plantation supplying the local area was also observed as was the changing pattern of forest cover along the route. Discussions were held with the respective owners regarding the types of fuel used (wood, bamboo), annual consumption, local prices, sources of fuels, etc. A brief description of the area and the study sites follows.

Study area : Yamethin district, Mandalay Division.

Total area : 2,400 square miles (approx.)

Site 1 : Pyawbwe township
: Cottage industries

Condensed milk industry

The only condensed milk industry in the study area using woodfuel, established in 1996. Annual consumption of woodfuel is about 639.84 solid cubic tons, and producing about 0.3 million viss of condensed milk. Woodfuel is imported from Thazi township, outside the study area. The cost of woodfuel is more than K 10,000 per truck load (7.11 tons).

Sugar and evaporated milk industry

Established in 1990, the industry is producing 54 thousand viss of evaporated milk and 1.08 million viss of sugar per annum. Here, bamboo fuel, instead of woodfuel, is used to boil milk. Dry bamboo is bought from Yamethin at a cost of K 7,000 per truck load. One truckload of bamboo is enough to boil about 10,000 viss of milk which produces about 4,000 viss of evaporated milk. Woodfuel is required for the sugar mill which consumes about 6-8 truck loads (7.11 tons /truckload)per month. Woodfuel is brought from Thazi township at a cost of K 10,000-12,000 per truck load. The production capacity is 100 bags (30 viss per bag) of sugar per day. Apart from sugar, about 1,500 viss of molasses is obtained per day as a by-product.

A preliminary agreement has been reached between private entrepreneurs at Pyawbwe township and local Forest Department personnel for the establishment of self-sufficient woodfuel plantations for the sugar and milk industries.

Alcohol distillery

Established in 1994, the factory can produce about 5,400 bottles of concentrated alcohol per month. Woodfuel is bought from Yinmabin area, Thazi township at a cost of K 12,000 per truckload which can last 5-7 days. One bottle of diluted alcohol (Super BE Lipo) is sold for K 33.

Site 2 : Yamethin township
: Local supply fuelwood plantation

The total area is 300 acres and this was established in 1984-85. The township Forest Department has distributed fuelwood to nearby villages from this plantation, 30 acres at a time in 1993 and 1995. The yield per acre is 51-52 tons. Within 1-3 years after felling, the coppice shoots, 4-6 shoots per stem, are large enough for the next harvesting.

Site 3 : Pyinmana township, village
: Lime industry

Being the largest consumer of woodfuel, all lime kilns are located where woodfuel costs are lowest. The cost of woodfuel here is just K 6,500 per truck load, almost one half the cost at Pyawbwe. The total input for a typical 7 ton capacity kiln, including labour charges is about K 14,050 of which the cost of woodfuel is K 9,750 (1.5 truck load). About 2-4 loads of lime could be discharged per kiln per month. However, the work has to be suspended during the rainy season. Discussions were held with the respective owners regarding the types of fuel used (wood, bamboo), annual consumption, local prices, sources of fuels etc.

1.8 Plenary Session/Recommendations

The outputs of the three working groups were presented in the plenary session on the morning of 30 November (Saturday) by the rapporteurs. After thorough discussions the summary of recommendations was approved. The recommendations are as follows:

- Conduct, urgently, a detailed case study on woodfuel supply and demand, including trade, for a state or division and apply the case study to other states and divisions. The case study should be in the form of a project
- Formulate a National Woodfuel Action Plan based on the information from the supply and demand studies
- Seek adequate funding and technical support from national and international agencies for conducting supply and demand studies and for implementing the National Woodfuel Action Plan
- Create appropriate policies and strategies for increased production of woodfuel
- Promote public awareness of the woodfuel crisis through extension services and the mass media
- Resolve the woodfuel crisis in cooperation with the ministries concerned and with full support of the state. The creation of a mechanism for inter-ministerial cooperation should be given the highest priority
- Promote community fuelwood forests and planting of fuelwood trees in private owned non-forest lands
- Establish extensive fuelwood plantations on suitable lands
- Create mechanisms to salvage logging residues from natural forests for woodfuel
- Develop capacity building in research and development in the field of biomass fuel

- Integrate pasture management into forest management plans, particularly in the Dry Zone

- Provide alternative sources of energy, to town dwellers in particular

- Develop and disseminate alternative energy sources other than woodfuel for domestic use in general and cottage industries in particular

- Distribute woodfuel saving stoves and fuelwood substitute stoves to both urban and rural communities at subsidised cost

- Provide loans to private entrepreneurs who wish to construct economically sound and environmentally friendly biomass kilns

- Monitor the use of improved cook stoves and biomass energy devices.

1.9 Closing Session

The Director-General of the Forest Department delivered a closing speech expressing his great appreciation to all the workshop attendees for their active participation and keen interest during the course of the four days-long workshop. He also thanked the Regional Wood Energy Development Programme for its invaluable support. He strongly urged the participants to implement the knowledge they acquired during the workshop in their future woodfuel development programmes.

PART II: TECHNICAL PAPERS/CASE STUDIES

1. WOOD ENERGY IN MYANMAR

by

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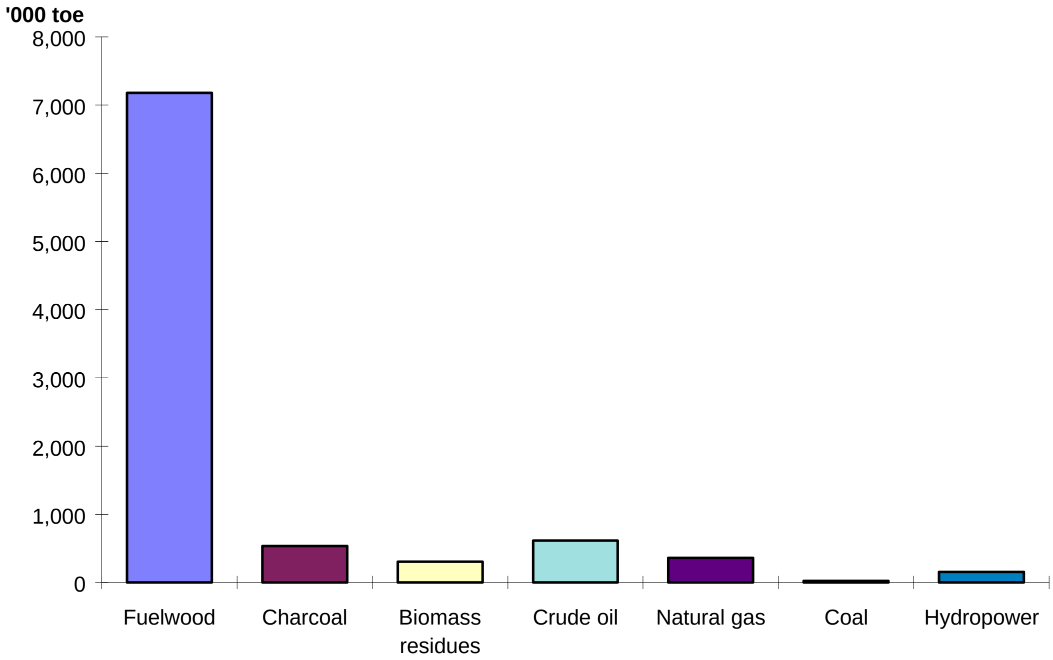
Introduction

An assessment of woodfuel and other biomass resources in seven townships in Myanmar was carried out by the authors. The seven townships, i.e. Yamethin, Meikhtila, Myingyan, Chauk, Magwe, Pyay and Pathein were surveyed in terms of woodfuel resources and consumers' energy use behavior. In these townships effective channels for two-way communication are needed to facilitate the participation of woodfuel users in woodfuel energy management. It is hoped that the study will prove useful for woodfuel energy management and planning in other areas of the country.

1.1 Energy Use Pattern

1.1.1 Energy resources

Energy Consumption by Source (1990)



Fuelwood is a vital energy source for household cooking and for some cottage industries. In the1970s kerosene was generally the main energy source for household cooking in urban areas. In local markets, kerosene and stoves using kerosene could be purchased easily. Statistics show that the inland production of kerosene was 47.69 million gallons and consumption was 96 million gallons in 1977. An insufficient amount of kerosene to meet the demand has resulted from giving priority to the production of petrol/diesel. Indeed the amount of kerosene available has been declining over the years.

This led to a change in the dominant source and form of energy for cooking with woodfuel becoming vitally important for both urban and rural areas. In 1990, woodfuel use was about 75 to 84 percent, or 6,880 to 7,700 toe (Tons of Oil Equivalent), while agricultural residues, crude oil, natural gas, coal and hydropower accounted for the remainder or 1,460 to 2,300 toe. The energy consumption sources and share for different types of fuels for 1990 is shown in appendix 1.

1.1.2 Woodfuel consumption

<u>Household cooking</u>

In the last decade, it was assumed that the annual consumption of woodfuel per household was 1.4 cu tons for urban and 2.5 cu tons (or 3.6 m^3) for rural areas. But after conducting the survey in 7 townships it is clear that the woodfuel consumption per household is much greater. (See appendix 2).The consumption of fuelwood in rural areas is estimated to be 3.76 ADT or 2.68 cu tons.

According to appendix 2, the consumption rates for biofuels are as follows:

Woodfuel /household /year	= 3.76 ADT	
Cotton stalk / household /year	= 0.46 ADT	
Pea stalk / household /year	= 2.28 ADT	Agricultural residues
Sesame stalk / household /year	= 1.20 ADT	Agricultural residues
Coconut or palm leaves / household /year	= 0.57 ADT	Agricultural residues
Rice husk / household /year	= 0.33 ADT	Agricultural residues
Sawdust / household /year	= 0.07 ADT	Other than woodfuel
Bamboo / household /year	= 0.12 ADT	Other than woodfuel
Total biofuel consumption per year	= 8.79 ADT	

(8.79 ADT =6.27cu tons)
1 ADT = 0.71 cu ton or 1 cu ton =1.40 ADT.

The figure for woodfuel consumption, according to the statistics of the Planning and Statistics Division of the Forest Department, was 19 million cu tons in 1994-95 with a forecast of 20 million cu tons in 2000-2001 for household cooking. See appendix 3. These figures are exclusive of the woodfuel used in cottage industries and other types of production such as brick making, pottery work, tobacco curing, jaggery boiling, condensing milk. It has been suggested that the woodfuel needs of these industries are up to 4 times greater than the recorded figure.

The consumption of woodfuel for small cottage industries

Due to the time limitation, only jaggery boiling, milk condensing, brick making and tobacco curing industries were studied.

Jaggery boiling

Site 1. Myingyan Township : Ku Gyi village

Production of jaggery	=	30	viss/tree/year
Use of fuelwood	=	0.13	cu ft /viss
Cost of fuelwood for boiling jaggery	=	1.63	kyat/viss
Retail price of jaggery	=	75	kyat/viss

Site 2. Chauk Township : Sha-pin village

Production of jaggery	=	24	viss/palm /year
Use of fuelwood	=	0.13	cu ft/year
Cost of fuelwood for boiling jaggery	=	4.69	kyat/viss
Retail price of jaggery	=	65	kyat/viss

Condensing milk

Site 1. Meiktila township: Ye-Cho village

To get 1 viss of condensed milk,

Milk (2 viss)	=	80	kyat(40 kyat/viss)
Sugar (0.62 viss)	=	60	kyat(97kyats/viss)
Fuel (bamboo)	=	24.5	kyat (0.19cu ft/viss)

(If sesame and cotton stalks are used instead of bamboo, the cost of fuel is reduced to 10 kyats/viss)

Cost for 1 viss of condensed milk	=	164.5	kyat/viss
Wholesale price	=	178.0	kyat/viss

Site 2. Myingyan township: Pyawbwe village.

To get 1 viss of condensed milk

Milk (1.7 viss)	=	68	kyats (40 kyats/viss)
Sugar (0.61 viss	=	61	kyats (100 kyats/viss)
Fuel (bamboo)	=	28	kyats (0.22 cu ft/viss)

Cost for 1 viss of condensed milk	=	157	kyats /viss
Wholesale price	=	200	kyats/viss

Brick making

Site 1. Chauk township: Gwecho village.

Cost of fuelwood for 1 brick	=	0.70 kyats
Amount of fuelwood for 1 brick	=	0.067 cu ft (stacked)
Wholesale price for 1 brick	=	3-4 kyats

Site 2. Pyay township: Sagataung village

Cost of fuelwood for 1 brick	=	0.63 kyats
Amount of fuelwood for 1 brick	=	0.04 cu ft (stacked)
Wholesale price for 1 brick	=	3.5-4 kyats

Tobacco curing

To cure 1 viss of tobacco:

Amount of fuelwood	=	0.17 cu ft (stacked)
Cost of fuelwood	=	2.85 kyat
Curing time	=	6 days

The volume of woodfuel annually harvested is estimated to be 57 times as large as that of teak annually extracted and 29 times that of commercially extracted hardwood. The consumption rate of woodfuel is directly proportionate to the population growth rate and using this as a basis, the consumption of woodfuel has been estimated to be increasing steadily at an annual average rate of 1.1%.

1.1.3 Forms of woodfuel

In Myanmar, the main biofuel is woodfuel and according to the data recorded by the Forest Department charcoal constitutes only 4 to 6% of the total woodfuel consumed.

Fuelwood

During the last decade Myanmar had experienced a rapid depletion of natural forest resources that has resulted in severe hardship for the people living in rural areas. Women and children now have to spend a considerably greater part of their time in gathering fuelwood and other biofuels.

In the rural areas fuelwood is used almost exclusively for household cooking. Only a limited amount of agricultural residues such as of cotton and pigeon pea stalk, sugar cane, bagasse, paddy straw, rice husks, sesamum stalks, and palm leaves is used. Fuelwood is also used in a variety of small cottage industries. The woodfuel usage of urban people is slightly less than that of rural people because of the substitution of commercial and other non-traditional energy sources such as coal briquettes and electricity. The woodfuel consumption pattern varies significantly from one state/division to another, according to differences in agro-ecological conditions, household sizes and availability of the other fuels. Most of the fuelwood consumed is for cooking purposes. Water heating and room heating are minor applications in Chin, Shan, Kachin States etc. where the temperature is very low in winter. The consumption of woodfuel is also linked to household size.

Supplies of fuelwood for rural households, generally, are obtained more often from pruning or pollarding branches of trees or even bushes. Although Gandasein (*Prosopis juliflora)* is difficult to use because of its sharp thorns, interlocked-grain wood, and hardness which makes it difficult to split, the rural people from the Dry Zone, who face a serious woodfuel shortage, use it , including its roots, extensively.

The most favoured species of fuelwood is Sha *(Acacia catechu)* in the Dry Zone and Kokko(*Albizzia lebbek)* Mezali (*Cassia siamea), and Eucalyptus* spp. are also used as fuelwood.

Specific gravity, calorific values and MAI (Mean Annual Increment) of some commonly recommended fuelwood species are given in appendix 4. However, both specific gravity and calorific value within a species are variable depending on the tree's age, percentage of sapwood and heartwood, growth rate and gum accumulation.

<u>Charcoal</u>

Charcoal is the second most favoured type of woodfuel and accounts for about 4 to 6% of the total woodfuel used in urban areas. About 24% of the of total population of 45 million in Myanmar live in urban areas and get fuelwood and charcoal by self- collection or purchasing, or both. In Yangon City, more than 50% of the residents use charcoal which comes from delta mangrove forests whose ecology is seriously threatened by over- exploitation.

The principal woodfuel production areas are Ayeyarwaddy Division, particularly the delta and the west coast, and Western Bago and Southern Magway Division with increasing quantities coming from Eastern Bago. Several other divisions or states produce limited quantities of charcoal mainly for local use while the coastal area of Rakine and Tanintharyi Division seem to be becoming increasingly important sources of charcoal for Yangon.

During the process of charcoal making an earth pit or brick and mud kilns are generaly used. The conversion rates from wood to charcoal using these are far below what could be achieved through technological innovation and more systematic kiln operations. The brick/mud kilns were estimated to have a range of between 9 and 14% by weight and the earth pit kilns ranged from 6 to 12%. In addition, 10% or more is lost as fines prior to final bagging. With improved production procedures the recovery rate could be increased from 25% to 45% for brick kilns and 20% for the earth kilns. It is thus assumed that 1/3 of charcoal by volume will be available from systematic charcoal burning.

Attempts are being made to control and reduce charcoal burning to help conserve the forests and to encourage the use of alternatives to fuelwood.

1.1.4 Price of woodfuel

Theoretically, the potential annual fuelwood supply from the existing forest areas appears to be much higher than the recorded figure for fuelwood production. However, the following factors constrain the fuelwood supply situation:

1. Limited access to forests near the population centres.
2. Limited transport facilities.
3. High percentage of logging residues left unutilized in the remote logging areas.

If biomass fuel used in rural areas is valued, it is estimated to be 200 to 400 kyats per household per month. But most of the rural people collect biofuel almost free of charge. The landless poor are used to collecting fuelwood from the natural forest, wood lots, and pollarding the road side and farm-edge trees. Some people depend on the regular flow of incomes from the sale of woodfuel for their living. They cut the wood, burn charcoal, and deliver it to the market.

At the market centre of townships in the Dry Zone, bundles of fuelwood 12 inches in mid-girth and 18 inches in length cost K 1.8 to K 4.0 per bundle and bags of charcoal, 26 inches X 14 inches X 6 inches, cost K 100 to K200 per bag. These fuels are transported from 1 to 50 miles away by truck, by cart, or on foot. Commercial sale of woodfuel is not allowed without the permission of the Forest Department and in some areas charcoal burning is strictly prohibited. Some prices of woodfuel in the 7 townships surveyed are given in appendix 5.

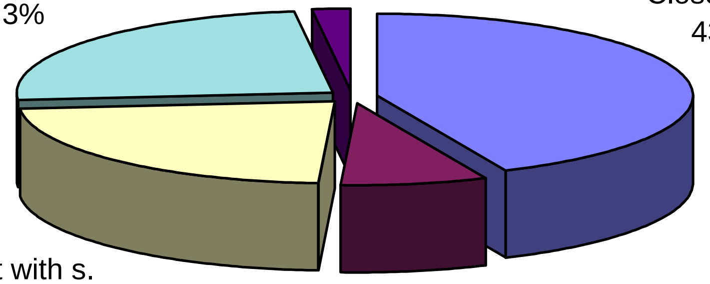
1.2 Existing Landuse and Landuse Change

1.2.1 Existing landuse

Topographically, the country is very rugged and mountainous in the north and in the west. The eastern part though hilly is a plateau land. There are mountain ranges running in a north-south direction and these alternate with flat plains in the middle part of the country. The flat plains are the basins of four main rivers namely the Ayeyarwaddy, Chindwin, Sittaung and Thanlwin.

The southernmost stretch of the country is the hilly region of peninsular Tanintharyi which shares a common border with Thailand. The country is most interesting from an ecological point of view as there are a wide range of latitudes with flat lands at sea level to snow-capped peaks of over 18,790 ft (5,727 m) and deep ravines. Temperatures in the area range between 7· C and 40· C and rainfall ranges between 30 in (750 mm) and over 220 in (5,500 mm). Due to the variety of climatic and topographical conditions and the wide latitudinal ranges there exist many types of forests with diverse species of both fauna and flora.

As Myanmar is a predominantly agricultural country, forests play a very important role in the rural economy providing fuelwood and housing materials as well as regulating water supplies for agriculture. The country's forest resources provide a substantial contribution to national economic development.



Forest Classification in 1989
Source: Kyaw Tint et al, 1989

According to an appraisal carried out in 1989, Myanmar has a forest cover of about 50.86% or 132,716 sq. miles (343,732 sq. km). Details by state/division are shown in appendix 6a and 6b. The distribution of the forests within the country is highly variable. Forest cover in the northern part of the country where population is sparse is fairly undisturbed and dense while in the densely populated areas, the forest cover is very low and in the central Dry Zone is practically devoid of high forests. Increasing population pressure, fuelwood demand, industrial wood processing and demand for additional land for agricultural expansion are reducing the extent of forested land and thereby accelerating forest degradation.

1.2.2 Forest degradation and depletion

The closed forest area was 323,216 sq km in 1975 and 292,579 sq km in1989. Thus, 30,637 sq km of forest cover degraded in 14 years and the average rate was about 218,836 ha per year. During the same period the whole forest cover (closed forest and forest fallow area) reduced from 500,736 sq km in 1975 to 498,626 sq km in 1989. Thus 211,000 ha disappeared in 14 years at the rate of 15,071 ha per year. So, during the 14 year period from 1975 to 1989 the closed forest cover degraded at the rate of 0.64% or 543,600 acres (about 220,000 ha) annually while the total forested area depleted at the rate of 0.04% or 37,000 acres (15,000 ha) annually. See appendix 7.

The rate of degradation of the forested area is quite alarming in the mangrove forests compared to other forest types of the country. The mangrove forests in the Ayeyarwaddy Division covered an area of 1,190,000 acres (481,593 ha) in 1974 and 880,000 acres (356,136 ha) in 1990. Thus, 310,000 acres (125,457 ha) of mangrove forest have been destroyed within a period of 16 years with an average of 19,375 acres (7,841 ha) or 1.63% per year. The annual rate of destruction of forest in the whole country between 1975 to 1989 is 0.64%. Therefore it is quite evident that the rate of destruction of mangrove forest is 2.5 times greater than the national rate of forest destruction (all types). This is due to excessive production of fuelwood and charcoal in the region. Increasing population pressure is also a main cause of forest destruction.

1.3 Source of Woodfuel Supply and Acquisition Methods

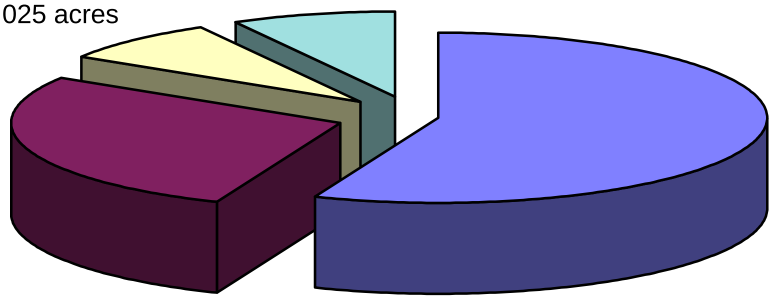
1.3.1 Supply source

As the estimated woodfuel consumption is at least 20 million cubic tons per year for household cooking, theoretically one million acres of natural forest have to be clear-felled to get this amount of woodfuel. In other words, one million acres of natural closed forest have to be depleted every year for the production of woodfuel. Fortunately, in reality the forest depletion rate is not as great as this as not all woodfuel supplies come from natural forests.

The main source areas for woodfuel apart from natural forests are fuelwood plantations, road sides and perimeter plantations or tops and lops from timber extraction areas.

1.3.2 Fuelwood plantations

Of the 1.42 million acres of plantations established by the Forest Department up to 1996, 28.11% are fuelwood plantations for village supply. The Forest Department has established, on average, 10,000 acres of fuelwood plantation annually. In 1995 and 1996, however, the yearly figure reached 34,000 acres. See appendix 8 for full details.



Plantation Established by Types up to 1996
Souce: Planning & Statistics Division, Forest Department

Most of the species planted for fuelwood are *Eucalyptus* species, Mezali (*Cassia siamea),* Bawsagaing (*Leucena leucocephla)*, and Kokko (*Albizia lebek).* The rotation for fuelwood plantations depends on Mean Annual Increment (MAI) of the species planted, soil type, spacing, and climate. According to research data, a 10 years old Eucalyptus plantation can produce the highest yield of fuelwood of about 52.8 stacked cu tons per acre and for Yemane (*Gmelina arborea)*, 8 years old is the best rotation to get the highest production of fuelwood of about 7.9 cu tons per acre. See appendix 9a and 9b for more details.

An assessment conducted by the Forest Department has indicated that a 5 year rotation is better from both a silvicultural and socio-economic point of view and the estimated output of fuelwood is 5 cu tons per acre per year Therefore, the total output of fuelwood from the plantations is 68,020 cu tons on average for 20 years between 1977 and 1996. It amounts to 0.34% of the total requirement of woodfuel for domestic cooking. See appendix 10.

1.3.3 Road side and perimeter plantations

With the limited data available, fuelwood production from the road side is too difficult to estimate. Along the road side, planted or natural trees were inventoried by random line counting and the data by townships are as follows.

1. Tatkon township	=	46 trees/ mile
2. Yamethin township	=	25 trees/ mile
3. Pyawbwe township	=	25 trees/ mile
4. Ma-hlaing township	=	32 trees/ mile

In some townships, road side trees are absent for up to hundreds of miles. The woodfuel produced from the trees along the road side, around the field/farm and within village compounds (perimeter plantation) is calculated to be about 2.81 million ADT or 2.00 million cu tons (World Bank, 1992) See appendix 11.

1.3.4 Tops and lops from timber extraction areas

Statistics shows that lops and tops from commercial teak wood extraction amounts to up to 20% of the total extracted wood (source: Wood Energy Development in Myanmar, U Soe Myint, Energy Planning Department). Annual timber extraction is 0.35 million cu ton of teak and 0.70 million cu ton of hardwood giving a total 1.05 million cu ton. So, using a 20% share of lops and tops available for woodfuel from commercial extraction of teak wood as a standard for other species the annual share of lops and tops in total wood extraction comes to about 0.21 million cu ton which can supply a large part of the fuelwood demand.

Therefore, the total supply of fuelwood is summarized as :

Fuelwood supply from forest plantation	= 0.068 million cu ton
Fuelwood supply from road sides and perimeter plantations	= 2.00 million cu ton
Fuelwood supply of tops and lops	= 0.21 million cu ton
Total	= 2.278 million cu tons
Annual estimated consumption of woodfuels	= 20 million cu tons
Therefore the annual cut amount of fuelwood from the natural forest (i.e. excluding the contribution from non-forest sources)	= 17.72 million cu tons

The Energy Sector Investment and Policy Review study concluded that the sustainable yield of fuelwood is 18.47 million ADT (13.12 million cu tons). See appendix 11. This means that 4.6 million cu tons of fuelwood should be substituted by alternative fuels or by commercial energy sources as soon as possible.

But this calculation of the sustainable yield for fuelwood is questionable and it is also complicated matter to define what kind of species, and what size of girth, are most appropriate for fuelwood, not to mention the problem of accessibility of the existing stock.

1.4 Suggested Measures to Address Key Issues and Overcome Constraints

1.4.1 Role of Forest Department in solving the fuelwood problem

Realizing the current trend of fuelwood consumption, the Forest Department has to increase its capacity to solve the woodfuel problem There are 4 tasks which the Forest Department has to perform:

(1) Establish very large plantations to increase the supply of fuelwood and charcoal.
(2) Encourage the communities to be self-sufficient in terms of fuelwood supply at the grassroots level by establishing their own plantations in the fields, around the farms and along road sides near by villages, i.e., conduct intensive tree planting outside the forest areas.
(3) Establish extension capabilities in the Forest Department to educate the people to participate in solving woodfuel shortage problems.
(4) Motivate the people to use alternative sources of energy and introduce conventional and non-conventional energy technology in combination with research activities.

Establishment of fuelwood plantations

In order to solve the fuelwood problem the Forest Department has been progressively establishing fuelwood plantations in the Dry Zone. The annual rainfall of this zone varies from14 inches (350 mm) to 25 inches (625 mm) and the temperature is as high as 110˚F (42˚ C) during the summer. With the depletion of Local Supply Reserves and the progressive reduction of the forested area, the fuelwood supply problem has reached a critical stage. The ‘Greening’ operations of the nine critical districts of the Dry Zone is a significant attempt to ease the fuelwood shortage and has the following objectives:

– to establish fuelwood plantations to increase the supply of fuelwood and charcoal

– to enhance extension capabilities of the Forest Department to facilitate the sustainable utilization of fuelwood resources at the grassroots level

– to reduce the pressure on the Local Supply Reserves which are heavily degraded

– to prevent further encroachment into more valuable Commercial Supply Reserves which are the source of timber for export and local consumption.

Fuelwood plantations established in the nine critical districts amounted to 15,250 acres in 1994-95 and 18,100 acres in 1995-96. There is also a plantation program for the period from 1996-97 to 2008-09 to establish 20,000 acres of plantations annually in these nine critical districts.

In addition, beginning from 1977-78, seedlings were distributed free of charge to local communities and governmental organizations to encourage them to establish fuelwood woodlots and tree planting campaigns outside the forest areas. Since the early 1990s, some 11 million seedlings have been distributed yearly. Accurate information regarding the survival rate of the seedlings planted and annual growth rate is not known at present.

Community forestry approach

Although village-owned plantation establishments were introduced in the 1980's, the plantation program was not quite accepted by the local people due to the lack of an extension service at that time. In the 1990's, the Forest Department initiated a program in which local people were to cooperate with the staff of the Forest Department in planning and implementing fuelwood planting programmes for the local people. This has encouraged people to participate in plantation activities. Although the fuelwood from the natural forest has become more and more scarce, people are still reluctant to establish their own fuelwood plantation using a community forestry approach. However, tree planting in the perimeter of farms, in gaps and along road sides is encouraged by the Forest Department for both woodfuel and other household needs, such as posts, poles and fodder.

The Forest Law 1992, allows private entrepreneurs to establish fuelwood plantations in the proximity of urban areas for trade purposes. According to the Community Forestry Instructions, groups or communes of local people also have the rights and privileges to establish and manage their own plantations. They can utilize or market the products from these plantations. The idea is to promote a community participatory approach. So far, attempts to establish such plantations have been made by a number of local communities, especially from the Dry Zone.

In 1996, a new community forestry approach was introduced. This involved some of the fuelwood plantations established by the Forest Department being transferred to local communes so that they could be managed as self-sufficient production systems to meet local needs.

Establishment of extension capability

For the last two decades, the local Supply Reserved Forests have been the chief means of supplying the rural people with forest produce, such as posts, poles, small timber, fuelwood, charcoal, bamboo and thatch etc. As the rural population constitutes about 76%, they generally subsist on the natural forests in the vicinity of their villages. The needs of the rural people at one time were met from the 1.67 million acres (6759 km^2) of Local Supply Forests. During the Second World War and its aftermath, these forests were almost denuded and were barely able to supply the needs of the people.

Extension activities should be conducted in the fuelwood scarce areas to make people aware of the important roles of wood energy, how to create appropriate supply sources, including through the reforestation of denuded areas in their surroundings, and their management. People’s participation is urgently needed to successfully address energy issues.

Extension services should be developed to encourage the widespread use of energy efficient stoves, the substitution of alternative fuels and the creation of energy resources.

Using energy efficient stoves is one of the most effective remedies for solving the problem of fuelwood shortages. Some areas use A-1 stoves disseminated by the Forest Research Institute (FRI) and introduced since 1994 as part of a UNDP project. The A-1 stove is well known for its efficiency in saving 40% of fuelwood and its convenience for household cooking. It is hoped that the improved stove will be widely disseminated as it can help to save on fuelwood consumption which in turn will help to reduce the rate of deforestation. The use of A-1 stoves may also lead to less collecting time for fuelwood and could enhance other income generation opportunities.

The A-1 stoves are produced by the Forest Research Institute (FRI) and also in Chaung U, Taungtwin-gyi, Pathein townships and Yangon. The price of a stove varies from 60 kyats to 130 kyats per unit depending on the transportation costs. Stoves produced and average price are described below:

Production site	Stoves produced	Average unit price (Kyat)	Total stove cost (Kyat)	Transport cost (Kyat)	Total cost (Kyat)	Total cost per stove (Kyat)
Chaung U	3,500	94	327,500	33,028	360,528	103.01
Yangon	1,271	94	118,930	13,854	132,784	104.47
Taungtwin	1,000	98	97,500	18,115	115,615	115.62
FRI	2,169	100	216,900	25,597	242,497	111.80
Pathein	1,048	60	62,880	11,828	74,708	71.29
Total	8,988	89	823,710	102,422	926,132	103.04

Source: Final Report of Fuel-Efficient Cook Stove Marketing Pilot Project.

The Forest Department should continue its efforts to increase the production and utilization of efficient stoves.

<u>The need to use alternative sources of energy and introduce advanced conventional and non-conventional energy technology</u>

In Myanamar most people use traditional biomass fuels such as fuelwood, charcoal and agricultural residues. Although electricity is important for domestic cooking in almost all of the urban areas and some rural areas, the main constraints to its widespread adoption are its limited availability and high cost. The cost of electricity is about 500 kyats per household per month for domestic cooking compared to about 300 kyats for fuelwood.

At present coal briquettes are being distributed in some fuelwood scarce townships, but it will take some time for public awareness regarding the benefits of coal briquettes to develop.

The introduction of non-conventional energy sources (solar, wind, etc.) is considered essential if Myanmar is to have a sustainable energy future. With the presently available resources, both manpower and funds, the Forest Departmend will not be able to meet the fuelwood needs of the country by establishing fuelwood plantations only. As energy demand depends on the size of the population directly, the Integrated Energy Planning (IEP) concept has to be adopted.

In India gasification technology is widely used by the rural people. About 1 million gasifiers have so far been installed in Indian villages. This means that for every 900 people there is one gasifier, producing 20 to 100 kilowatts of electricity. The appropriateness and cost effectiveness of this technology should be investigated to determine whether it should be promoted in Myanmar.

The Forest Department is one of the main institutions which plans and monitors woodfuel production. The Planning and Statistics Division of the Forest Department has prepared a five-year plan starting from 1996-97 to 2000-01. The projected production of fuelwood and charcoal for five-year is shown in appendix 3.

These data are estimated from the per capita consumption basis assuming that a rural household (5 persons) uses 2.5 cubic tons of woodfuel per year. With the average growth rate at 1.87%, the population of Myanmar will be 44.1 million in 1995-96 and projected to be 49.3 million by the end of the Year 2000. By the year 2000, the population will be nearly 50 million (percent of the rural and urban population being 76.05% and 23.95% respectively) and consumption of woodfuel will be about 20 million cubic tons.

As use of fuelwood and charcoal still accounts for a considerable amount of the energy used in the country, wood supplies for fuel are dwindling daily. Wood has been used as fuel since the existence of mankind resulting in an upward trend in the depletion of forests. Without forest cover, water flow and climate cannot be regulated; watersheds cannot be protected; hills become bare; rivers, streams and springs dry up; soils become eroded; flora and fauna disappear; turning the land into dry and desolate tracts. Therefore forests need to be properly managed and measures have to be ta{en to arrest the extensive depletion of forests due to fuelwood cutting. However, destruction of forests will continue as long as a substitute for fuelwood is not widely adopted or without the widespread integration of trees into the farming system. If substitutes are made available, the country's forests will cease to be plundered and efforts to green the country will become effective. Thus, finding a substitute for wood as fuel is a priority task for all citizens of Myanmar.

1.5 Conclusions

1. The Forest Department alone will not be able to solve the fuelwood problems. An integrated approach by individual departments concerned is urgently needed.

2. People's participation is also required to resolve the fuelwood situation in Myanmar. Unless the public participate any attempts to ease the problem will be unsuccessful. Extension activities should be carried out to raise public awareness.

3. Information and data related to the fuelwood situation should be systematically and fully collected. Only then can proper planning be carried out as part of any future fuelwood plantation programme.

4. More cooperation in the region with countries experiencing a similar fuelwood situation is essential. Regional organizations such as the "Regional Wood Energy Development Programme" (RWEDP) can play an important role here.

5. Woodfuel will continue to be a major source of domestic energy in Myanmar and hence more attention should be given to proper planning so that sufficient supplies are available and deforestation can be reduced as soon as possible.

1.6 References

Final Report (MYA/93/034), n.d.	Fuel-Efficient Cookstove Marketing Pilot Project.
Forest Department, n.d.	Forest Resources of Myanmar.
Forest Department, n.d.	Forestry Situation in Myanmar. n.d.
Forest Department, 1993	Lecture Note for Training on Utilization of Bioenergy.
Kyaw Tint , U Shwe Kyaw, U Sit Bo and U Aung Kyaw Myint, n.d.	An Appraisal of the Forest Cover of Myanmar Using 1989 Landsat TM Imageries.
Planning & Statistics Division, F.D., n.d.	Annual Plans of the Forest Department.
U Khin Maung Nyunt, 1995	Fuelwood Situation in Myanmar.
U Soe Myint, n.d.	Wood Energy Development in Myanmar.
U Soe Tint, 1984	Fuelwood Outturn of Plantations.
World Bank, 1992	Energy Sector Investment and Policy. Review Study. 16 March.

Appendix (1)

Energy Consumption by Sources in 1990

(Thousand toe)

Sr.	Energy sources	Household	Transport	Industrial	Other	Total	Percent
1	Fuelwood	7181.5				7181.5	78.27
2	Charcoal	535.6				535.6	5.84
3	Biomas residues	227.8			75.9	303.7	3.31
4	Crude oil	7.3	362.5	134	109.8	613.6	6.69
5	Natural gas			194.6	167.1	361.7	3.94
6	Coal			23.6		23.6	0.26
7	Hydropower	48.3		88.1	19.5	155.9	1.7
	Total	8000.5	362.5	440.3	372.3	9175.6	100

Energy Consumption by Source (Percent)

Sr.	Energy resources	1975	1980	1985	1987	1988	1989
1	Fuelwood	78.9	73.6	74.8	76.2	78.6	79.5
2	Charcoal						
3	Biomas residues	21.1	26.4	25.2	23.8	21.4	20.5
4	Crude oil						
5	Natural gas						
6	Coal						
7	Hydropower						
	Total	100	100	100	100	100	100

Source: Wood Energy Development in Myanmar. U Soe Myint. Energy Planning Department.
Note: toe = Tons of Oil Equivalent.

Appendix (2)

Biofuel Consumption

Per household per annum

(ADT)

Township	Village	Fuelwood	Cotton Stalk	Pigeon Pea Stalk	Sesamum Stalk	Coconut or Palm Leaves	Rise Husk	Sawdust	Bamboo	Total
3	4	5	6	7	8	9	10	11	12	13
Myingyan	Pyawbwe	1.68	2.45	4.41	0.39					8.93
Myingyan	Lal-thit	1.19	2.18	3.01						6.38
Yamethin	-	6.6								6.6
Chauk	Taung-nauk	5.52		7	1.29					13.81
Chauk	Sha-bin	1.66		8.37	1.44					11.47
Magwe	Daung-the	7.53			8.83					16.36
Pathein	Thitpok-kon	1.97				1.04		0.43	1.16	4.6
Pathein	Waya-chaung	7.25								7.25
Pathein	kosu	1.85				4.16		0.3		6.31
Pathein	Apin-hnit-se	2.34				0.54	3.27			6.15
Total		37.59	4.63	22.79	11.95	5.74	3.27	0.73	1.16	87.86
Average/Household		3.759	0.463	2.279	1.195	0.574	0.327	0.073	0.116	8.786

cted during field survey from 22.8.96 to 9.9.96 by the authors.

ry Ton:

Appendix (3)

Consumption of Woodfuel in Myanmar

(Thousand cubic ton)

Sr.	Year	Wood for Fuel	Wood for Charcoal	Total	Remark
1	2	3	4	5	6
1	1970-71	9972	432	10404	
2	1971-72	9967	633	10600	
3	1972-73	10108	528	10636	
4	1973-74	11149	711	11860	
5	1974-75	10490	705	11195	
6	1975-76	10873	849	11722	
7	1976-77	11337	1143	12480	
8	1977-78	11678	1128	12806	
9	1978-79	12452	1920	14372	
10	1979-80	12545	1587	14132	
11	1981-81	13049	1818	14867	
12	1981-82	13608	1851	15459	
13	1982-83	14334	2295	16629	
14	1983-84	15045	2157	17202	
15	1984-85	15752	1587	17339	
16	1985-86	16741	2598	19339	
17	1986-87	16972	2442	19414	
18	1987-88	17223	2544	19767	
19	1988-89	17383	2283	19666	
20	1989-90	17660	2646	20306	
21	1990-91	17913	2094	20007	
22	1991-92	17668	1947	19615	
23	1992-93	18003	2403	20406	
24	1993-94	17988	1254	19242	
25	1994-95	18018	774	18792	
26	1995-96	18070	1026	19096	
27	1996-97	17781	1044	18825	
28	1997-98	18110	1053	19163	
29	1998-99	18444	1059	19503	
30	1999-2000	18784	1071	19855	
31	2000-2001	19122	1077	20199	

Source: Planning & Statistics Division. Forest Department.

Note: 3 volumes of wood are burned to produce 1 volume of charcoal.
Woodfuel consumption of cottage industries and for industrial purposes is excluded.

Appendix (4)

Some Fuelwood Species and Essential Data

Sr.	Species	Specific gravities	Calorific value Kcal per kg	(Mean Annual Increment) m3/ha/annum	Rotation Years
1	2	3	4	5	6
1	Acacia auriculiformis	0.6-0.75	4800-4900	10-12	10-12
2	Acacia decurrens (Green wattle)	0.5-0.7	3530-3940	6-16	15
3	Acacia melonoxylon	0.6-0.7		5-10	7-10
4	Acacia mollissima (Black wattle)	0.5-0.7		7-10	7-10
5	Acacia senegal		3200	5	
6	Albizia lebek (Kokko)	0.55-0.6	5200	5	10-15
7	Azadirachta indica (Tama)	0.56-0.85	High	8-10	8
8	Caliandra callothyrsus (Sha-ni)	0.51-0.78	4500-4750	5-20	1
9	Cassia siames (Mezali)	0.6-0.8		15	5-10
10	Casuarina cunninghamiana	0.9			10
11	Casuarina equisetifolia(Ka-bwi)	0.8-1.2	4950	7-10	7-10
12	Eucalyptus camaldulensis	0.6	4800	10-20	7-10
13	Eucalyptus grandis	0.4-0.55	3055	17-45	6-10
14	Eucalyptus tereticornis	0.75	4800	10-20	10
15	Eucalyptus torreliana		High		10
16	Eucalyptus robusta	0.7-0.8		10-35	10
17	Gliricidia sepium(Thinbaw-ngusat)		4900		7
18	Grevillea robusta (Khataw-hmi)	0.57		10-15	10-15
19	Leuceana leucocephala	0.54	4200-4600	24-100	5-7
20	Pithecolobium dulce (Thinbaw-magyi)		3200-5600		10
21	Prosopis juliflora(Gan-da-sein)	0.7	4213	7-8	10
22	Psidium guajava (Malaka)	0.8	4792		10
23	Samanea saman (Thinbaw-kokko)	0.48			10
24	Sesbania grandiflora(Pauk-pan-byu)	0.42		5-6	2
25	Terminalia catappa (Banda)	0.59		5-6	10-15
26	Mangrove species	0.7-1.0	4300		8

Souce: Planning & Statistics Division. Forest Department

Appendix (5)

Price of Biomass Fuel

Sr.	Township/ Village	Fuelwood k/cartload	Fuelwood bundle k/(1½ x Girth 1')	Fuelwood k/ 50cu-ft	Charcoal k/bag	Cotton stalk k/cartload	Pigeon pea stalk k/cartload	Sesamum stalk k/cartload	Bamboo bundle k/(4' x girth 1')	Mill-cut k/cartload	Cow dung k/cartload	Briquettes k/unit	Rice husk k/cartload
1	Kyauktaga	-	-	-	150	-	-	-	-	-	-	-	-
2	Yedashe	400	-	-	200	-	-	-	-	167	-	-	100
3	Yamethin-Thekwe	350-400	-	-	100-150	-	-	-	-	-	-	-	-
4	Meikhtila	400-600	1.8	-	-	-	-	-	35	-	-	-	-
5	Myingyan-Pyawbwe		3-4	300	-	200	100	-	-	-	-	2	-
6	Myingyan-Lalthit	250	4	833	200	-	-	-	-	-	50	-	-
7	Myingyan-Kugyi	400	-	-	-	-	-	-	-	-	-	-	-
8	Chauk-Gwecho	-	-	500-625	-	-	-	-	-	-	-	6	-
9	Chauk-Taungnauk	200	-	-	-	-	-	100	-	-	-	-	-
10	Chauk-Shapin	-	-	-	-	-	50-100	-	-	-	-	-	-
11	Magwe-Daungthe	250	1.5	-	-	-	-	-	-	-	-	-	-
12	Magwe	200	-	-	-	-	-	-	-	-	-	-	-
13	Taungtwingyi	-	-	-	-	-	-	-	-	-	-	-	-
14	Aunglan	-	-	450	-	-	-	-	-	-	-	-	-

Source: Data collected during field survey from 22.8.96 to 9.9.96 by the authors.

Note: K = Kyat

1 bag of charcoal = 1.5 baskets

1 cartload of rice husk/ cow dung = 50 baskets= 1.06 ADT

1 cartload of agricultural residue = 37.8 cu ft = 1.06 ADT

1 cartload of fuelwood = 25 cu ft stack = 16 cu ft solid.

Appendix (6.a)

Area Under Forest as of 31-3-1996 (sq mile)

(Provisional)

Sr.	State/Division	Area	Reserved Forests	Percent	Public Forests	Percent	Total Forests	Percent
1	2	3	4	5	6	7	8	9
1	Kachin	34379	2217.82	6.45	26741.02	77.78	28958.84	84.23
2	Kayah	4530	146	3.22	1839.33	40.60	1985.33	43.83
3	Kayin	11731	1633.44	13.92	3470.11	29.58	5103.55	43.50
4	Chin	13907	696.8	5.01	6454.54	46.41	7151.34	51.42
5	Sagaing	36534	9424.89	25.80	15325.24	41.95	24750.13	67.75
6	Tanintharyi	16736	4498.78	26.88	8951.31	53.49	13450.09	80.37
7	Bago	15214	5236.61	34.42	740.45	4.87	5977.06	39.29
8	Magway	17305	3940.31	22.77	595.59	3.44	4535.9	26.21
9	Mandalay	14295	3837.39	26.84	349.2	2.44	4186.59	29.29
10	Mon	4748	726.81	15.31	761.78	16.04	1488.59	31.35
11	Rakhine	14200	816.6	5.75	7654.27	53.90	8470.87	59.65
12	Yangon	3927	440.38	11.21	23.43	0.60	463.81	11.81
13	Shan	60155	3764.76	6.26	19403.65	32.26	23168.41	38.51
14	Ayeyarwady	13567	2780.87	20.50	244.22	1.80	3025.09	22.30
TOTAL		261228	40161.46	15.37	92554.15	35.43	132715.61	50.80

Source: Planning & Statistics Division, Forest Department.

Appendix (6.b)

Forest Cover According to 1989 Appraisal

(Area in km^2)

Sr.	State/Division	Closed Forest	Degraded Forest	Forest with S. Cultivation	Non-forest	Water Bodies	Total
1	2	3	4	5	6	7	8
1	Kachin	72,718	2,292	8,119	5,147	763	89,039
2	Kayah	3,536	1,606	4,165	2,345	79	11,731
3	Kayin	12,155	1,068	11,080	5,897	182	30,382
4	Chin	17,640	882	17,062	419	14	36,017
5	Sagaing	56,950	7,157	5,163	24,201	1,150	94,621
6	Tanintharyi	33,755	1,083	5,637	2,112	756	43,343
7	Bago	14,473	1,274	5,594	16,914	1,148	39,403
8	Magway	4,864	6,884	15,433	16,205	1,433	44,819
9	Mandalay	6,630	4,303	6,611	18,710	768	37,022
10	Mon	2,739	1,130	2,804	5,032	591	12,296
11	Rakhine	20,059	1,881	3,482	8,980	2,375	36,777
12	Yangon	1,164	145	478	7,998	386	10,171
13	Shan	41,679	18,335	66,896	27,991	895	155,796
14	Ayeyarwaddy	4,907	2,928	1,865	22,649	2,787	35,136
	TOTAL	**293,269**	**50,968**	**154,389**	**164,600**	**13,327**	**676,553**
	Percent of total area	**43.3**	**7.5**	**22.8**	**24.3**	**2**	**100**

Source: An Appraisal of the Forest Cover of Myanmar Using 1989 Landsat TM Imageries.
Dr. Kyaw Tint, U Shwe Kyaw, U Sit Bo and U Aung Kyaw Myint.

Appendix (7)

Total Forest Cover in 1975 and 1989

Forest categories	Area, km^2					
	1975		1989		Change 1975/1989	
	Absolute	%	Absolute	%	Absolute	%
Actual forests	323,216	47.8	292,579	43.2	-30,637	-4.6
Forest fallow	177,520	26.2	206,047	30.5	28,527	4.3
Total	500,736	74.0	498,626	73.7	-2,110	-0.3

Source: An Appraisal of the Forest Cover of Myanmar Using 1989 Landsat TM Imageries.
Dr.Kyaw Tint, U Shwe Kyaw, U Sit Bo and U Aung Kyaw Myint.

Appendix (8)

Forest Plantation By Year and Type

(Acres)

Year	Type of Plantation				Total
	Commercial	Village Supply	Industrial	Watershed	
1	2	3	4	5	6
1896-1941	94543	22010	0	0	116553
1948-1962	3039	1710	0	0	4749
1963	1097	734	0	0	1831
1964	1997	1952	86	0	4035
1965	4322	2333	57	0	6712
1966	4080	1967	15	0	6062
1967	6318	2165	111	0	8594
1968	7500	1757	99	0	9356
1969	5219	1769	126	0	7114
1970	4769	3049	111	0	7929
1971	4038	2726	86	0	6850
1972	2602	5078	104	0	7784
1973	3721	2928	79	0	6728
1974	2276	3983	82	0	6341
1975	2916	4621	59	0	7596
1976	3731	3931	59	0	7721
1977	5058	3791	99	0	8948
1978	5562	5024	49	0	10635
1979	7927	8036	519	151	16633
1980	20769	10895	563	1119	33346
1981	28400	9029	699	4490	42618
1982	36238	8626	1300	8780	54944
1983	40286	15407	1900	10635	68228
1984	45754	17068	3541	9785	76148
1985	46026	26467	6860	10448	89801
1986	46745	19689	8515	6462	81411
1987	42804	16630	13690	6711	79835
1988	40481	14330	12251	6862	73924
1989	34130	3222	6049	2879	46280
1990	45250	14841	11300	4465	75856
1991	45107	17960	9649	3971	76687
1992	42833	19499	10201	5515	78048
1993	33124	27671	8016	7816	76627
1994	15590	31485	2200	6525	55800
1995	29000	34100	7050	10005	80155
1996	33375	33183	5500	7100	79158
Total	**796627**	**399666**	**111025**	**113719**	**1421037**
Percent	**56**	**28**	**8**	**8**	**100**

Souce: Planning & Statistics Division. Forest Department.

Appendix (9.a)

Output of Fuelwood Plantations

Sr.	Particulars	Sha	Eucalypts	B	Mezali	Sha
1	2	3	4	5	6	7
1	Locality	Mondaing	Yupadaung	Yezin	Hlaingtat	Mondaing
2	Year of Planting	1970	1972	1980	1979	1980
3	Age at the time of measurement	12	10	2	4	3
4	Spacing (feet)	12 x 12	12 x 12	7 x 7	12 x 12	12 x 12
5	Maximum d.b.h (inches)	6	11	3.5	4.5	1.2
6	Minimum d.b.h (inches)	2.5	1	1.8	0.9	0.7
7	Average d.b.h (inches)	4.1	4.95	2.4	2.6	1.04
8	Maximum height (feet)	19	62	26	23	8
9	Minimum height (feet)	13.9	12.1	16.6	9.7	5.6
10	Average height (feet)	17	38	12	17	6.5
11	Maximum crown diameter (cuft)	14.6	24.6	12	18	8
12	Minimum crown diameter (cuft)	7.8	2	4.5	7	4.3
13	Average crown diameter (cuft)	9	12	6.4	12.6	5.5
14	Maximum solid volume/tree (cuft)	1.8	20	1.26	2.6	0.13
15	Minimum solid volume/tree (cuft)	0.36	0.056	1.8	0.1	0.06
16	Average solid volume/tree (cuft)	1.27	3.79	0.63	0.9	0.09
17	Average stacked volume/tree (cuft)	2.92	8.71	1.45	2.1	0.21
18	Outturn per acre (stacked) (cutons)	17.7	52.8	25.7	12.7	1.27

Source: Fuelwood Outturn of Plantations. U Soe Tint. Planning &Statistics Department. Ministry of Forestry.

Appendix (9.b)

Production of Fuelwood from Plantations

Sr.	Species	Rotation (Year)	Production of fuelwood (Cubic ton)		Remark
			Minimum	Maximum	
1	Cassia siames (Mezali)	7-10.	-	3.4	
2	Leucaena leucocephla (B)	5-10.	6.7	9	
3	Albizia lebek (Kokko)	10-15.	-	1.1	
4	Casuarina equisetifolia (Ka-bwi)	7-10.	-	-	
5	Gmelina arborea (Yemane)	5-8.	4.5	7.9	
6	Azadirachta indica (Tama)	8	3	3.8	
7	Sesbania grandiflora (Pauk-pan-byu	5-10.	4.5	5.6	
8	Acacia catechu (Sha)	10-12.	3.8	4.5	
9	Acacia arabica (Subyu)	10	-	1.1	

Source: Planning & Statistics Division. Forest Department.

Appendix (10)

Establishment of Fuelwood Plantation and Estimation of Fuelwood Output

Sr.	Year	Area (Acre)	Estimation of Fuelwood Output			Remark
			First cut cubic-ton	Coppice cubic-ton	Total cubic-ton	
1	2	3	4	5	6	7
1	1977-78	3791	25390	2948	28338	
2	1978-79	5024	14640	5082	19722	
3	1979-80	8036	19915	4543	24458	
4	1980-81	10895	23105	8463	31568	
5	1981-82	9029	19655	4880	24535	
6	1982-83	8626	18955	6638	25593	
7	1983-84	15407	25120	7702	32822	
8	1984-85	17068	40180	6552	46732	
9	1985-86	26467	54475	6318	60793	
10	1986-87	19689	45145	8373	53518	
11	1987-88	16630	43130	13393	56523	
12	1988-89	14330	77035	18158	95193	
13	1989-90	3222	85340	15048	100388	
14	1990-91	14841	132335	14377	146712	
15	1991-92	17460	98445	25678	124123	
16	1992-93	19499	83150	28447	111597	
17	1993-94	27671	71650	44112	115762	
18	1994-95	31485	16110	32815	48925	
19	1995-96	31400	74205	27717	101922	
20	1996-97	33183	87300	23883	111183	
Total		333753	1055280	305127	1360407	

Souce: Planning & Statistics Division. Forest Department.

Note: Assuming that production of fuelwood from plantations is about 5 cubic-ton per acre when 5 years old.
Average production of fuelwood is 68,020 cubic-tons per year.

Appendix (11)

Estimate of Fuelwood Standing Stock By Division and State

(million ADT)

Sr.	State/Division	Standing Stock	Sustainable Yield				
			Forest	Sawmill Residues	Roadside,Farm, & Village Trees	Total Yield	Crop Residues
1	2	3	4	5	6	7	8
1	Ayeyarwady	62.7	0.96	0.08	0.22	1.26	1.396
2	Yangon	11.9	0.18		0.22	0.4	0.512
3	Bago	177.1	2.6	0.03	0.53	3.16	1.101
4	Shan	164.4	3.05	0.01	0.52	3.58	0.354
5	Rakhine	130.5	1.87	0.02	0.3	2.19	0.293
6	Mandalay	70.5	1.14	0.01	0.13	1.28	0.606
7	Sagaing	91.5	1.64		0.13	1.77	0.544
8	Magway	87.2	1.61	0.01	0.11	1.73	0.329
9	Mon	11.7	0.23		0.21	0.44	0.237
10	Tanintharyi	83.7	1.29	0.03	0.12	1.44	0.074
11	Chin	55.9	1.04		0.01	1.05	0.047
12	Kayah	16.8	0.33		0.02	0.35	0.025
13	Kayin	69.2	1.1		0.17	1.27	0.102
14	Kachin	89.7	1.43	0.01	0.12	1.56	0.093
	Total	1122.8	18.47	0.2	2.81	21.48	5.713

Source: World Bank, 1992. Background Report on Biomass Sector. Paul Ryan.

2. WOODFUEL FLOW/MARKET FROM PYINMANA TO YANGON: A CASE STUDY

by

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Introduction

This paper reports on a study of the woodfuel flow / market from Pyinmana to Yangon and its effect on the price of the woodfuel. It also covers the adverse effect on the growing stock of the forests around the Pyinmana environs and suggests ways to combat such disastrous effects.

In 1959, a bag of charcoal (90 lbs bag) cost K 4 in Pyinmana. At that time, there was little demand for charcoal either from Yangon or neighboring areas (Thein U, 1959). In 1985, when there was still little or no demand for charcoal from neighbouring towns and Yangon, a bag of charcoal in Yezin costs a bout K 10 and about K 15 in Pyinmana. In 1996, the price of a bag of charcoal in Yezin and Pyinmana has risen exorbitantly to K 100 and K 150 respectively, while in Yangon it is about K 300 per bag. In a matter of 11 years (from 1985 to 1996) the price of a bag of charcoal has risen from K 10 to K 150. How has this come about ?

2.1 Past and Present Production of Woodfuel and Its Flow from Pyinmana to Yangon

Myanmar is an agriculture-based country and 76% of the population resides in rural areas and their heavy dependence on the forest and its produce is of an extremely high order, particularly for fuelwood, fodder and food (National Forestry Action Programme,1995.) In fact, some of the poorest rural communities are totally dependent on forests for their livelihood. They earn their living by cutting firewood and / or burning charcoal and carrying it on foot in bags or baskets and selling it at the local village markets. Even in the rainy season, in places where the rainfall is not very high, such as in the environs of Yezin, the rural people continue their fuelwood transactions because they still have to earn some money to eat in the rainy season; indeed there is no other alternative for them

Thus, the exploitation of fuelwood is being carried out in almost all the accessible forested areas, to the extent of exceeding the carrying capacity of the forests leading to degradation and even deforestation (N.F. Action Programme, 1995) and adverse ecological and socio-economic impacts, including severe woodfuel shortages (Osei, W.Y., 1990).

Charcoal consumed in Myanmar is mainly produced from the public forests in localities where fairly extensive areas of suitable species still exist. The main consumers are the residents and industries in big towns. The main charcoal producing divisions are Insein, South Pegu, Yamethin, Thayetmyo, Minbu, East Katha, West Katha and the divisions of the Shan State.

Charcoal for Yangon town is brought in from Delta, Insein, south Pegu and Yamethin Divisions. (Thein, U, 1959).

Firewood consumption for the whole country amounted to 7,896,333 tons (in solid wood) and charcoal consumption amounted to 309,932 tons (charcoal converted to firewood in 1959). Therefore, the total consumption of firewood and charcoal for the whole country amounted to 8,206, 265 tons of firewood (in solid tons) in 1959.

Myanmar fuelwood production for household energy (both urban and rural) from degraded forests, fuelwood plantations, *taungya* effected forests and certain closed forests was 18 million cubic meters in 1994-95, equivalent to 12,713,281 tons (NFAP, 1995), while the actual amount of fuelwood for household consumption amounted to 8,206, 265 tons in 1959 (Thein, U, 1959). The population of Myanmar in 1959 was 21.938 million while in 1994 it was approximately 43 million. Population-wise, if we double the 1959 figure, the projected fuelwood consumption in 1994 would amount to 16,412,530 tons. This is a very conservative estimate but still it exceeds the 1994 actual production of 12,713,281 by 3,699,249 tons. Fuelwood consumption for the whole country is projected at 41.72 million cubic meters by 2000.

The flow of fuelwood from town to town and from Pyinmana to Yangon can be said to have been stagnant in 1959 as fuelwood was seemingly self-sufficient for the towns in each forest division except in the Dry Zone, the critically fuel deficient states and divisions, and in Yangon city which received fuelwood from the delta regions.

The total production of fuelwood and hardwoods in 1959 was 8,401,578 tons and 574,951 tons, respectively with a corresponding percentage of 93.6% and 6.4% of the combined production.

The 1959 -1966 data show an average yearly increase of 186,590 tons in the consumption of fuelwood for the whole country. Thus, from 1959 to 1994, there was to be an increase of 6,350,650 tons (Gale D.G., 1968). This figure is, of course, a very conservative estimate. Therefore, the projected fuelwood consumption in 1994 would be 14,752,228 tons (i.e. 8,401,578 + 6,350,650). Population-wise, if we double the 1959 consumption of 8,401,578 tons, it amounts to 16,803,156 tons. Both these projected conservative estimates exceed the 1994 actual production of 12,713,281 tons by 2 to 3 million tons. It should be noted that some official statistics may underestimate woodfuel consumption in some countries by as much as 20 times (Openshaw, K., 1978).

Using the estimate of the National Academy of Sciences in which a rural person burns as much as a ton of firewood a year, the present Myanmar rural population of 34.2 million (76% of 45 million) would burn 34.2 million tons or 48.42 million cubic meters of firewood a year which exceeds the fuelwood projection of 41.72 million cubic meters for the year 2000 by 6.70 million cubic meters (NFAP, 1995).

No record was available for the flow or market of charcoal and firewood from Pyinmana to Yangon 30 years ago. However, 37 years ago U Thein(1959), in his report to the FAO, indicated that there was little or no flow of, or market for, charcoal and firewood from Pyinmana to Yangon but that there was some flow of fuelwood from Yamethin to Yangon.

From appendix A, it can be seen that a considerable volume of charcoal was exported to Yangon from Pyinmana ranging from 11,311 tons in 1991-92 to 28,948 tons in 1993-94, from 6,681 tons to 15,254 tons from Takkon and 3,254 tons to 18,990 tons from Lewe.

The flow from Tharyarwaddy township ranged from 3000 tons in 1991-92 to 16,500 tons in 1995-96. For the Pyay township, the flow decreased from 27,190 tons in 1992-93 to 1,310 tons in 1995-96. From the Insein township, the charcoal flow was only 3,397 tons in 1994-95 and 3,923 tons in 1995-96. Ironically, the charcoal flow from far away Thazi increased from 133 tons in 1992-93 to 2,539 tons in 1994-95 and decreased to 1,185 tons in 1995-96. It seems that it is still remunerative to transport charcoal to Yangon which is over 330 miles from Thazi. Possibly, the price of charcoal in Yangon has gone up to the extent that it covers the cost of transporting the charcoal and at the same time allows considerable profit. There is no recorded flow from Thazi to Mandalay which is considerably nearer to Thazi than to Yangon, except for a 10 tons flow in 1993-94. Probably, the price of charcoal in Mandalay is not high enough to encourage traders to make such transactions to Mandalay.

At present there is no flow or market of firewood from Pyinmana to Yangon. It is definitely not remunerative to transact firewood from Pyinmana to Yangon. However, it seems profitable to transact firewood from Lewe which is just 10 miles away from Pyinmana, indicated by the fact that there is an increase of flow from 666 tons of firewood in 1992-93 to 3,885 tons in 1995-96. (Appendix B).

There is no flow or market of firewood to Yangon either from the Tharyarwaddy township or the Pyay township.

Taikkyi is the only town from the Insein township to export firewood to Yangon with 15,644 tons in 1994-95 and 4,807 tons in 1995-96 (Appendix B).

The annual production of firewood ranges from 7,236 tons in 1933-34 to 19,270 tons in 1992-93 in Yamethin township, from 10,607 tons in 1995-95 to 50,587 tons in 1994-95 in Insein township, from 7,215 tons in 1995-96 to 14,047 in 1994-95 in Pyay township, and from 6,284 tons in 1993-94 to 15,818 tons in 1992-93 in Tharyarwaddy township (Appendix B).

Annual charcoal flow/market ranges from 19,559 tons to 58,120 tons in Yamethin township, from 3,397 tons to 3,923 tons in Insein township, from 1,310 tons to 27,109 tons in Pyay township, and from 3,000 tons to 16,500 tons in Tharyarwaddy township (Appendix A).There may be some variation in the annual flow of both charcoal and firewood depending upon the market demand, price of the commodities and the cost of transporting the commodities. The increasing flow of charcoal to Yangon in the past 5 or 6 years indicates the scarcity of charcoal in Yangon and one of the obvious results of this scarcity is the rising price not only in Yangon but also in Pyinmana. The rising price has made the export of charcoal to Yangon very lucrative, indeed so lucrative that charcoal production in Pyinmana is now solely directed to this export market resulting in an artificial scarcity of charcoal in Pyinmana and a subsequent exorbitant price-rise from K15 to K 150 for a bag of charcoal. Other than these exports of charcoal and firewood to Yangon, a considerable volume of firewood and charcoal is also utilized for domestic use, by rural cottage industries, and by the Pyinmana sugar mill factory. This, together with the unrecorded production and the growing demand of the increasing rural and urban population of Pyinmana township, has led to the same adverse affects as mentioned before. It should be borne in mind that the data in this paper are from officially recorded data and the deficits are from unrecorded production (Han, S., 1990).

For example, country-wise, in 1979, for the total consumption of 10.7 million tons, there was an official production of only 0.98 million tons, the deficit of 9.77 million tons being supplied by un-recorded production (Han, S., 1990).

From the projected data of U Thein (1959) there was an annual increase of fuelwood consumption of only 186,590 tons which is very low as the figures are projected from the old 1959-66 data. However, an annual increase of consumption of 1 million tons is more realistic taking into consideration an annual increase of 1 million people for the whole country. This has exerted a heavy toll on the productive capacity of the local supply reserves (which are meant to supply fuelwood) to the extent that they are no longer productive and fuelwood is now extracted from the public forests and even illegally from reserved forests (Han, S., 1990).

2.2 The Adverse Effects of Overtaxing Forest Resources

In Pyinmana township, heavy extraction of firewood and charcoal has been carried out, legally or otherwise, for domestic consumption, cottage industries and particularly trade when a market (especially in Yangon) for charcoal became established. The extractions for trade have been carried out beyond the carrying capacity of the accessible forests resulting in the degradation and denudation of the forests.

Furthermore, the rural population almost always use firewood for domestic purposes (they rarely use charcoal) and their method of gathering firewood and their indiscriminate use of firewood has an adverse effect on the growing stock of the forests, particularly the saplings and poles. Every year, indiscriminate cutting of saplings and poles, including the valuable commercial species such as teak, pyinkado, padauk etc., is carried out as and when the people are in need of firewood. Usually, they have the habit of cutting very young and small saplings so that they can use them after only a short period of 3 or 4 days drying in the sun. Some of them stockpile them for the rainy season which has the adverse affect of greatly reducing the growing stock of forests, particularly the valuable commercial species. If the local supply forests become unproductive, they go to the public forests and finally to the reserved forests when the public forest’s stock of saplings and poles becomes depleted. Sometimes they also cut firewood for trade to earn some extra-income resulting in a very depleted stock of saplings and poles. Eventually, the neighbourhood becomes denuded and the land becomes bare, except for some local useless grasses. After years of repeated annual fires and erosion, the bare rock becomes visible and this is the ultimate destiny of once very productive forest lands.

This denuded neighbourhood area continues to expand as time goes on, compounded by annual fires which kill all the fire tender species which sprout during the rainy season. So it is not only the charcoal trade which has a very adverse affect on forest resources but also the indiscriminate cutting and use of firewood by the rural people which form the majority of the population of Pyinmana township.

The writer undertook an exercise in which 58 trees of varying sizes, particularly of saplings and pole size, were used so as to work out the estimated number of trees (of varying girth) that have to be cut down to produce 1 ton of firewood or 1 bag of charcoal. Branches were measured down to 0.4' mid-girth.

From table 1 it can be seen that a tree of GBH 0.6 feet produces only 0.06905 cu ft. Table 1 shows the corresponding number of saplings, poles or posts of varying GBHs to produce 1 ton of firewood or 1 bag of charcoal. This is just a crude estimate giving a graphic picture of the enormity of the detrimental affects on the country's forest resources and of the ecological degradation, particularly of the young growing stock which would have ultimately formed the future Annual Yield and Annual Allowable Cut had it not been cut down for firewood and charcoal production.

2.3 Discussion and Conclusions

The most critical impacts of woodfuel use (beyond the carrying capacity of the resources) are those of an ecological nature, namely, the loss and/ or degradation of the natural vegetation and also the socio-economic stress imposed upon the poorer rural population (Osei, W.Y., 1990). The situation is not yet critical in terms of depletion in all states and divisions although it has been or is critical in Yangon, Ayeyarwaddy, Mon State, Mandalay Division, Magway and Sagaing Division. This, of course, results in a greater flow from the divisions or states or towns which still have ample fuelwood to the deficient states, divisions and towns. The greater the extent of the scarcity, the higher the price rise, as is evidenced by the Yangon situation. The price will rise if the demand is not met. And if the demand is met by the practises described earlier severe adverse ecological and socio-economic effects will result. We are thus in the horns of a dilemma.

The depleting growing stock of our forests, particularly the saplings and poles, due to overtaxing our forest resources for woodfuel and other forest products, produces a chain reaction not only in reducing the Annual Allowable Cut and the overall yield from our forests but also the food production system and general economy of the country. The demand for woodfuel will rise due to growing population, both urban and rural, and the growing urban demand for charcoal results in rapid escalation of deforestation (Kalapula, E.S., 1989) .The increase in population has simply swallowed up most moderate efforts at tree planting. It is obvious, therefore, that the rise in energy demand ,including demands for firewood ,could partially be curbed by family planning (National Academy of Sciences, 1980).

Myanmar is using a tremendous amount of fuelwood annually amounting to 17.235 million tons in 1990 (Han, S., 1990) while the projection from 1959 data (U Thein, 1959) amounted to 16,412,530 tons for 1994. The actual production for 1994 was only 12,713,281 million tons (NFAP, 1995). An annual deficit of approximately 4 million tons of fuelwood is a very large amount of wood which would amount to 2,896 million trees of 0.6 foot GBH or 148 million trees of 1 foot GBH or 44 million trees of 2 foot GBH. On average, we have to plant 1,029 million trees to accommodate the annual increase in the consumption of woodfuel. If we take it sapling-wise, (i.e. from 0.6-0.9 foot GBH.), on average we require 973 million saplings (973/4 =243.25) to accommodate the annual increase in fuelwood consumption of 4 million tons. Pole-wise, (i.e. from 1.0 to 1.9 feet GBH.), we require 81.6 million poles (204/10= 20.4) to accommodate the same 4 million tons annual increase in fuelwood consumption. If we take it post-wise, (i.e. from 2.0 to 2.9 feet GBH), we require 34.4 million posts (86/10=8.6) to accommodate the same increase in consumption. Collectively, we require 363 million saplings, poles and posts to accommodate the annual 4 million tons fuelwood consumption increase. {(973+81.6+34.4)/3 =363}

If our annual consumption of fuelwood amounts to 17 million tons (Han, S., 1990), we will have to cut down 4135.25 million saplings or 346.8 million poles or 146.2 million posts or collectively cut down 1542.75 million saplings, poles and posts from our remaining forest reources. Such an enormous fuelwood problem appears insurmountable (See Table 1).

Han (1990) has given a very thorough and comprehensive analysis of the Myanmar fuelwood situation and has suggested some suitable strategies to resolve the country's fuelwood problem. These include bioenergy plantations integrated into sound land-use planning for rural community development. These would act as buffers between the high-value forests and the rural communities who live off the land. The annual percentage of fuelwood plantations should be raised from 25% to 40% and thus saving the high-value natural stands. Matching of site to species is of great importance to acquire the highest possible mean annual increment. He also pointed out that there are other variables that are hard to resolve and which aggravate the fuelwood problem; they are:

1. containing and stopping illegal and unrecorded extractions in natural stands and in plantations.
2. ensuring proper treatment and maintenance of the plantations
3. switching to alternative energy sources and
4. patterns of demographic change.

It is of utmost importance to rehabilitate the denuded public forests and reforest the local supply reserves (Han, S., 1990). Governments of nearly all the wood-deficit countries have had tree planting programmes - in some cases for decades. But for most of them, the sheer magnitude of the need for fuelwood and the growth in demand makes the problem seemingly insurmountable. Another problem is that those in office who are supposed to combat the problem seem not to be really aware of the urgency of the increasing scarcity of firewood. Perhaps one reason that the firewood scarcity has not provoked world attention is that the shortage appears essentially local and seems limited in its consequences to the actual users of the wood. But the problem is spreading into large areas, increasing in severity year by year, and exacerbating other problems leading to deforestation and reduction in food production on a global scale (National Academy of Sciences, 1980).

In the Myanmar situation , it would be well worth planting bioenergy plantations of ***Acacia mangium*** in the high-rainfall area of lower Myanmar on a very extensive scale. This tree has been successfully planted in Indonesia and Malaysia for decades on millions of hectares of various kinds of land, including marginal land, to supply pulp to the paper mills. It could also be planted in large areas around the Sittaung Paper Mill and Yene Paper Mill. The species is relatively easy to propagate (either from seed or by vegetative means), shows fast early growth, and can grow satisfactorily on otherwise unproductive sites. It is particularly suitable for controlling soil erosion and weeds in areas heavily infected with Imperata grass. Its wood can be used for pulp, saw timber , and the wood chips for particle hardboard , medium density fiber board , pulp and paper industries, and fuelwood and charcoal due to the wood's good calorific value (Awang, K and Taylor, D., 1993).

Up to 1993 Indonesia had planted 1.8 million ha.of ***A. mangium*** plantations and by 1999/2000, a total of 6.2 million ha of plantations will have been established to produce pulp, paper, rayon, building materials, furniture and energy. The tree has been successfully introduced into Malaysia, Thailand , Taiwan, China and Vietnam, both as fuelwood plantations and timber stands in mixed forests (Awang, K and Taylor, D.,1993). It can also be planted in high rainfall ,non- forest areas such as farms, unused land, school yards, *Kyaungs*, market squares, parks , home gardens and in village communities to combat the fuelwood problem. By using a shorter rotation of 6 years, the heart-rot attack at 8 years old (Malaysian experience) can be overcome. At present , there is no heart-rot attack on ***A. mangium*** in the environs of Pegu and they are thriving very well and have grown over 3 feet GBH. In the humid tropics where the average rainfall is 70-80 inches ***Acacia auriculariformis*** should be tried out for bioenergy plantations. In the Dry Zone , Eucalyptus and some other indigenous species such as ***Cassia siamea*** and particularly ***Leucaena Leucocephala*** can be planted on a very extensive scale to combat the fuelwood deficit in Myanmar. In extreme situations or conditions where the introduction of other species has been unsuccessful, Eucalyptus can be tried as there are instances where it has been successfully introduced in stringent conditions where the annual rainfall is only 12 inches to 15 inches.

The continued destruction of our forests as a result of illegal cutting and marketing , slash and burn practices, conversion of forest area for farming, infrastructure development and settlement has seriously reduced our growing stock, particularly of valuable commercial species. The over-exploitation has caused a shortage of both timber and woodfuel, especially woodfuel (firewood) for household uses, resulting in the exorbitant price rise of both commodities which imposes severe socio-economic stresses on the poorer communities. There is an urgent need to alleviate these stresses and one way of combating this is through a massive reforestation programme. The concept is simple enough but the implementation is not. Even when the political will is there and enough funds are allocated , reforesting vast areas is most difficult and complex. Planting millions of trees and successfully nurturing them to maturity is quite difficult, and thus these reforestation programmes frequently fail.

To be successful, reforestation efforts require a formidable administrative super- human effort to protect the young trees for years until they can be harvested. Reforestation also requires massive popular support. In country after country, the lesson is that tree planting programmes are most successful when local communities are involved and when the people, including foresters and administrators, become aware of the gravity of the problem and perceive clearly that tackling it is for their own good. They must become active participants in conserving what is part of their national heritage. History has shown that civilizations have declined as a result of the mismanagement of soil and natural resources.

There is no single magic solution to the woodfuel problem but some blend of fuel conservation, extensive tree planting and reforestation and new technologies could certainly relax its stranglehold on any country. The failure of many affected countries to meet the woodfuel challenge does not, in the final analysis, reflect an absence of effort and suitable technologies but rather a failure to establish a coordinated approach to management pertaining to local assessments, local participation, decentralization, a multidisciplinary approach and social organization (Mearns, R. and Leach, G., 1989).

Table 1. Showing the respective no. of trees to produce one ton of firewood or one bag of charcoal for the corresponding GBHs.

G.B.H (ft)	Volume (ft^3)	No. of trees to produce 1 ton of firewood	No. of trees to produce 1 bag of charcoal
0.6	0.06905	724	241.4
0.7	0.38698	129	43.1
0.8	0.70492	71	23.6
0.9	1.02286	49	16.3
1	1.3408	37	12.4
1.1	1.65874	30	10.0
1.2	1.97667	25	8.4
1.3	2.29461	22	7.3
1.4	2.61255	19	6.4
1.5	2.93049	17	5.7
1.6	3.24842	15	5.1
1.7	3.56636	14	4.7
1.8	3.8843	13	4.3
1.9	4.20224	12	4.0
2	4.52017	11	3.7
2.1	4.83811	10	3.4
2.2	5.15605	10	3.2
2.3	5.47399	9	3.0
2.4	5.79192	9	2.9
2.5	6.10986	8	2.7
2.6	6.4278	8	2.6
2.7	6.74574	7	2.5
2.8	7.06367	7	2.4
2.9	7.38161	7	2.3
3	7.69955	6	2.2
3.1	8.01749	6	2.1
3.2	8.33542	6	2.0
3.3	8.65336	6	1.9
3.4	8.9713	6	1.9
3.5	9.28924	5	1.8
3.6	9.60718	5	1.7
3.7	9.92511	5	1.7
3.8	10.2431	5	1.6
3.9	10.561	5	1.6
4	10.8789	5	1.5
4.1	11.1969	4	1.5
4.2	11.5148	4	1.4
4.3	11.8327	4	1.4

Appendix A Charcoal Flow/ Market to Yangon

Annual Production / Flow to Yangon   in tons

Towns	1991-92	1992-93	1993-94	1994-95	1995-96
	Yamethin Township				
Yamethin	-	-	-	-	-
Byawbe	-	-	-	-	-
Takkon	4480 / 8248	13351 / 06681	6000 / 10182	11000 / 15254	10364 / 7676
Pyinmana	7186 / 11311	33547 / 24903	10000 / 28948	18379 / 27622	11819 / 20935
Lewe	7710 / -	10304 / 8274	10000 / 18990	8790 / 3254	9711 / 3916
Total (Flow to Yangon)	19559	39858	58120	46130	32527
	Pyay Township				
Thegon	-	-	-	-	-
Shwedaung	-	-	-	-	-
Pandaung	-	23200 / 23200	10000 / 10000	6600 / 6600	- -
Paukkaung	-	3000 / 3990	7500 / 7365	3250 / 1596	- / 1310
Total (Flow to Yangon)	-	27109	17365	8196	1310
	Tharyarwaddy Township				
Tharyarwaddy	-	-	2000 / 2000	1500 / 1500	1000 / 1000
Letpadan	-	1000 / 1000	2000 / 2000	2000 / 2000	1000 / 1000
Minhla	1000 / 1000	-	-	1500 / 1500	-
Okpo	2793 / 2000	6200 / 6200	8000 / 8000	6000 / 6000	829 / 400
Gyobinkauk	-	-	2000 / 2000	1900 -	- / 700
Nattalin	-	-	-	2000 / 2000	13400* / 13400
Zigon	-	-	-	-	-
Total (Flow to Yangon)	3000	7200	14000	13000	16500

* Taungnyo Dam area

Appendix A (Contd.)

Towns	1991-92	1992-93	1993-94	1994-95	1995-96
	Insein Township				
Hlegu	-	800	1000	1290	1000
		-	-	-	-
Hmawbi	-	-	-	-	-
Taikkyi	-	-	-	3397	3923
				3397	3923
Total (Flow to Yangon)	-	-	-	3397	3923
Thazi	2000	3000	3000	3000	3000
	-	133	532	2539	1185
Nyaunglaybin	-	-	-	-	-
Kyauktaga	-	200	-	500	3000
		-		500	500
Total (Flow to Yangon)		133	532	3039	1685
Grand Total (Flow to Yangon	22559	74381	77417	73762	55945

Appendix B Firewood Flow / Market to Yangon

Annual Production / Flow to Yangon — in tons

Towns	1991-92	1992-93	1993-94	1994-95	1995-96
Yamethin Township					
Yamethin	-	-	-	-	-
Byawbe	2847 / -	1500 / -	1209 / -	1443 / -	1615 / -
Takkon	669 / -	5036 / -	3855 / -	6844 / -	6100 / -
Pyinmana	2529 / -	6287 / -	2127 / -	8097 / -	9325 / -
Lewe	7264 / -	6447 / 666	- / 1816	272 / 2336	1485 / 3885
Total Annual Production / Flow to Yangon	13309 / -	19270 / 666	7230 / 1816	15213 / 2336	18525 / 3885
Pyay Township					
Thegon	- / -	1062 / -	1903 / -	1198 / -	49 / -
Shwedaung	-	269 / -	484 / -	1045 / -	427 / -
Pandaung	-	1350 / -	934 / -	1581 / -	1450 / -
Paukkaung	-	5108 / -	2523 / -	10223 / -	5298 / -
Total Production	-	7789 / -	5844 / -	14047 / -	7215 / -
Tharyarwaddy Township					
Tharyarwaddy	-	1603 / -	876 / -	3477 / -	1663 / -
Letpadan	2872 / -	3379 / -	1320 / -	3040 / -	1026 / -
Minhla	454 / -	5761 / -	289 / -	2673 / -	1004 / -
Okpo	1356 / -	1619 / -	796 / -	1247 / -	1900 / -
Gyobinkauk	834 / -	831 / -	517 / -	1915 / -	1344 / -
Zigon	2871 / -	2625 / -	2486 / -	1957 / -	300 / -
Nattalin	-	-	-	-	-
Total Production	12448	15818	6284	14309	7237

Appendix B (Contd.)

Towns	1991-92	1992-93	1993-94	1994-95	1995-96
Kyauktaga	-	2090 -	2914 -	2539 -	1271 -
Thazi	8811 -	12556 -	14880 -	13720 -	3333 -
Nyaunglaybin	-	-	-	-	-
Total	8811 -	14646 -	17794 -	16259 -	4604
	Insein Township				
Hlegu	-	15560 -	10948 -	34943 -	5800
Hmawbi	-	-	-	-	
Taikkyi	-	8224 8224	4542 4542	15644 15644	4807 4807
Total	-	23784 8224	15490 4542	50587 15644	10607 4807
Grand Total Flow to Yangon (from available data)	34568 -	81307 8890	52648 6358	110415 17980	48188 8692

Appendix C Data from felled trees showing the corresponding volumes

NO	SPECIES	GBH(ft)	VOLUME(ft^3)
1	LUNBO	1.6	1.54
2	IN	1.4	2.89
3	KYUNGAUTNWE	1.5	1.27
4	LUNBO	1.3	1.82
5	INGYIN	1.65	4.04
6	THITKYI	1.6	3.68
7	KYUNGAUTNWE	1.1	1.31
8	KABAUNG	0.75	0.55
9	THITKYI	0.98	0.99
10	LUNBO	0.95	1.03
11	KABAUNG	0.88	0.73
12	IN	1	1.25
13	MAZALI	1.26	1.67
14	BAWZAGAINE	0.75	0.63
15	NIPASAE	0.7	0.35
16	HTAUKKYANT	0.92	0.98
17	IN	1	1.52
18	NIPASAE	0.95	0.93
19	THANDAE	1	1.06
20	TAWTHAPAY	0.88	0.85
21	TAWTHAPAY	0.93	0.90
22	HTAUKKYANT	0.83	0.85
23	HTAUKKYANT	0.92	0.95
24	PHANKHA	1.25	2.29
25	THITKYI	1.2	1.59
26	INGYIN	1.08	1.74
27	IN	1.22	1.99
28	KYUNGAUTNWE	1.2	1.68
29	THINWIN	1.27	2.12

NO	SPECIES	GBH(ft)	VOLUME(cf^3)
30	SIT	1.43	2.64
31	THINWIN	0.8	0.75
32	BAWZAGAINE	1.19	2.13
33	KYUN	1.25	2.73
34	KYUN	1.19	2.03
35	PADAUK	1.25	2.23
36	PADAUK	0.9	1.26
37	DAHAT	1.18	0.78
38	DAHAT	0.9	0.68
39	DAHAT	0.93	1.38
40	YINMA	1.42	4.10
41	YINMA	1.15	2.05
42	YAMANAE	1.06	1.60
43	KYUN	0.95	1.26
44	KYUN	1.29	2.80
45	KYUN	0.85	0.83
46	KYUN	1.02	1.37
47	KYUN	1.09	1.51
48	KYUN	1.14	2.17
49	KYUN	1.03	1.72
50	KYUN	0.77	0.74
51	KYUN	0.93	1.14
52	KYUN	0.79	0.73
53	KYUN	0.78	0.70
54	KYUN	1.24	2.42
55	KYUN	1.14	3.02
56	KYUN	1.4	3.23
57	KYUN	1.42	3.05
58	KYUN	0.98	1.13

2.4 References

Asian Institute of Technology, 1984	Fuelwood Strategies and Action Programs in Asia.
Awang, K. and Taylor, D., 1993	Growing and Utilization of Acacia mangium. Winrock International Institute and FAO. Bangkok. Thailand.
Awang, K. and Taylor, D., 1993	Acacias for Rural, Industrial and Environmental Development. Winrock International Institute and FAO Bangkok. Thailand.
Eckholm, E., 1975	The Other Energy Crisis. Worldwatch Paper. 1. Worldwatch Institute, Washington, D.C. USA.
FAO Field Document No. 12, 1989	Wood Based Energy System in Rural Industries and Village Applications. Philippines.
Forest Department, Burma, 1995	National Forest Action Plan. Issues and Options.
Gale, Mg, 1968	Report on the Investigation into the Energy Resources, Firewood and Charcoal Sector. Forest Department (In Burmese).
Han, Saw, 1990	Analysis of the Fuelwood Situation in Myanmar.
Kalapula, E.S., 1989	Woodfuel Situation and Deforestation in Zambia.
Mearns , R. and Leach, G., 1989	Energy for Livelihoods: Putting People Back into Africa's Woodfuel Crisis.
National Academy of Sciences, 1980	Firewood Crops, Shrubs, Tree Species for Energy Production. Vol. I
National Academy of Sciences, 1983	Firewood Crops, Shrubs, Tree Species for Energy Production.
Openshaw, K., 1978	Woodfuel : A time for Re-assessment .
Osei, W.Y., 1990	Woodfuel Use in Ghana: Its Nature and Impact at the Village Level.
Thein, U., 1959	The Fuelwood Situation in Burma. FAO Occasional Paper No. 6.

3. The Dissemination of A-1 Fuelwood Cookstoves

by

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Introduction

The woodfuel consumption of Myanmar is relatively high and increasing at the rate of 2.3%. per year. Domestic home cooking accounts for about 99% of the total amount of fuelwood consumed in the country.

In order to solve the problem of energy supply for cooking and other domestic uses, efforts on increasing biomass production and its efficient conversion into energy have to be meticulously planned and implemented. The Forest Department (FD) has launched a project to establish fery large scale plantations to meet the woodfuel demand. Several fast growing species are being introduced and planted. However, it will take some time before these plantations are able produce woodfuel. It is, therefore urgent to bridge the gap between woodfuel demand and supply in order to avoid the depletion of forests.

3.1 Improved Cookstove Development Programme in Asia

In the majority of countries in South East Asia, traditional cookstoves are commonly used by the rural community and fuelwood is the main source of energy in these stoves. Because of the carbon cycle involved in the burning processes the stoves pose a health hazard. However, the people neglect this hazard as they have no alternative to this energy source. Awareness of the fact that a traditional cookstove is inefficient and creates a bad environment has led to efforts to develop an improved cookstove (ICS). Indeed the creation of an ICS has become a preliminary objective of research in energy development.

Such a research programme to develop an improved cookstove was initiated in India in 1950. The main thrust of this work was the reduction of smoke intensity in the kitchen. A number of research institutes throughout India developed a modified type of the traditional mud Chula. Work was also initiated on developing more fuel efficient coal fire stoves. Subsequently, the international stove programme was initiated by the Food and Agriculture Organization (FAO) of the United Nations in 1961. Mr. Singer, an FAO consultant developed a number of high-mass brick and mud chimney stoves.

Real interest in the development of stoves was kindled in 1976 when the oil crisis occurred. It was also realized that the forests of the world were rapidly depleting and thus the emphasis changed from the health aspects of the ICS to the energy conservation aspect. The first Research and Development (R&D) programme was initiated in Guatemala where a group of US volunteers were working on a relief programme with the indigenous people.

A statistical approach using, factorial analysis was developed, to determine whether changing dimensions in the stove, fuel type, and environmental conditions such as wind had a significant impact on the performance of stoves.

Similar experimental programmes were carried out in India, Thailand and Kenya on both wood and charcoal stoves.

Many developing countries in Asia have been implementing an ICS programme for a number of years. However, the development pace and achievement among countries vary widely. In some countries large-scale national programmes have been in operation for many years, such as in China, India and Sri Lanka while others are still in various pilot stages.

The Regional Wood Energy Development Programme (RWEDP) in Asia under the FAO was established in 1985, in order to accelerate wood energy development activities in the region. At present 15 countries namely, Bangladesh, Bhutan, China, India, Indonesia, Laos, Malaysia, Maldives, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand and Vietnam are involved in this programme with Cambodia having observer status.

Among the various activities pursued by this project is an ICS development programme. Several Regional Training Courses on ICS production and various Expert Consultations have been organized in various member countries.

3.2 Improved Cookstove Development Programme in Myanmar

The traditional open-fire stove which is most widely used in the rural area of Myanmar has an efficiency of only about 5 to 15%. Its efficiency could be enhanced to about 10 to 25% with the ICS. This would mean a 50% saving of fuelwood at least. So if all the existing cookstoves within the country could be replaced with improved ones, the demand for fuelwood would be reduced drastically. This would then be within the supply range of the sustainable source, so that there would be no need to overcut the forest.

The Myanmar ICS programme started in the Forest Research Institute (FRI), Yezin in 1986. Initially, traditional commercial stoves were studied and some ICSs were developed and tested.

3.2.1 Research on the 'One Stick Fuelwood Cookstove'

Research on the 'one stick fuelwood stove' was initiated in 1987 (Doo, C.,1987). At first the stove was made of galvanized sheet, which later was replaced by locally available clay. Based on limited field trials in nearby village households, the results were quite encouraging: 38% of the fuelwood is saved, cooking time is reduced and the cost is reasonable. On the other hand, the stove cracks quite early and some improvement in the raw material used is said to be necessary. It is also rather heavy and not easily portable.

3.2.2 Research and Development of A-1 Fuelwood Cookstove

Some fuelwood and charcoal cookstoves were made and tested at FRI in 1992. The original designs were developed by the National Energy Administration and the USAID. Some sample stoves were supplied by RWEDP through the Pilot Watershed Management Project for Kinda

Dam, Phugyi and Inlay Lake Project-(MYA /81/003). Some 160 fuelwood stoves were made initially. Out of these, 45 stoves were given to the Pilot Watershed Management Project for field trial. The stoves were said to be distributed to the Mintain-bin , Southern Shan State region which is one of the project areas.

According to information collected from the users, the new cookstove:

(a) can save about 30% of fuelwood consumption compared to the traditional cookstove

(b) does not last long. Some cracks were formed within a few months.

Based on the experiences gained so far, different mixing ratios of clay, rice husk and grog were tested to improve the durability. Taking the best mixing ratio of clay and grog, 500 stoves were produced with a change in the stove's air-inlet. Instead of placing one air-inlet directly under the firewood feeding hole, two air-inlets were placed at the sides so the stove would be able to bear the weight of firewood without breaking.

Out of these 500, 432 stoves were sold to households in 40 villages near Yezin. The price of the stove was 100 Kyats. The addresses of the buyers were noted for further observation.

Evaluation of the performance of the stoves was carried out at three villages, Seinsapin, Thayet-taw and Laetha in March, 1994. Data on fuelwood consumption, cooking time, durability, smokiness, etc. were collected at 21 households. The families visited consisted of 2 to 11 members and the amount of fuelwood used with the traditional stove is said to be in the range of 2 to 10 cartloads (1 cartload = 45 ft^3 = 1.27 m^3). After introducing the FRI cookstoves, the fuelwood consumption was reduced to 1 to 6 cartloads. Although the sample size is small, there is a definite indication that about 49% of fuel- wood is saved and also a saving of time in cooking compared to the traditional open-fire cookstoves. The quality of the stoves was improved at a later stage of development and is now more durable.

As the stoves become popular and the need of mass production became necessary it was thus desirable to designate a proper name. Therefore, the Name "A-1" was given to the stove as the rural population were very familiar with the popular A-1 Movie Production Company.

Table 1. Status of A - I FuelWood Cookstove Dissemination

Sr.No.	Name & Address of A-1 Stove Factory	Starting Date	Type Manual / Moulding	Quality	No. of A-1 Stoves Manufactured up to 9/96	Regions to which Stoves Disseminated	Remarks
1	FRI , Yezin	Oct-94	both	good	24,000	Nine Arid Zones, Middle part of Myanmar, Fuelwood Proj. Area,Watershed Proj. Area,PSI*.	continuing
2	U Myint Swe, Tat-kone	Dec-94	moulding	fair	9,000	Tat-kone, Yemethin, Pyawbwe, Leiway	ceased, because of the high payment of stove-makers
3	U Kyi Win, Pathein	Dec-94	moulding	poor	8,000	Bogalay, Latputta, PSI*	continuing
4	Co operative, Kokko-gwa village, Taungdwingyi Township	Dec-94	moulding	fair	700	Taungdwingyi	ceased, because of the high payment of stove-makers
5	Daw Ohn Kyi, Pyinmana	Jan-95	manual	good	3,000	Yeminthin District	produced by the special request of Yemethin District LORC
6	U Hla Kyaw, U Hla Myint, U Tin Aung, U Mya Thaung, U Tin Hnwe, U Hla Win, Daw Myint Khaing, etc., Mae-zalikan Village, Thazi Township	May-95	moulding	fair	20,000	Watershed Proj. Area,Thazi, Meik-htila, Nwa-hot-gyi	continuing almost all potters from the village are making A-1 stoves
7	U Hla Nyunt Maung, Salin	May-95	moulding	fair	600	Salin	ceased, because of the abund - ance & availability of rice husk
8	U Aye Lwin, Kokko-gwa Village, Taungdwingyi Township	Jul-95	moulding	fair	11,000	Magwe, Taungdwingyi, Yenan-chaung, Kyaukpadaung, PSI*	continuing
9	Daw Khin Khin Gyi, Daw Cho Aye, Daw Khin Myo Oo& Daw Lwin Khaing, Chaung Oo	Aug-95	moulding	fair	8,000	Chaung - Oo, PSI*	continuing
10	Win Ngwe Toe-Cooperative, Kyaukpadaun	Aug-95	moulding	fair	5,500	Kyaukpadaung	continuing
11	U Soe Aung, Pathein	Aug-95	moulding	poor	1,500	Bogalay, Myaungmya, Latputta, Kyankhinn, Yangon	continuing
12	Daw Aye Aye Than, Au-yaw, Pindaya	Sep-95	manual	poor	550	Pindaya	poor quality, very slow production, no baking kiln, going to build a kiln
13	U Myint Swe, Kyauktaing, Inlay	Sep-95	manual	poor	650	Inlay	poor quality, very slow production, no baking kiln, going to build a kiln
14	Co-operative, Na-hto-gyi	Oct-95	moulding	fair	5,500	Na Hto-gyi, Taung tha, Myingyan, Mandalay	temporarily stopped, hired 2nd batch trainees from Thazi
15	U Zaw Min Htoo, Pyinmana	Oct-95	manual	good	1,400	purchased by FRI	trained & guided by FRI
	Total No. of A-1 Fuelwood Cookstoves Manufactured				**99,400**		

*** PSI -- Population Services International, Yangon** - Fuel-Efficient Cookstove Marketing Pilot Project disseminated A-1 stoves in North-Dagon, Hlaingthaya, Shwe Pyi Thar, Dala & Thanlyin townships.

3.3 Dissemination Programme of A-1 Fuelwood Cookstoves

A committee headed by the Minister of Industries was formed in November, 1994 with the object of trying to find substitutes for woodfuel and to try and proliferate these substitutes. Under the supervision of this committee, several demonstrations of various types of fuel and cookstoves were displayed at various parts of Myanmar with this in mind.

The first demonstration was given at Myanmar Science and Technology Research Department (MSTRD), Kanbe, Yangon, in the first week of December 1994. Subsequent demonstrations were given at Aunglan, Magwe, Kyaukpadaung, Seikphyu, Pakhokku, Monywa, Ye-Oo, Sagaing, Mandalay, Myingyan Meikhtilar and Tat-kone from 24 th February to 15th March, 1995. Similar demonstrations were made at Shwe-nat-taung, Mawlamyein, Thahton and Kyaikhto in the second and third weeks of June, 1995 and at Pathein and Yangon in the third week of July, 1995 and in the first week of October, 1995, respectively. Fortunately, FRI got a chance to display and demonstrate the A-1 fuelwood cookstove at these demonstrations. An illustrated brochure was prepared do show dhe advantages which can be gained by using the A-1 cookstove. Hundreds of these brochures were distributed to the public who came to the demonstrations.

Soon after these demonstrations, the Township Law and Order Restoration Councils from Magwe Division, Sagaing Division and Mandalay Division purchased a large number of A-1 stoves from FRI to disseminate them throughout their regions. The price of one A-1 stove was 100 Kyats.

Coincidentally, the Nine Critical Districts Greening Project, the Community Multipurpose Fuelwood Woodlots Project (MYA / 93 / 003) and the Watershed Management Project for Three Critical Areas (MYA / 93 / 005) also ordered thousands of A-1 stoves from FRI to disseminate them among their project areas.

Thus, FRI tried to initiate a mass production programme to manufacture A-1 stoves. A factory to manufacture A-1 stoves was built at FRI, Yezin and the manufacturing programme was started in October, 1994.

To produce and disseminate more A-1 stoves, two training sessions on making A-1 stoves were also given at FRI. By the special request of the Director of the Community Multipurpose Fuelwood Woodlots Project, the first training session was conducted from 5th April, 95 to 9th April, 95. Ten trainees from Magwe, Kyaukpadaung and Chaung-Oo attended this training workshop. All trainees were highly skilled local potters. Two methods of making A-1 stoves were taught in this course: namely, the manual method i.e. the traditional method of making pots and other earth-utensils, and the moulding method.

The second training session was held from 24th July, 95 to 28th July, 95. The training session was organised by the Watershed Management Project for Three Critical Areas and FRI. Fifteen local potters from Thazi, Nyaungshwe and Pindaya attended this session.

All trainees from the two training session were very active and they showed a keen interest during the courses.

FRI has issued an open invitation to government organisations, cooperatives and private entrepreneurs who are interested in manufacturing A-1 stoves to come and study the FRI A-1 Stove Factory at Yezin.

Three technicians from MSTRD studied at the FRI A-1 stove factory during the last week of December, 1995. U Hla Nyunt Maung and U Zaw Min from Salin and U Myint Swe from Tat-kone and some local potters from Pyinmana who were very keen to manufacture A-1 stoves, also studied at the FRI A-1 stove factory.

Based on the techniques gained from the training sessions, and on individual studies, some cooperatives and private entrepreneurs from Salin, Taung-twingyi, Na-hto-gyi, Tha-zi,Tat-kone, Chaung-Oo, Pindaya and Inlay are now manufacturing A-1 stoves on their own and are now disseminating them to the neighbouring villages and towns.

3.4 Results and Discussions

The names and addresses of the A-1 stoves producers, types of A-1 stove produced either by manual or moulding, assessment of quality (based on exhaust gap height; size, shape & no. of grate holes; standard dimensions of stove, etc.), number of stoves produced and regions to which the stoves were disseminated are given in table 1.

According to this table, it can be seen that A-1 stoves are manufactured in various parts of the country - Magwe Division, Mandalay Division, Sagaing Division, Shan State and Ayeyawaddy Division.

Most of the producers are still manufacturing and disseminating the A-1 cookstoves. Only two producers stopped temporarily because of the high wages of the stove-makers. One producer from Salin also ceased to produce the stove, because most of the households from Salin region are now using rice-husk cookstoves. The price of rice husk is said to be very cheap compared to fuelwood in the Salin region.

From table 1, it can also be seen that the total number of A-1 stoves disseminated up to the end of September, 1996 is 99,400. The names of the districts where the A-1 stoves were disseminated are: Yemethin, Meikhtila, Myingyan, Magwe, Pakhokku, Minbu, Thayet, Monywa, Sagaing, Katha, Taunggyi, Yangon, Myaungmya and Pathein.

The Forest Department has estimated that about 77% of the energy consumption in the country still comes from woodfuel. Woodfuel used per household annually in urban and rural areas is about 1.4 and 2.4 tons, respectively which is a very conservative estimate. Thus, it can be assumed that, on average 2.0 tons of woodfuel are used per household annually.

By using one A-1 cookstove, at least 40% of fuelwood can be saved per household annually. It means that, 2.0 tons x 0.40 = 0.80 ton of fuelwood can be saved annually by using an A-1 stove. Therefore, it can be concluded that, by using 99,400 A-1 stoves, 79,520 tons of fuelwood can be saved annually.

According to one study, the average output of a 10 years old fuelwood plantation is about 50 to 60 tons per acre. Based on a 10 years rotation, the average annual yield per acre will be about 5.5 tons. Thus, 79,520 tons of fuelwood which can be saved by using 99,400 stoves is equivalent to about 14,458 acres (5,851 ha) of fuelwood plantations.

The cost of fuelwood plantation per acre ranged from 1,050 Kyats to 3000 Kyats depending on the type of plantation. This does not include land cost, supervision cost and inventory cost.

However, by taking the average establishment cost of fuelwood plantations per acre as 1500 Kyats, it will cost 21.687 million Kyats to establish 14,458 acres of fuelwood plantations.

On the other hand, the cost of 99,400 A-1 stoves is only 9.94 million Kyats. This is less than half of the cost of establishing 14,458 acre of fuelwood plantations.

If the dissemination programme of A-1 stoves could be developed into a large-scale programme led by the Forest Department and operated throughout the whole country, the total number of A-1 stoves used by the rural population can be increased enormously.

3.5 Conclusions

According to the dissemination programme of A-1 fuelwood cookstoves initiated by FRI, it can be concluded that :

1) A-1 stoves have been disseminated to various regions of Myanmar within two years.

2) By using 99,400 A-1 stoves, 99,400 households can save nearly half of their money for buying fuelwood or can save nearly half of their time for gathering fuelwood. The health hazard to the 99,400 housewives due to smoke from cooking fire will be significantly reduced.

3) By using 99,400 A-1 stoves, the Forest Department can save about 11.75 million Kyats of budget.

4) By using more A-1 stoves, considerable areas of fuelwood plantations can be saved annually and other valuable commercial and industrial plantations could take their place in those areas.

5) The greater the number of A-1 stoves used the greater the reduction in fuelwood consumption, thereby lessening the depletion of forests.

3.6 References

Doo, C., 1987 — Studies of energy source from different types of one-stick fuelwood stove, FRI Leaflet No. 9 / 86-87. 10 pp.

Myint, T. & Soe Tint, 1992 — Study on the heat utilization efficiency of improved cookstoves, Forestry Science Research Paper. 10 pp.

Tint, S. & U Aung, 1992	Country Report on Subregional Expert Consultation on Improved Cook Stove Development Programme in South Asia Countries. 2-5 April 1991, India.
Tint, S. & Win Kyi, 1994	Improved cookingstoves, Paper presented at the Workshop Seminar organized by the Community Multipurpose Fuelwood Woodlots Project, October,1994, Poppa. 9pp.
Tun, T. & Win Kyi, 1991	Status on wood energy development of Myanmar Country paper submitted to the Programme for the Exchange of Visits of National Coordinating Committee Members Between Participating Countries. RWEDP in Asia, 22-30 July 1991, Bangkok, Thailand.

4. Woodfuel Flows in the Dry Zone of Myanmar: A Case Study

by

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4.1 Development Background

This study 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 socio-economic status of fuel collectors and traders who are the prime movers of biofuel (woodfuel, bamboofuel, 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 in the winter and summer months of 1992. The study was sponsored by the 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: socio-economic status of fuel gatherers and traders, the trade chain from the resource area to the markets, and the amount of biofuel consumed in two urban centres of the Dry Zone. The report is primarily based on information gathered randomly from households and individuals of 8 villages in the resource area and 8 market centres in the plains.

The findings in the study area were presented at the "Regional Course on Trade in Wood Fuel Related Products" which was held at the Pakistan Forest Institute in Peshawar, Pakistan, from 1 - 4 October 1995.

4.2 Fuelwood Situation in Myanmar

Foresters in Myanmar are well aware of the basic needs of the rural as well as the urban communities in matters of timber supply, but consumption of firewood is regarded as being of secondary importance.

Due to population pressure and heavy reliance on biofuel, the forest cover of the country has been greatly affected, decreasing from 57% in 1958 to 47% in 1980. Although loss of forest cover and degradation of forests are due to many factors, one of the major reasons is the use of biofuel in terms of firewood and charcoal, not only for domestic uses but also for restaurants and cottage industries such as lime burning, brick making, palm sugar production, etc. Heavy reliance on biofuel is reflected in the World Bank report of Myanmar for 1991 (table 1).

With 47% of its land area under forests, Myanmar can still be considered as fortunate when compared to some of its neighbours.

Table 1. Primary energy supplies of Myanmar in 1991

	Type of Energy	Gross Supply (Thousand toe)	Percent of Total
1.	Fuelwood	9,437.60	76.70
2.	Biomass Residues	764.70	6.20
3.	Crude Oil	695.40	5.70
4.	Imported Diesel	43.70	0.40
5.	Natural Gas	1,012.50	8.20
6.	Coal	25.60	0.20
7.	Hydro Power	321.60	2.60
	Total	12,301.10	100.00

toe = Tons Oil Equivalent

However, due to 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, one state and six divisions are now classified as fuel deficit areas.

One of those fuel deficit areas, 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. The case study highlights the source of fuel supply from the eastern fringe area and the trade mechanism involved in supplying the consumers of the central Dry Zone.

4.3 User Groups

User groups are consumers in and around the 7 market centres of the Dry Zone. In these areas woodfuels are used extensively by both domestic and industrial sectors. However, there have been substantial changes in the past due to the shift in the availability of energy sources other than woodfuels.

Before 1970, when kerosene was available, both in urban and rural areas, the government, through the Industrial Development Cooperation (IDC) introduced the kerosene stove which was widely accepted because of its efficiency, low cost and convenience in handling.

However, in the mid-seventies, kerosene became a scarce commodity and the kerosene stove had to be abandoned. Later, the government tried to introduce gas stoves but due to the supply problem, gas fuel could not be relied upon for daily use. At present, both domestic and cottage industries depend largely on biofuel, particularly in the form of fuelwood, charcoal, mill off-cuts, sawdust, bamboofuel and agricultural residues. In urban centres, where electricity is available, electric stoves are also used but the erratic supply of electricity, makes this source unreliable.

As such, consumers have switched back to woodfuels which in turn is leading to the depletion of the supply area.

4.3.1 Population and households in the user area

The user area which consists of one of the most densely populated divisions in the country has a density of 320 persons per square mile, which is about double the national average. The size of population and the number of households in 1991, covering 8 townships which account for the major consumption of wood and bamboofuel derived from the eastern fringe resource area, are shown in table 2.

4.3.2 Consumption pattern

Although there are 67,037 urban and 308,474 rural households in the user area, woodfuel consumption is mainly concentrated in two urban centres of the Dry Zone nearest to the supply area, i.e. Thazi and Meikhtila. Records show that in the 1991 approximately 153,703 tons of fuelwood and 604,800 bundles of bamboo fuel were consumed by 58 cottage industries, 293 food stalls and 25,170 households in these centres. This is shown in table 3.

4.4 Supplier Groups

The supply area or the source of fuel in the fringe consists of 13 Local Supply Reserves covering an area of 61,500 acres. Surrounding these areas, there are 6 main villages and 5 smaller villages from which labour for fuel gathering is drawn. These 11 villages are important for woodfuel transactions and are considered to be the main supply centres of the resource area.

Most of the people in these villages engaged in fuel collection and trade are primarily farmers. For generations they have been supplementing their income during the off-farm season by extracting forest products. The population size and the number of households and the number of people engaged in woodfuel collection and trade from these villages can be seen in table 4.

4.5 Types of Biofuel

The resource area produces biofuel in the form of firewood, charcoal, mill off-cuts, saw-dust and bamboo fuel and agricultural residues. Bamboofuel is mainly used by cottage industries for the production of evaporated milk.

4.5.1 Woodfuel

In order to prevent forest degradation and soil erosion, the Forest Department practices a selective system for fuelwood extraction. A list of fuelwood species has been drawn up in order of their suitability. According to the annual prescribed quota, selective trees with a fixed girth limit are allowed to be cut for extraction. In the area, 23 species have been listed as fuelwood species and are shown in table 5. The species most popular with consumers are **Than, Dahat, Kyungauknwe**, etc.

Table 2. Population 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. Meikhtila	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. Taugtha	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

Table 3. Estimated woodfuel consumption in two urban centres in 1991

Consumer	Meikhtila		Thazi		Total	
	Woodfuel (ton)	Bamboofuel (bundles)	Woodfuel (ton)	Bamboofuel (bundles)	Woodfuel (ton)	Bamboofuel (bundles)
1. Cottage industries	4,128	4,968,000	792	1,080,000	4,920	6,048,000
2. Food stalls	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

Table 4. 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

Table 5. Selected fuelwood species in the Yinmabin and Pyinyaung areas

Fuelwood species		Average weight at 12% (m.c.)		
Local name	Botanical name	kg/m^3	lbs/cft	Main use
Than	*Terminalia oliveri Brandis*	895	56	Fw/Ch
Dahat	*Tectona hamiltoniana Wall*	897	55	Fw/Ch
Gyo	*Schleichera oleosa (lour.) Merr.*	1,087	68	
kyun-gauk-new	*Vitex limonifolia Wall.*	991	62	
Thanbe	*Sterospermum neuranthun Kurz.*	665	41	Fw
Bebya	*Crotoxylon neriifolium Kurz.*	863	54	Fw/Ch
Te	*Diospros burmanica Kurz.*	1,119	70	Fw/Ch
Pyaukseik	*Holoptelea intergrifolia 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 tintoria 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.*	32f0	20	Fw
Bonmeza	*Albizia chinensis (Osbeck.) Merr.*	415	26	Fw
Didu	*Salmalia insignis Schoot. & Endl.*	495	31	Fw
Aukchinsa	*Diospros ehretiodes Wall.*	703	44	Fw

Note: Fw = Fuelwood, Ch = Charcoal

Besides the listed woodfuel from the resource area, a considerable amount of supporting fuel is derived from the Dry Zone area in the form of stems, twigs and uprooted stumps of mesquite trees. This species, **Prosorpis julitlora,** was introduced in the Dry Zone around 1950. Although regarded as a pest in the area, it is now increasingly used in evaporated milk production, caustic soda boiling, palm-sugar production and yarn dyeing.

4.5.2 Bamboofuel

Out of 75 species of bamboo found in Myanmar, the species most widely used in the area as a source of energy is **Hmyin** (Dendrocalmus strictus). The resource area provides the bamboo, which is particularly used, mainly in dried form, for the production of evaporated milk. Evaporated milk producers prefer bamboofuel to other biofuels because a fire can be started very fast and the heat generated can be controlled with ease. In addition, by using bamboo as fuel, the colour of the milk product remains whitish which attracts a higher price. With biofuels other than bamboo, the colour is often brownish and this lowers the price of the product.

Hmyin is a bamboo commonly found in upper or lower Myanmar particularly in dry soil types. Under favourable conditions, the culms are 50 ft. long, 3-4 inches in diameter. In dry localities the size is much smaller and the culms are much more solid, thus it is referred to as a male bamboo. In the resource area, where Hmyin is scarce, thick-walled bamboos such as **Thaik** and **Wanwe** are used as substitutes.

4.5.3 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 blacksmithies. In urban areas it is used for domestic cooking as well as in restaurants, tea shops and noodle shops where instant cooking is essential. The species commonly used for charcoal making are **Than, Dahat** and **Sha.**

4.5.4 Mill off-cuts

Three saw-mills in the resource area produce mill off-cuts which are taken to recutting mills in the user group area, particularly to Thazi and Meikhtila. The mills process the off-cuts into smaller pieces and bundle them for sale as fuelwood. Users prefer this type and pay higher prices as the fuel is dry, consists of assorted commercial timber, is easy to use and has a higher heating value.

4.5.5 Sawdust

The same saw-mills produce sawdust which is increasingly used for institutional cooking but hardly for domestic purposes because of its inconsistent supply and difficulty of controlling heat in the stoves commonly used by households.

4.5.6 Agricultural residues

Agricultural residues such as pigeon pea stalks, ziziphus shells, sesame stalks are usually obtained from agricultural farms in the Dry Zone. Rice-husks, paddy-stalks and coconut shells are transported from the southern fringe areas.

4.5.7 Trade Mechanism

The main actors in the woodfuel distribution system are the traders who have their business base in the villages of the woodfuel resource area. The traders are the holders of the permits issued by the Thazi Forest Township. Traders organise the supply by hiring woodfuel gatherers and at the same time keeping regular contact with the consumers as well as with the authorities concerned with their trade.

There are 6 woodfuel distribution centres in the resource area of which only 4 are of major importance in the distribution chain. The Yinmabin and Yebokson centres supply both woodfuel and bamboofuel while Thahtaygon and Hlaingdet centres supply mainly bamboofuel. From Pyinyaung, the road-side centre mainly supplies woodfuel to the local lime burning units while the rail-side centre supplies a considerable and growing quantity of unrecorded woodfuel along Pyinyaung-Thazi rail line. This informal woodfuel trade deals in small bundles of fuelwood collected by casual workers from poor areas of Thazi. Kywetatson is the main supply centre for charcoal. 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 nearby and in urban centres as there is no formal wholesaler in the urban markets trading in woodfuel. 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.

Previously, there were 10 main woodfuel market centres, the farthest from the resource area being Myingyan and Yenangyaung which are located at a distance of over 100 miles by road or rail. However, due to the increase in transportation costs, which was mainly because of rising oil prices, these far away market centres have become less important. At present, most of the woodfuel goes to Thazi, Meikhtila, Pyawbwe, Wundwin and Mahlaing. Due also to the high price of woodfuel and shortage of supply, some consumers have started to switch to using local substitutes such as mesquite (thorny) woodfuel and agri-residues, whenever feasible.

Besides woodfuel from the main resource area, some woodfuel and bamboofuel from the upper reaches of the inundated area of Kinda Dam is also finding its long way down the hill to the market centres. Most of the woodfuel 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 Ayeyarwaddy 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 6.

Table 6. Main woodfuel supply and distribution channels

Suppl 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
Meikhtila	-		WB	39	WBMC S	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	-		-			
Myingyan	W	102	WB	97	B	93	-		-			
Kyaukpadaung	-		B	99	B	95	-		-			
Yenanchaung	-		-		B	133	-		-			

Note: Type denotes the type of woodfuel supplied, W = Fuelwood, B = Bamboofuel, M = Mill off-cuts, C = Charcoal and S = Sawdust.

4.6 Socio-economic Status of People Involved in Fuel Trade

Woodfuel gathering and trade is normally considered a secondary source of income for the collectors, particularly during the off-farm season in the supply area. Traders and middlemen also come into existence in filling the gap between the gatherers and the end-users and most of them come from the villages of the supply area. For the gatherers, although woodfuel collection is secondary, the income generated is considerably high compared to other categories of casual labour. However, the majority of people involved are not well-off due mainly to the increase in the price of basic commodities.

In fact, traders are better-off financially than gatherers, but they also have to face the same situation of increasing prices in transportation due to increases in the price of oil and other items related to transport such as spare parts for vehicles. Their socio-economic status can be seen in table 7.

Table 7. Average income and expenditure of woodfuel traders and gathers

Occuption	Income in Kyats/year			Expenditures Kyats/year	Surplus
	Woodfuel	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)
Thahtaygon					
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 bamboofuel while FW denotes fuelwood.

4.7 Resource Potential of the Supply Area

The resource area is under the management of the Forest Department, which is the principal agency responsible for regulation, control and development of woodfuel in Myanmar. Although the Department has long recognised 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 to manage woodfuel on a sustainable basis through the application of a ‘coppice with standards’ system in the local supply reserves which constitute nearly 5% of the total forest area. This was designed to provide woodfuel and other forest products to nearby towns and villages. However, as the demand outstripped the supply, sustainable management ceased to function. This situation has resulted in the fuel resource areas, particularly in the plains, being over-exploited and now the plain reserves are virtually denuded.

In 1983-84, the Forest Department carried out an inventory of 7 forest reserves which are designated as the fuel source of the supply area. The inventory data indicated that woodfuel and bamboofuel supply could be sustained for 16 years and 6 years, respectively with the (then) current rate of prescribed cuts. Inventory data for woodfuel and bamboo can be seen in tables 8 and 9.

Table 8. 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
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	61,769
5	34,150	33,814	67,964	6,768	17,107	23,875
6	381,375	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

Table 9. Growing stock of bamboo 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	2,130.02	1,926.70	774.55	4,831.27
Thaik	Bambusa tulda	271.09	329.19	338.87	939.15
Wa-myin	Bambusa griffithiana	38.73	67.77	96.82	203.32
Wanwe	Dinochloa m'clellandi	242.05	435.69	319.50	997.24
Thana-wa	Thyrostachys oliveri	1,365.15	1,278.01	1,394.20	4,037.36
Tin-wa	Cephalostachyum	19.36	38.73	38.73	96.82
Kyathaung	Pergracile Bambusa polymorpha	3,301.53	4,163.22	4,579.54	12,044.29
	Total	7,367.93	8,239.31	7,542.21	23,149.45

4.8 Assessment of Present Situation of Biofuel Supply and Trade

1. Due to the heavy reliance of consumers on biofuel, the resource area is greatly exhausted. This is mainly due to two factors :

    (a) Consumers in the Dry Zone have very little alternative but to depend on biofuel, mainly woodfuel.

    (b) Most of the people in the resource area have no other job opportunities and rely on the natural forest for their livelihoods. Some people from the plains migrate and settle in the resource area and earn their living by collecting woodfuel which is easily available for ordinary labourers.

2. Due to over-exploitation and partly due to increases in the prices of commodities and transportation, biofuel trade in the resource area is not stable, affecting the socio-economic status of all parties: gatherers, traders and consumers of cottage industries.

3. Although the resource area is heavily exploited, the supply of woodfuel and the demand of the consumers are not well balanced.

4. The government has initiated UN and government aided projects to prevent the degradation of resources and the environment and at the same time to develop the living conditions of the people, especially in the rural communities. All these activities are mainly centred on the formation of community forests, woodlots and the greening of the Dry Zone. They also emphasise the dissemination of efficient cookstoves and alternative fuels other than woodfuel. However, the remedy is not sufficient to completely arrest degradation.

4.9 Recommendations

As a result of the study, the following recommendations are deemed relevant to a strategy of coping with the prevailing issues of the bioenergy sector:

1. The woodfuel deficit problem of the central Dry Zone is no longer a local one. It has now become a national issue which should be contained by a multi-agency as well as by a multi-disciplinary approach.

2. The Forest Department should put more emphasis on rehabilitation of the existing fuel resource areas and on the systematic control of harvesting.

3. Time is already ripe for the Department to take a strong initiative to facilitate people's participation and the creation of community forests, as well as privately owned forests, in all the fuel deficit regions of the country.

4. The Department should also encourage and support the introduction and distribution of alternatives to fuelwood energy and fuel efficient cookstoves in all the fuel deficit areas of the country and should educate the people so that they are willing to adopt them.

5. In order to carry out and instil the activities and messages of the Department in matters of bioenergy, an effective and action-oriented extension service should be created at FRI.

6. Data on the current status of fuelwood supply, demand and trade for particular localities as well as the states or divisions should be collected for proper planning and management.

7. As Myanmar is under the umbrella of RWEDP, a regional wood energy project, active participation in the region should be stepped-up so as to acquire more technical know-how and exchange ideas with other member countries. In this way Myanmar's biofuel crisis can be resolved.

8. Although efforts have been made by the Forest Department and other related agencies to contain the biofuel crisis, it is envisaged that increasing support by the government in terms of improving the supply of commercial energies such as kerosene, electrical power or gas in the currently fuel deficit areas is vital in order to deter further degradation of forest resources and the environment.

5. Woodfuel Position with Particular Reference to Mangrove Areas in Myanmar

by

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Introduction

About 35% of the world's mangroves cover is found in Malaysia, Thailand, Myanmar, Indonesia, Singapore, Cambodia and Vietnam However, in the absence of sustainable management, it is estimated that about 30-40% of the region's mangroves have been lost up to now.

Table 1 indicates the extent of mangrove areas in each country in the Asia-Pacific region. Population density and per capita GNP are also indicated to enable a comparison of each country's economic status.

Table 1. Mangrove forest areas of Asia-Pacific Region

Country	Area of Mangroves (ha)	Population Density (n/km^2)	Per Capita GNP (US$)
Indonesia	2,176,271	77.9	530
Malaysia	652.219	43.0	1,840
Bangladesh	417,013	629.9	140
Papua New Guinea	411,600	6.7	462
Myanmar	382,023	60.6	190
India	356,500	209.9	260
Thailand	287,000	110.0	-
Vietnam	286,400	168.8	-
Pakistan	249,499	105.1	350
Philippines	246,699	165.3	790
Sri Lanka	4,000	-	-

Sources : Area from Seanger et al (1983) ; population density and real per capita GNP, 1981 data from 1983 World Development Report, World Bank, U.S.A Washington DC. FAO (1980) Forest Resources in Tropical Asia.

Thailand : Charrupal, T. (1981)
Assessment of Mangrove Forest Area in Thailand by Using LANDSAT Imagery.

Myanmar : Pe Thein, Forest Department, Myanmar.
Notes on Mangrove Forests of Myanmar. Dec 1989.

The mangroves of Myanmar extend along the coast line from latitude 20 N and 10 N, longitude 94 E and 98 E for over sixteen hundred kms, but spreading into the estuaries and delta wherever tidal action makes possible the favourable growth of all varieties of mangroves. Many islands along the coast especially in the south are also full of mangrove forests, but there are long stretches of breaks in the north where the coast line is rocky or sandy or unfavourable for its growth.

The extent of the mangrove forest of Myanmar may be stated as follows:
(1) Rakhine State ---------------------------- 64,750 ha
(2) Ayeyarwaddy Division-------------------- 177,252 ha
(3) Tanintharyi Division---------------------- 140,021 ha

Total 382,023 ha

5.1 Mangrove Depletion and Degradation

The main causes of mangrove depletion and degradation are:

a) Reclamation and conversion of mangroves to industrial and housing sites, aquaculture and agriculture, tourist resorts, and beach improvements.
b) Uncontrolled and unsustainable uses of mangroves for domestic and fishery related uses, fuelwood and charcoal. Loss of diversity through monoculture, pollution with chemicals, pesticides etc.
c) Upstream watershed deforestation and resulting increase in nutrient and pollutant loads downstream, and
d) Reduction of available water to mangroves due to uncontrolled damming and irrigation activities.

The following table indicates the changes of mangrove areas during the 60 year period (1924 to 1984) in the Ayeyarwaddy Division, Myanmar.

Table 2.

Location	Forest Area including Byaik			Vacant Land, Agriculture and Overcutting		
	1924	1954	1984	1924	1954	1984
Ayeyarwaddy Division	625,222	579,487	447,073	0	45,735	5,659
Bogalay Township	343,636	316,632	271,107	0	27,004	72,529
Laputta Township	230,930	217,858	164,142	0	13,072	66,788
Moulmyaingkyun Township	50,656	44,997	11,824	0	5,659	38,832

The extent of forest depletion and degradation in the same areas may be presented as follows (%):

Table 3.

	1924	1954	1984
Ayeyarwaddy	0	7.32	28.49
Bogalay	0	7.86	21.11
Laputta	0	5.66	28.92
Moulmyaing Kyun	0	11.17	76.66

The National Forest Survey and Inventory of Myanmar was carried out during 1983-84 and a special survey and inventory was undertaken for Laputta Township in 1990-91. From these two sets of inventory data the productive capacity of delta mangroves and its state of depletion have been estimated and are presented in table 4 below.

Table 4.

Location	1983-84 Inventory		1990-91 Inventory	
	Stack wood cu ft per acre	Stack tons per acre	Stack wood m^3 per ha	Stack tons per acre
(1)	(2)	(3)	(4)	(5)
Ayeyarwaddy Delta	494.832	9.897	-	-
Bogalay Township	560.910	11.218	-	-
Laputta Township	377.360	7.547	2.400	0.686
Pyinalan Reserve	-	-	2.562	0.732
Kakayan Reserve	-	-	1.469	0.420
Kyagan-kwinbauk Reserve	-	-	3.834	1.096

Source: Inventory data from NFMI Project (UNDP/FAO : MYA/85/003)

5.1.1 Stock position

Stock per acre even in 1983-84 is poor when compared to the stock data of Malaysia with 23.57 to 36.37 Hoppus tons per acre (FAO, 1982) and a growth rate of 20 tons/ ha / year in Thailand .

Stock position in 1990-91 (i.e. 7 years after) is worst in Laputta with its reserves varying from 0.42 to 1.09 stack tons / acre. During a field trip (1992) information from the local forest staff confirmed that the stock situation in Bogalay and other areas of Ayeyarwaddy was not much better.

5.1.2 Yield Position

Applying the stock data of Table 4 to the forest areas in Ayeyarwaddy Division, possible annual yield with a rotation of 20 years was calculated as shown in table 5 below.

Table 5.

Location	Mangrove Area (acres)	1983-84 Yield Position			1990-91 Yield Position		
		Stack tons per acre	Total stock (stack tons)	Possible Yield (stack tons)	Stack tons per acre	Total stock (stack tons)	Possible annual yield (stack tons)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ayeyarwaddy Delta	447,073	4.897	4,424,682	221,234			
Bogalay Township	271,107	11.218	3,041,278	152,064			
Laputta Township	164,142	7.547	1,238,779	61,939	0.686	112,601	5,630
Pyinalan Reserve	76,268				0.732	55,828	2,791
Kakayan Reserve	57,692				0.420	24,231	1,212
Kyagan-kwinbauk Reserve	30,182				1.096	33,079	1,654

Annual yield position in 1983-84 for Laputta was 61,939 stacked tons (col.5). The yield in 1990-91 after seven years dropped sharply down to 5,630 stacked tons (col.8).

5.2 Energy Production and Projection of Woodfuel Flows in Myanmar

Energy Production by sources in Myanmar for the year 1992-93 is given in table 6. The table indicates that 81% of the energy came from biomass, with natural gas supply 7.4%, oil 7.6%, hydropower 3.3% and coal 0.5% only. Biomass, therefore, is the country's major source of energy supply.

Table 6. Primary Energy Supply in 1992-93

Source	Gross Supply (Thousand toe)	Percent
Oil	934.9	7.60
Gas	911.5	7.41
Coal	61.5	0.50
Hydropower	412.1	3.35
Biomass	9,981.1	81.14
Total	12,301.1	100.00

toe: Tons Oil Equivalent.

Source: Regional Wood Energy Development Programme in Asia GCP/RAS/131/NET, Bangkok, April 1996.

Energy Consumption by sector in 1990 is given in table 7

Table 7. Final Energy Consumption by Sector in 1990

(Thousand toe)

	Household	Transport	Industry	Others	Total	Percent
Fuelwood	7181.5	0.0	0.0	0.0	7181.5	78.27%
Charcoal	535.6	0.0	0.0	0.0	535.6	5.84%
Biomass residue	227.8	0.0	75.9	0.0	303.7	3.31%
Petroleum products	7.3	362.5	134.0	109.8	613.6	6.69%
Gas	0.0	0.0	194.6	167.1	361.7	3.94%
Coal	0.0	0.0	23.6	0.0	23.6	
Electricity	48.3	0.0	88.1	19.5	155.9	0.26%
Total	8000.5	362.5	516.2	296.4	9175.6	1.70%
Percent	87.19%	3.95%	5.63%	3.23%	100%	100%

Source: World Bank Report (1991)

Table 7 indicates that the household sector dominates energy consumption with an estimated 87.2%. Industry accounts for 5.6%, transport 4% and other uses 3.2%. Consumption of fuelwood accounts for 78.3% and that of charcoal 5.8%, thus the two together (woodfuel) accounted for 84.1%. These figures indicate the important roles of woodfuel and the forestry sector in the country. Unless other woodfuel substitutes can be introduced, this trend will continue and endanger the country's forests and the environment.

Inclusive of rural as well as urban requirements the production of woodfuel for the last 10 years may be recorded as follows:

Year	**Production (000m^3)**
1987	30,104
1988	30,238
1989	31,387
1990	32,060
1991	32,238
1992	32,349
1993	33,845
1994	32,986
1995	33,012
1996	32,943

Source: Ministry of National Planning and Economic Development (1996)

Estimates of woodfuel Standing Stock by Division and States were made by the World Bank Mission in 1990 and the figures are presented in table 8 in million ADT (Air Dried Tons).

Table 8. Estimates of woodfuel standing stock by Division/State (million ADT)

Sustainable Yield

Division/ State	Standing Stock	Forests	Sawmill Residues	Roadside Farm & Village Trees	Total Yield	Crop Residues
Ayeyarwaddy	62.7	0.96	0.08	0.22	1.26	1.396
Yangon	11.9	0.18	0	0.22	0.40	0.512
Bago	177.1	2.60	0.03	0.53	3.16	1.102
Shan	164.4	3.05	0.01	0.52	3.58	0.354
Rakhine	130.5	1.87	0.02	0.30	2.19	0.293
Mandalay	70.5	1.14	0.01	0.13	1.28	0.606
Sagaing	91.5	1.64	0	0.13	1.77	0.544
Magway	87.2	1.61	0.01	0.11	1.73	0.329
Mon	11.7	0.23	0	0.21	0.44	0.237
Tanintharyi	83.7	1.29	0.03	0.12	1.44	0.074
Chin	55.9	1.04	0	0.01	1.05	0.047
Kayah	16.8	0.38	0	0.02	0.35	0.025
Kayin	69.2	1.10	0	0.17	1.27	0.102
Kachin	89.7	1.43	0.01	0.12	1.56	0.093
Total	1122.8	18.47	0.20	2.18	21.48	5.714

Source: World Bank Mission Estimates (1990)
ADT: Air Dry Ton.

Total biomass yield of 27.194 (21.48+5.714) ADT is equivalent to (27.194 x 1.8) = 48.949 million m^3. This quantity of biomass is quite adequate for the requirement of the whole country. Nonetheless the surplus and deficit by states and divisions may vary and the woodfuel as well as biomass flow within the country needs to be studied. In the first place we may have to project the Standing Stock for different periods.

Projected changes in standing stock of woodfuel for different periods were estimated by the World Bank Mission as follows:

Table 9. Projected changes in standing stock of woodfuel up to 2005 (million ADT)

Division / State	1990	1995	2000	2005	2005 figure as % of 1990 figure
Ayeyarwaddy	61.99	52.42	42.45	31.39	50.64
Yangon	11.29	10.04	8.73	5.95	52.70
Bago	153.11	152.71	150.71	147.67	96.45
Shan	120..82	121.72	121.90	121.78	100.79
Rakhine	161.76	163.24	164.07	164.31	101.58
Mandalay	69.79	64.52	59.02	52.37	75.04
Sagaing	87.76	83.21	77.32	70.37	80.18
Magway	11.16	9.49	5.52	0.30	2.69
Mon	56.14	53.87	51.33	48.51	86.41
Tanintharyi	51.00	52.48	53.44	54.32	106.51
Chin	16.68	18.06	19.60	21.11	126.56
Kayah	54.32	54.85	55.37	55.87	102.85
Kayin	89.01	90.06	91.02	91.85	103.19
Kachin	75.59	77.04	79.66	81.62	107.98
Total	1020.42	1003.71	980.14	947.42	--

Source: World Bank Mission Estimates (1990)
ADT: Air Dry Tons.

Standing stock position in 2005 is quite discouraging when compared to 1990. Only one division and six states are left to supply the needs of the woodfuel requirement adequately. The positions of Magway, Ayeyarwaddy and Yangon are the worst.

From table 9, projections of woodfuel consumption, trade and net surplus/deficit by division/state have been made and are shown in tables 10, 11 and 12 below for the years 1990, 2000 and 2005.

Table 10. Projections of woodfuel consumption trade and net surplus/deficit (million ADT) by Division/State, 1990, 2000 and 2005

Division/ State	Sustainable Yield Woodfuel	Internal Consumption	Export	Import	Net Surplus/ Deficit	Crop Residue Fuel	Crop Residue Consump-tion	Biomass Surplus Deficit
1990								
Ayeyarwaddy	1.26	3.99	1.20	0.10	-3.83	1.40	0.13	-2.56
Yangon	0.40	2.70		1.80	-0.50	0.51	0.46	-0.45
Bago	3.16	3.12	0.20		-0.16	1.01	0.15	0.70
Rakhine	2.19	1.63	0.20		0.36	0.20	0.05	0.60
Shan	3.57	2.98			0.59	0.35	0.09	0.35
Mandalay	1.28	3.79		0.40	-2.11	0.61	0.20	-1.70
Sagaing	1.77	3.19	0.40		-1.82	0.54	5.17	-1.45
Magway	1.73	2.64	0.20	0.20	-0.91	0.33	0.11	-0.69
Mon	0.44	1.35			-0.91	0.24	0.04	-0.71
Tanintharyi	1.43	0.74	0.10		0.59	0.07	0.02	0.64
Chin	1.05	0.30	0.20		0.55	0.05	0.01	0.59
Kayah	0.35	0.14			0.21	0.02	0.00	0.23
Kayin	1.27	0.85			0.42	0.01	0.02	0.50
Kachin	1.56	0.74			0.82	0.09	0.04	0.87
Total	21.46	28.16	2.50	2.50	-6.70	5.61	1.49	-2.58

Source : World Bank Mission Estimates (1990)
ADT : Air Dry Tons

Table 11. Projections of woodfuel consumption trade and net surplus/deficit (Million ADT) by Division/State, 2000

Division/ State	Sustainable Yield Woodfuel	Internal Consump-tion	Export	Import	Net Surplus/ Deficit	Crop Residue Fuel	Crop Residue Consump-tion	Biomass Surplus Deficit
2000								
Ayeyarwaddy	0.86	4.51	1.00	0.30	-4.35	1.40	0.50	-3.45
Yangon	0.31	3.46		2.20	-0.95	0.51	0.38	-0.82
Bago	3.11	3.58	0.70		-1.17	1.01	0.40	-0.56
Rakhine	2.21	1.84	0.40		-0.03	0.29	0.20	-0.06
Shan	3.62	3.36	0.10		0.16	0.35	0.37	0.14
Mandalay	3.03	4.37		0.70	-0.64	0.61	0.48	-0.51
Sagaing	1.56	3.68	.60		-2.72	0.54	0.41	-2.59
Magway	0.86	3.01	.10	.30	-1.95	0.33	0.33	-1.95
Mon	0.40	1.52			-1.12	0.24	0.17	-1.05
Tanintharyi	1.50	0.83	0.30		0.37	0.07	0.09	0.35
Chin	1.23	0.34	0.30		0.59	0.05	0.04	0.60
Kayah	0.36	0.15			0.21	0.02	0.02	0.21
Kayin	1.30	0.95			0.35	0.10	0.11	0.34
Kachin	1.64	0.85			0.79	0.09	0.10	0.78
Total	21.99	32.45	3.50	3.50	-10.46	5.61	3.60	-8.45

Source : World Bank Mission Estimates (2000)
ADT : Air Dry Tons

Table 12. Projections of woodfuel consumption trade and net surplus/deficit (million ADT) by Division/State, 2005

Division/ State	Sustainable Yield Woodfuel	Internal Consump-tion	Export	Import	Net Surplus/ Deficit	Crop Residue Fuel	Crop Residue Consump-tion	Biomass Surplus Deficit
2005								
Ayeyarwaddy	0.59	4.71	1.00	0.30	-4.82	1.40	0.80	-.4.22
Yangon	0.21	4.30		2.40	-1.69	0.51	0.51	-1.69
Bago	3.05	3.85	0.70		-1.50	1.01	0.51	-1.00
Rakhine	2.21	1.96	0.50		-0.25	0.29	0.29	-0.25
Shan	3.63	3.75	0.10		-0.22	0.35	0.35	-0.22
Mandalay	0.96	4.74		0.70	-3.08	0.61	0.61	-3.08
Sagaing	1.42	3.95	0.60		-3.13	0.54	0.54	-3.13
Magway	0.06	3.34		0.30	-2.98	0.33	0.33	-2.98
Mon	0.38	1.59			-1.21	0.24	0.27	-1.24
Tanintharyi	1.52	0.95	0.50		0.07	0.07	0.07	0.07
Chin	1.33	0.36	0.30		0.67	0.05	0.05	0.67
Kayah	0.36	0.17			0.19	0.02	0.03	0.18
Kayin	1.31	1.06			0.25	0.10	0.10	0.25
Kachin	1.68	0.94			0.74	0.09	0.09	0.74
Total	18.71	35.67			-16.96	5.61	4.55	-15.90

Source : World Bank Mission Estimates (2005)
ADT : Air Dry Tons

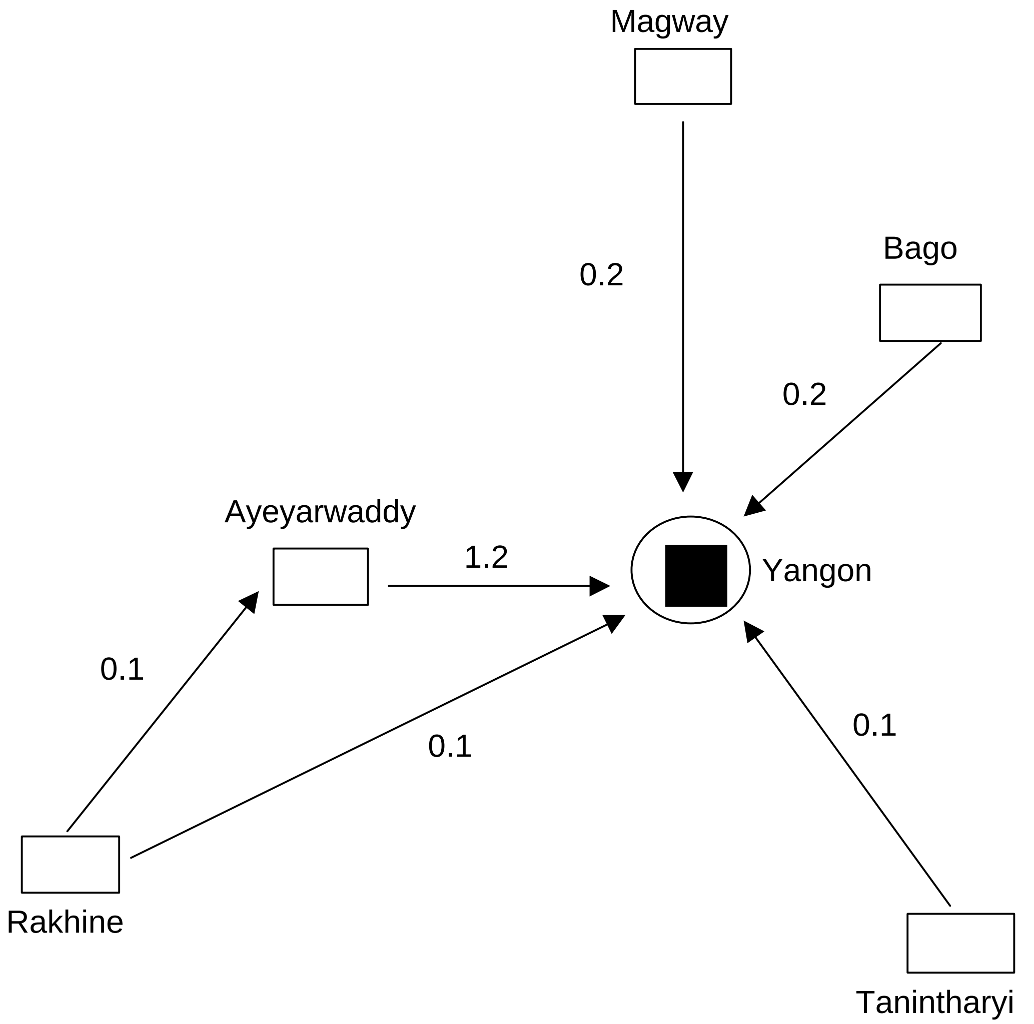
Since this study is confined to the mangrove areas, woodfuel flows in Rakhine, Ayeyarwaddy, Tanintharyi and their neighbouring divisions such as Yangon, Bago,and Magway have to be reviewed separately. The projections of woodfuel consumption trade and net surplus/deficit for the mangrove areas and their neighbouring divisions are made in Table 13.

Table 13.

Division/State	Sustainable Yield Woodfuel	Internal Consumption	Export	Import	Net Surplus Deficit	Crop Residue fuel	Crop Residue Consumption	Biomass Surplus/Deficit	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1990									
Ayeyarwaddy	1.26	3.99	1.20	0.10	-3.83	1.40	0.13	-2.56	Imported from Rakhine
Yangon	0.40	2.70	-	1.80	-0.50	0.51	0.46	-0.45	
Bago	3.16	3.12	0.20	-	-0.16	1.01	0.15	+0.70	
Rakhine	2.19	1.63	0.20	-	0.36	0.29	0.05	+0.60	
Magway	1.73	2.64	0.20	0.20	-0.91	0.33	0.11	-0.69	Imported from Chin State
Tanintharyi	1.43	0.74	0.10	-	0.59	0.07	0.02	+0.64	
2000									
Ayeyarwaddy	0.86	4.51	1.00	0.30	-4.35	1.40	0.05	-3.45	Imported from Rakhine
Yangon	0.31	3.46	-	2.20	-0.95	0.51	0.38	-0.82	
Bago	3.11	3.58	0.70	-	-1.17	1.01	0.40	-0.56	
Rakhine	2.21	1.84	0.40	-	-0.03	0.29	0.20	+0.06	
Magway	.0.86	3.01	0.10	0.30	-1.45	0.33	0.33	-1.95	Imported from Chin State
Tanintharyi	1.50	0.83	0.30	-	0.37	0.07	0.09	+0.35	
2005									
Ayeyarwaddy	0.59	4.71	1.00	0.30	-4.82	1.40	0.80	-4.22	Imported from Rakhine
Yangon	0.21	4.30	-	2.40	-1.69	0.51	0.51	-1.69	
Bago	3.05	3.85	0.70	-	-1.50	1.01	0.51	-1.00	
Rakhine	2.21	1.96	0.50	-	-0.25	0.29	0.29	-0.25	
Magway	0.06	3.34	-	0.30	-2.98	0.33	0.33	-2.98	Imported from Chin State
Tanintharyi	1.52	0.95	0.50	-	0.07	0.07	0.07	+0.07	

Trade of woodfuel in Yangon catchment for 1990, 2000 and 2005 may be illustrated diagrammatically as in figures 1 to 3.

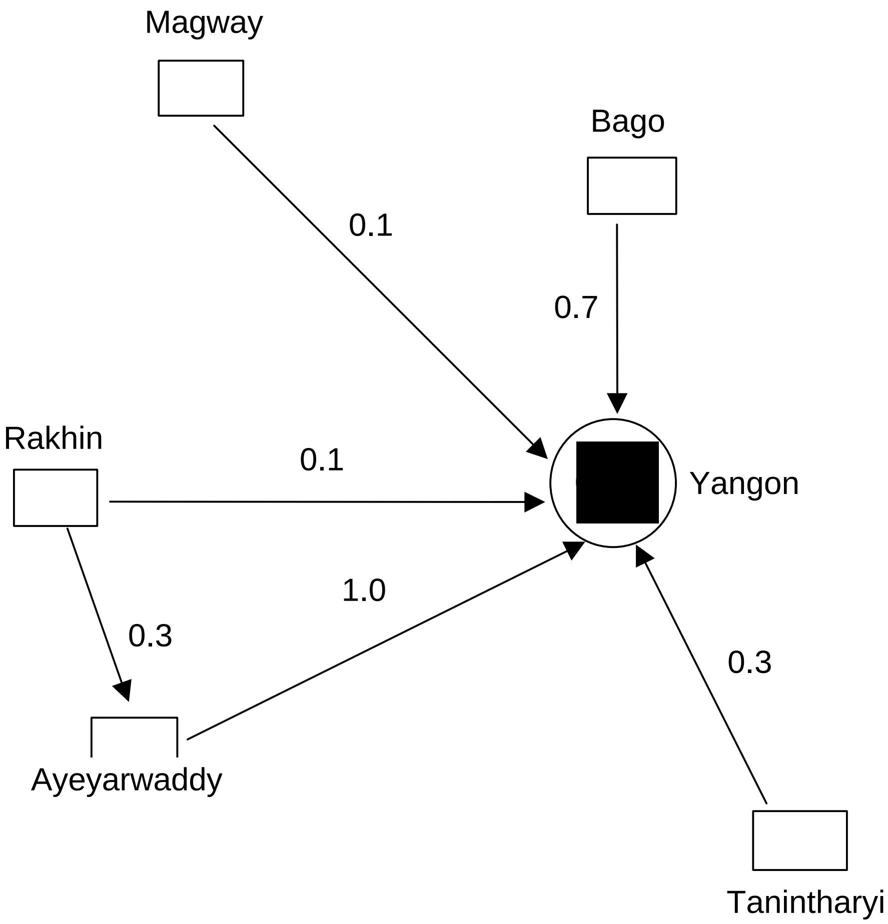
Figure 1: Trade of woodfuels in Yangon Catchment, 1990.
(million ADT)



Yangon consumption in 1990 estimated at 2.7 million ADT of which 1.8 million ADT was imported.

Source: Myanmar Energy Sector Investment and Policy Review by World Bank Team, May 1991.

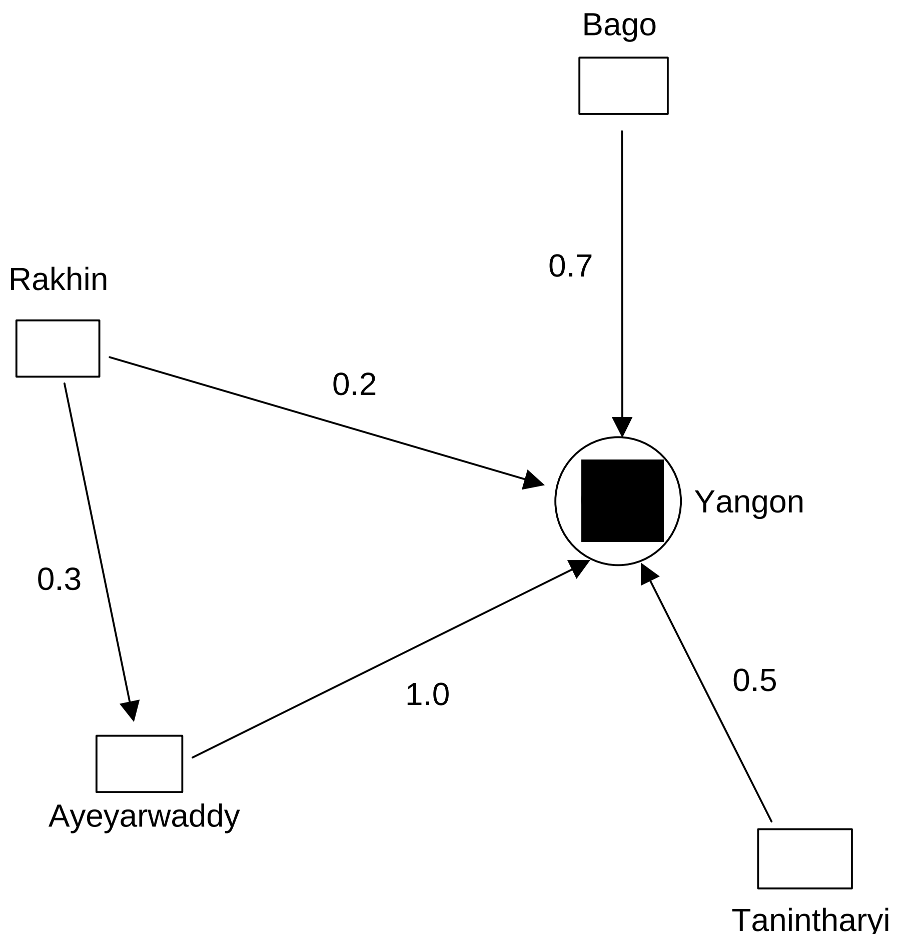
Figure 2: Trade of woodfuels in Yangon Catchment, 2000
(million ADT)



In 2000, Yangon woodfuel consumption is projected to be 3.46 million ADT of which 2.2 million ADT is imported.

Source : Myanmar Energy Sector Investment and Policy Review by World Bank Team, May 1991.

Figure 3: Trade of Woodfuels in Yangon Catchment, 2005
(million ADT)



In 2005, Yangon woodfuel consumption is projected to be 4.3 million ADT of which 2.4 million ADT is imported.

Source : Myanmar Energy Sector Investment and Policy Review by World Bank Team, May 1991.

5.3 Woodfuel Situation and Woodfuel Substitutes

Since 1990-91 the position of woodfuel particularly in Ayeyarwaddy has changed appreciably as legal action against fuelwood cutting, charcoal burning and transportation has been enforced. Nevertheless, the size of the woodfuel requirement in the region remains the same and if the flow of woodfuel from mangrove areas is restricted, substitutes will certainly come from non-mangrove forest areas or from the nearby forest divisions.

Alternative energy sources such as electricity, gas and hydropower cannot yet contribute a sufficient energy to meet the shortfall.

Residue from sawmilling amounts to an annual average of 163,065 cubic metres from teak and 231,757 from non-teak hardwoods. This quantity of residue could be used as a raw material for large scale briquetting production.

According to the 1996 report by the Ministry of Planning and Economic Development, the yield of paddy for the year 1995-96 is estimated at between 362.7 to 937.85 million baskets. The average comes to 650 million baskets. This quantity is equivalent to 13.585 million metric tons. With a 17 percent yield of rice husk, the quantity of rice husk available for the year will be 2.31 million metric tons. This much rice husk could be available for the production of biomass briquettes.

In Table 8, a substantial quantity of crop residue is available in Ayeyarwaddy, Yangon, Bago, Mandalay and Sagaing Divisions. (FRI) Forest Research Institute, Yezin has already developed fuel efficient A-1 stoves and the demand for these is said to be increasing. Mr. E. Bayoumi in his Field Document No. 3 paper (UNDP/FAO, MYA/93/003) on "Comparative Controlled Standard Cooking Tests" in 1995 has stated that FRI (A-1) stoves have achieved a saving of more than 33% in fuel wood and more than 45% in time compared to the 3 stone traditional stoves. He has also calculated that an annual fuelwood saving of 2,721,659 tons could be made in the Dry Zone area alone if these A-1 stoves were widely distributed.

<u>Efficiency of charcoal kilns</u> Conversion rates from fuelwood to charcoal are below what could be achieved. According to the World Bank Mission, weight to weight conversion is between 9 and 14% for the brick kilns and 6 to 12% for the pit kilns. By improving kiln designs, conversion techniques and quality, as well as size and species of woodfuel used, there is plenty of opportunity to improve the conversion rate.

Comparative figures for charcoal production for Myanmar, Malaysia and Thailand are presented in table 14.

Table 14.

Activity	Myanmar	Malaysia	Thailand
Cost charcoal kiln	US $ 5,000	US $ 7,000	US $ 6,000
Number of burns per year	12	8	12
Vol. of wood stacked per burn	20 tons	55 tons	66 tons
Conversion to charcoal	2.31 tons	10.5 tons	-
Percentage conversion	11.55%	19.09%	33.3%
Average size of wood fed	2 cm dia	8 cm dia	6-10 cm dia
Length of wood fed	3-4 feet	6 feet	6 feet
Number of days per burn	10-12	25	45
Royalty payable	K 115	174 MR	5 baht/ m^3
Regeneration fees paid	-	?	15 baht/ m^3

Source: Report on Mangrove Forest Products and Utilization of the Ayeyarwaddy Delta by U OHN, National Consultant (MYA/90/93). Data collected in Satun Province, Thailand, August 1996.

As regards the woodfuel species, Rhizophora are preferred for charcoal making. Their moisture content (mc) when felled is about 40% (as % of oven dry weight) compared to Avicennia wood which ranges from 70-95%. Rhizophora wood dries to about 25% mc after two months whereas Avicennia requires up to six months to dry to 35% mc. (FAO Forestry Paper 117).

For bioenergy plantations, the potential energy yield per unit area (i.e. above ground biomass) rather than volume is the important measure. For example, a pine plantation with twice the standing volume of a Rhizophora forest has 24% less potential energy per unit area. The high heat value of 4,400 KCL/kg has been cited for R. mangle in Ecuador.

Out of 92,000 acres (37,232 ha) planted annually in Myanmar about 40% consists of bioenergy plantations i.e. 36,800 acres or 14,893 ha. By using mangrove forests MAI of $10m^3$/year/ha, the annual production of woodfuel from bioenergy plantations with 10 years rotation could reach only 1,489,300 m^3 a year which is only a little less than 5% of the country's annual requirement (see Section 5.3). This indicates that the woodfuel crisis cannot possibly be solved by the Forest Department alone. Unless the local communities are involved the problem will soon be out of control and it will certainly force the people to further encroach into or destroy the natural forests.

The Forest Department has been distributing around 11 million tree seedlings free of charge annually to local communities and governmental organizations in an attempt to raise woodlots and for use in roadside planting. It is, however, difficult to determine to what extent this programme has been successful.

Trees growing in homegardens or homesteads, border plantings, scattered in paddy and dry land agricultural fields, fallows and in all other kind of agroforestry systems form the major source of fuelwood in most Asian countries.

If homestead and agricultural land tree plantings could be effectively pursued the woodfuel problem could be reduced significantly.

5.4 Recommendations and Conclusions

5.4.1 Recommendations

Techniques of making available fuelwood substitutes such as electricity, solar energy, wind energy, fuel oil, natural gas, coal and cool dust, paddy husks, saw dust and other agricultural residues have to be developed and/or encouraged by the government as well as by co-operatives, NGOs & etc.

FRI (A-1) stoves are now accepted both by rural as well as urban households. Reports suggest that around 80, 000 stoves have been distributed so far.

Meanwhile, the use of fuelwood substitutes such as heat energy in household applications and in txe manufacture of bricks, pottery, and tobacco drying etc. has to be displayed or demonstrated at festivals and market centres all over Myanmar.

By improving charcoal kiln designs and conversion techniques (Section 5.4), the production of charcoal could either be improved or woodfuel inputs reduced considerably.

A few selected people from the Charcoal Kiln Association (NGO) should be sent to Malaysia or Thailand to study kiln designs and techniques of conversion. The alternative is for the NGOs or the government to hire a suitable charcoal kiln expert or consultant from abroad to transfer the technology to the local charcoal producers.

Priority on the sale of requested machineries, equipments, fertilizers and insecticides, etc. should be given to the private entrepreneurs/local communities who are engaged in the establishment of bioenergy, commercial and industrial plantations.

Selected personnel from the relevant government departments and local communities should be sent abroad for training and/or post graduate studies related to energy sector development, the mangrove forest ecosystem and its natural environment and at the same time, trained professionals should be assigned to the relevant problem areas for at least 3 years once they have completed their studies.

Increased public awareness and a positive response to the Community Forestry Instructions of the Forest Department are vital to the successful establishment of bioenergy plantations.

5.4.2 Conclusions

Since the mangrove resources are so seriously depleted and degraded a concerted and coordinated programme to restore this potentially renewable and vital ecosystem which could provide for multiple uses on a sustainable basis should be established before any other development projects or activities are implemented.

It would not be wise to expect the foresters to take on this enormous responsibility of restoring this ecosystem alone. It is a problem which concerns everyone in the mangrove areas and adjoining divisions. Authorities at all levels should realize the depth of the problem in the first place and combine their resources to make a concerted effort to solve these socio-economic and environmental problems.

Besides, it is logically impossible for the Forest Department bioenergy plantations to be established on a scale large enough to ensure that the future woodfuel requirement of the country is met.

Directed social forestry, community forestry and farm forestry planting will continue and the benefits from such projects or progarmmes will give local people greater confidence in establishing self-help schemes.

Community forestry projects or programmes are likely to become gradually more successful in the future, but only when the social foresters become more skillful at their jobs. In the meantime, all projects or progammes should be designed to take the needs of local communities more into account.

5.5 Bibliography

Pe Thein,1987	Notes on Mangrove Forests of Myanmar.
FAO, 1990	Regional Wood Energy Development in Asia. Programme GCP/RAS/131/NET
World Bank, 1991	Energy Sector Investment and Policy Review.
U OHN, 1992	Report on Mangrove Forest Products and Utilization of the Ayeyarwaddy Delta. FAO/FO: MYA/40/003, Field Document No. 4, Yangon.
Forest Department, 1993	Forestry Fact Sheets.
FAO, 1994	Forestry Paper 117, Mangrove Forest Management Guidelines, Rome.
Bayoumi, 1995	Comparative Controlled Standard Cooking Tests. UNDP/FAO: MYA/93/003, Field Document No. 3, Yangon.
Dr. Myint Han, 1995	Fuelwood Substitutes to Solve Fuelwood Crisis in Myanmar. Myanmar Forestry Journal, vol. 3, No. 2, April, 1995.
FAO, 1996	Regional Wood Energy Development Programme in Asia. GCP/RAS/154/NET
Ministry of National Planning & Economic Development, 1996	Report on Financial, Economic and Social Conditions for the Union of Myanmar for the Year 1995-96.
Soe Win Hlaing and Sein Htoon Linn, 1996	The Role of Forestry to Combat Desertification in Myanmar. National Awareness Seminar on the Convention to Combat Desertification, Yangon, 1996.

6. OUTPUT OF FUELWOOD SPECIES AND SOME EXPERIMENTAL FINDINGS ON FUELWOOD PRODUCTION

by

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Introduction

Ad present 7 states and divisions (out of 14 states /divisions) which are densely populated (about 71 percent of total population are living there) and with little forest and tree cover (having only about 33 percent of the total forest cover) face a fuelwood shortage problem to some degree. In order to bridge the demand / supply gap of the fuelwood in those areas, the authorities concerned have taken various measures emphasizing:

(1) increased production of fuelwood through establishing and expanding fuelwood plantations, and
(2) reduced consumption of fuelwood through more efficient charcoal production systems and cooking devices and substitution by other fuels.

Before 1970, the average annual planting rate of village supply fuelwood plantations was less than 1,500 acres (600 ha) and it increased to about 4,320 acres (1,750 ha) in the 1970s. In the 1980s, the annual planting rate of fuelwood plantations increased to 14,140 acres (5,720 ha) which is about 3.3 times that of the previous decade. Between 1990 and 1995 it reached 24,300 acres (9,800 ha), the highest recorded.

During a period of 20 years from 1973 to 1992 the Forest Department established about 220,000 acres (89,000 ha) of village fuelwood plantations all over the country except for Kayin State. 55 percent of these plantations are in the Dry Zone fuelwood deficit areas (Mandalay, Sagaing and Magwe divisions), 27 percent in other fuelwood deficit areas (Yangon, Ayeyarwaddy, Mon and Bago divisions), 17 percent in Shan State which is likely to face the same problem in the near future and 1 percent in the remaining states and divisions.

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Even though the Forest Department is increasing its annual target of fuelwood plantations year after year, the expected fuelwood production is still inadequate to meet the present and future demand.

In 1978, the Forest Research Institute0was established in Yezin with the objective of providing technical information on all aspects of forestry and forest based activities in order to increase the contribution of the fobest and forest lands to the well-being of the nation. Since then, the FRI has conducted quite a number of experimental research activities mostly under the following research programmes:

(1) Sustainable forest management in natural forests.
(2) Establishment of mixed woods and agro-forestry plantations with fast growing species.
(3) Utilization of lesser used species (LUS) and non-wood forest products.
(4) Wood energy development.

FRI is trying to conduct applied research which could be useful for field foresters and other related agencies. Some experimental studies are, therefore, concerned with morphological and anatomical characteristics, seed storage, germination and growth, species trial, planting techniques, chemical and physical properties of forest plantation soil, fuelwood output and coppicing power for some fuelwood species and also charcoal production, improved cooking stoves etc. in support of the wood energy development programme.

This paper consists of two parts. The first part deals with the output of some fuelwood species recently investigated at some localities and the second part is concerned with the basic technical information about fuelwood plantations gained from past experiments.

Though the technical data are based on experimental findings, some of them are presented just for discussion as they are only preliminary results and require follow-up research for completion. Nevertheless, this basic information will be helpful for foresters and non-foresters who are or will be engaged in planning or implementing fuelwood plantation programmes.

6.1 Volume of Output of Some Common Fuelwood Species

In order to estimate the volume of output of some fuelwood species commonly used in fuelwood plantations in Myanmar, a suitable number of sample trees in each plantation was felled and the stem and branches were cut into 6 feet- long pieces up to one inch diameter. It was then stacked for volume measurement and converted into solid volume per unit area.

The fuelwood plantations established in Yedashe, Yamethin and Pyinmana townships were selected for volume assessment and the species included Eucalyptus camaldulensis, Leucaena leucocephala, Albizzia lebbek, Albizzia procera, Acacia catechu, Acacia auriculiformis, Acacia senegal, Cassia siamea, Tectona hamiltoniana and Acacia holosericea. The plantations were formed in three different spacings using 8.5' x 8.5' (2.5 m x 2.5 m), 10' x 6' (3 m x 1.8 m), 12' x 12' (3.7 m x 3.7 m) and in different years between 1983 and 1990. The estimated output volumes of a few species based on previous measurements were also presented for comparison.

Eucalyptus camaldulensis

Description	1. Yeni,Yedashe T.S	2. Yeni, Yedashe T.S
Year of establishment	1987	1990
Year of volume measurement	1996 (9 years old)	1996 (6 years old)
Original spacing	10' x 6' (3m x 1.8m)	10' x 6' (3m x 1.8m)
Trees/acre (Trees/ha.)	726 (1794) trees	726 (1794) trees
No. of trees felled	478 trees	264 trees
Solid volume/acre Solid volume/hectare	82.3 Hoppus tons 366.5 m^3	81.1 Hoppus.tons 361.2 m^3
Mean annual increment/acre Mean annual increment/hectare	9.1 Hoppus tons 40.7 m^3	13.5 Hoppus tons 60.2 m^3

***Leucaena leucocephala* (Bawzagaing)**

Description	1. Yeni, Yedashe T.S	2. Shwe-min-wun Yamethin T.S
Year of establishment	1983	1987
Year of volume measurement	1996 (13 years old)	1996 (9 years old)
Original spacing	8.5'x 8.5' (2.6m x 2.6m)	12'x 12' (3.7 m x 3.7m)
Trees/acre (Trees/ha.)	603 (1490) trees	303 (748) trees
No. of trees felled	5 trees	303 trees
Solid volume/acre Solid volume/hectare	85.5 Hoppus tons 380.8 m^3	31.4 Hoppus tons 139.8 m^3
Mean annual increment/acre Mean annual increment/hectare	6.6 Hoppus tons 29.3 m^3	3.5 Hoppus tons 15.5 m^3

***Leucaena leucocephala* (Bawzagaing)**

Description	3. Le-byin Yamethin T.S	4. Shwe-min-wun Yamethin T>S
Year of establishment	1984	1984
Year of volume measurement	1996 (12 years old)	1996 (12 years old)
Original spacing	12' x 12' (3.7 m x3.7 m)	12' x 12' (3.7 m x 3.7 m)
Trees/acre (Trees/ha.)	303 (748) trees	303 (748) trees
No. of trees felled	23 trees	72 trees
Solid volume/acre Solid volume/hectare	20.1 Hoppus tons 89.5 m^3	18.6 Hoppus tons 82.8 m^3
Mean annual increment/acre Mean annual increment/hectare	1.7 H.tons 7.6 m^3	1.6 Hoppus tons 7.1 m^3

Note : T. S = Township**.**

***Albizzia lebbek* (Kokko)**

Description	Yezin (Pyinmana Township)
Year of establishment	1983
Year of volume measurement	1996 (13 years old)
Original spacing	8.5' x 8.5' (2.6 m x 2.6 m)
Trees/acre (Trees/ha.)	603 (1490) trees
No. of trees felled	10 trees
Soild volume/acre Solid volume/hectare	71.3 Hoppus tons 317.5 m^3
Mean annual increment/acre Mean annual increment/hectare	5.5 Hoppus tons 24.4 m^3

***Albizzia procera* (Sit)**

Description	Yezin (Pyinmana Township)
Year of establishment	1983
Year of volume measurement	1996 (13 years old)
Original spacing	8.5' x 8.5' (2.6 m x 2.6 m)
Trees/acre (Trees/ha.)	603 (1490) trees
No. of trees felled	10 trees
Solid volume/acre Solid volume/hectare	66.4 Hoppus tons 295.7 m^3
Mean annual increment/acre Mean annual increment/hectare	5.1 Hoppus tons 22.7 m^3

***Acacia catechu* (Sha)**

Description	Yezin (Pyinmana Township)
Year of establishment	1983
Year of volume measurement	1996 (13 years old)
Original spacing	8.5' x 8.5' (2.6m x 2.6 m)
Trees/acre (Trees/ha.)	603 (1490) trees
No. of trees felled	20 trees
Solid volume/acre Solid volume/hectare	37.9 Hoppus tons 168.8 m^3
Mean annual increment/acre Mean annual increment/hectare	2.9 Hoppus tons 13.0 m^3

Acacia auriculiformis

Description	Yezin (Pyinmana Township)
Year of establishment	1983
Year of volume measurement	1996 (13 years old)
Original spacing	8.5' x 8.5' (2.6m x 2.6 m)
Trees/acre (Trees/ha.)	603 (1490) trees
No. of trees felled	5 trees
Solid volume/acre Solid volume/hectare	37.6 Hoppus tons 167.5 m^3
Mean annual increment/acre Mean annual increment/hectare	2.9 Hoppus tons 12.9 m^3

Acacia senegal

Description	Yezin (Pyinmana Township)
Year of establishment	1983
Year of volume measurement	1996 (13 years old)
Original spacing	8.5' x 8.5' (2.6m x 2.6 m)
Trees/acre (Trees/ha.)	603 (1490) trees
No. of trees felled	10 trees
Solid volume/acre Solid volume/acre	35.6 Hoppus tons 158.6 m^3
Mean annual increment/acre Mean annual increment/hectare	2.7 Hoppus tons 12.2 m^3

***Cassia siamea* (Mezali)**

Description	Yezin Pyinmana T.S	Shwe-min-wun Yamethin T.S
Year of establishment	1983	1984
Year of volume measurement	1996(13 Years old)	1996(12 Years old)
Original spacing	8.5' x 8.5' (2.6 m)	12' x 12' (3.7 m)
Trees/acre (Trees/ha.)	603 (1490) trees	303 (748) trees
No. of trees felled	20 trees	72 trees
Solid volume/acre Solid volume/hectare	30.9 Hoppus tons 137.6 m^3	23.0 Hoppus tons 102.4 m^3
Mean annual increment/acre Mean annual increment/hectare	2.4 Hoppus tons 10.6 m^3	1.9 Hoppus tons 8.5 m^3

***Cassia siamea* (Mezali)**

Description	Yamethin Township
Year of establishment	1984
Year of volume measurement	1996 (12 Years old)
Original spacing	12' x 12' (3.7 m x 3.7 m)
Trees/acre (Trees/ha.)	303 (748) trees
No. of trees felled	108 trees
Solid volume/acre Solid volume/hectare	26.4 Hoppus tons 116.1 m^3
Mean annual increment/acre Mean annual increment/hectare	2.2 Hoppus tons 9.7 m^3

***Tectona hamiltoniana* (Dahat)**

Description	Yezin (Pyinmana Township)
Year of establishment	1983
Year of volume measurement	1996 (13 years old)
Original spacing	8.5' x 8.5' (2.6m x 2.6 m)
Trees/acre (Trees/ha.)	603 (1490) trees
No. of trees felled	25 trees
Solid volume/acre Solid volume/hectare	28.5 Hoppus tons 126.9 m^3
Mean annual increment/acre Mean annual increment/hectare	2.2 H.tons (9.8 m^3)

Acacia holosericea

Description	Yezin (Pyinmana Township)
Year of establishment	1984
Year of volume measurement	1996 (12 years old)
Original spacing	8.5' x 8.5' (2.6 m x 2.6 m)
Trees/acre (Trees/ha.)	603 (1490) trees
No. of trees felled	10 trees
Solid volume/acre Solid volume/hectare	14.3 Hoppus tons 63.7 m^3
Mean annual increment/acre Mean annual increment/hectare	1.2 Hoppus tons 5.3 m^3

Summary of output volumes of some fuelwood species
(based on measurements taken in 1996)

Sr No.	Species	Age (year)	Spacing in feet	Solid volume		MAI		Locality
				Ht/ac	m^3/ha	Ht/ac	m^3/ha	
1	*Eucalyptus camaldulensis*	6	10'x6'	81.1	361.2	13.5	60.2	Yezin
	Eucalyptus camaldulensis	9	10'x6'	82.3	366.5	9.1	40.7	Yezin
2	*Leucaenia leucocephala*	13	8.5'x8.5'	85.5	380.8	6.6	29.3	Yezin
	Leucaenia leucocephala	9	12'x12'	31.4	139.8	3.5	3.5	Yamethin
	Leucaenia leucocephala	12	12'x12'	20.1	89.5	1.7	1.7	Yamethin
	Leucaenia leucocephala	12	12'x12'	18.6	822.8	1.6	7.1	Yamethin
3	*Albizzia lebbek*	13	8.5'x8.5'	71.3	317.5	5.5	24.4	Yezin
4	*Albezzia procera*	13	8.5'x8.5'	66.4	295.7	5.1	22.7	Yezin
5	*Acacia catchu*	13	8.5'x8.5'	37.9	168.8	2.9	13.0	Yezin
6	*Acacia auriculiformis*	13	8.5'x8.5'	37.6	167.5	2.9	12.9	Yezin
7	*Acacia senegal*	13	8.5'x8.5'	35.6	158.6	2.7	12.2	Yezin
8	*Cassia siamea*	13	8.5'x8.5'	30.9	137.6	2.4	10.6	Yezin
	Cassia siamea	12	12'x12'	23.0	102.4	1.9	8.5	Yezin
	Cassia siamea	12	12'x12'	25.9	116.1	2.2	9.9	Yamethin
9	*Tectona hamiltoniana*	13	8.5'x8.5'	28.5	126.9	2.2	9.8	Yamethin
10	*Acacia holoseriacea*	12	8.5'x8.5'	14.3	63.7	1.2	5.3	Yezin

Note: MAI = Mean annual Increment Ht/ac = Hoppus tons/acre
m^3/ha=Cubic meters/hectare

Summary of output volumes of some common fuelwood species
(based on previous measurements taken in 1982 and 1986)

Sr No.	Species	Age (year)	Spacing in feet	Solid volume		MAI		Locality
				Ht/ac	m^3/ha	Ht/ac	m^3/ha	
1	*Eucalyptus camaldulensis*	10	12'x12'	34.9	155.3	3.5	15.6	Yupataung
2	*Cassia siamea*	4	12'x12'	8.4	37.4	2.1	9.3	Hlaing tat
	Cassia siamea	4	9'x9'	9.6	33.6	2.4	8.4	Hmawbi
3	*Acacia catchu*	12	12'x12'	11.7	52.1	1.0	4.5	Mondaing
	Acacia catchu	5	12'x12'	25.0	111.3	5.0	22.3	Yupataung
	Acacia catchu	4	9'x9'	6.9	24.3	1.7	6.1	Hmawbi
	Acacia catchu	4	5'x5'	13.6	47.5	3.4	11.9	Hmawbi
4	*Leucaenia leucocephala*	4	9'x9'	11.8	41.1	3.0	10.3	Hmawbi
	Acacia catchu	4	5'x5'	22.2	77.6	5.6	19.4	Hmawbi
6	*Albezzia procera*	4	9'x9'	7.4	25.8	1.9	6.5	Hmawbi
	Albezzia procera	4	5'x5'	21.9	76.5	5.5	19.1	Hmawbi

Note: MAI = Mean annual Increment Ht/ac = Hoppus tons/acre
m^3/ha=Cubic meters/hectare

6.2 Some Other Experimental Findings on Fuelwood Production

6.2.1 Chemical and physical properties of forest soil in fuelwood deficit areas

In line with the large scale forest plantation program, the Forest Research Institute has, since 1980, studied the physical and chemical properties of forest soils in different localities in order to provide technical information for the determination of the species-site matching plan.

Bago Yoma forest soil

Bago Yoma forest is one of the areas where the large scale plantation programme was launched many years ago. In 1982, FRI presented a paper describing some physical and chemical properties of soils under different types of forest in East Bago Yoma. The study area covered Yenwe, Bondaung, Palwe and Ngalaik reserved forests in Bago, Taungoo, Pyinmana and Yamethin forest districts, respectively.

Generally, forest litter accumulation is well developed and good enough to control run off and soil loss in all types of forest under the study area except *taungya* (shifting cultivation). All forest surface soils are moderately acidic(pH 5.3 to 6.6), well supplied with organic matter and a satisfactory level of primary plant nutrients (N,P,K.) for tree growth.

Dry Zone forest soils

Dry Zone soils are generally poor and degraded as the area has very limited precipitation and a high evaporation rate. Due to its large population with fewer trees and little forest cover, the fuelwood shortage problem became serious in this area many years ago. In order to ensure a sustainable supply of fuelwood and environmental stability, the Forest Department launched a large scale plantation programme.

In 1983, the FRI produced a research leaflet on the physical and chemical properties of Dry Zone forest soils covering three sites in Meiktila and Dry Zone forest districts. Again in 1996, some studies of the physical and chemical properties of soil samples and soil profiles from the plantations of 19 townships in Sagaing and Mandalay Divisions were presented in a research paper.

In the 1983 document it was stated that Yupataung and Inbinwa soils with sandy clay loam texture and with considerable amount of organic matter are more favorable to tree growth than the Pyinma area with its sandy loam soil texture. Yupataung, having a neutral soil reaction, is superior to the other two sites where only tree species adaptable to alkali conditions should be selected. However, the nutrient levels of the study areas are not sufficient even for the minimum requirement of plant growth and therefore leguminous or soil improving tree species have to be considered for plantation establishment. Where necessary, chemical fertilizer or organic manure should be applied especially at the time of planting.

In the 1996 document it was stated that most of the plantation soils (in 19 townships) are associated with active alkalinity except for those in 2 townships (Yinmarbin and Tatkon). The organic matter content of the majority areas varies from 1 to 4 % which is suitable for satisfactory growth. But 3 plantation sites in Nyaungoo, Tat-kon and Yamethin Townships have little organic matter.

Total nitrogen content and phosphorus concentration levels in all areas are lower than the minimum requirements of 0.07 % and 0.005 %, respectively, for normal growth. The potassium levels in all areas except 5 plantation sites (in Meiktila, Kyaukpadang , Mahlaing, Naungoo and Tat-kon Townships) are also lower than those of normal forest soils. The secondary nutrients (sodium, calcium and magnesium)are generally normal in the study area.

The soil textures of the study area are mostly sandy loam and loamy sand which are unable to retain moisture and maintain the nutrients due to the intense rain and poor water holding capacity. In some places there are clay pans or sand stone layers at about 70 cm depth and hence future growth and survival of seedlings are very much doubtful even although they grow well at the beginning.

Mangrove forest soil

The salty mud of tropical mangrove forests is found in the delta areas of Yangon and Ayeyarwaddy divisions and also in Rakhine and Tanintharyi coastal areas. The study area includes 2 reserved forests (Meinmahla and Kadonkani) and one unclassified forest (Chaungtha) in the Ayerarwaddy division. Some of the mangrove forests in this division are now severely degraded and over-exploitation of firewood and charcoal not only for domestic demand but also for export to other divisions is one of the main causes. Natural regeneration should therefore be improved to ensure a more stable supply of fuelwood, timber and other forest products.

According to the soils study in 1989, the soils from the study areas have a good structure and fine texture. The soils are slightly acid and the nutrient content is high. All of them have favorable physical and chemical properties and a satisfactory level of primary plant nutrients for tree growth.

Among the study areas, Chaungtha soils are more acidic and have the highest organic matter content, and higher concentration of nutrients, but very low concentration of phosphorus.

As mangrove soils are under the influence of tidal brackish or salt water, the soil salinity is high. Electrical conductivity is between 4.1 to 18.6 m mhos/cm in the case of Meinmahla and Kadonkani and between 2.8 to 3.0 m hos/cm at Chungtha. The organic matter content varies from 5 to 15 % in Chaungtha area and 4 to 9 % at Meinmahla and Kadonkani depending on species composition.

6.2.2 Choice of species for successful fuelwood plantation

In order to establish a successful fuelwood plantation, the selection of correct species for the right site is of utmost importance and therefore the following points are to be thoroughly considered at the planning stage:

(a) Use of multipurpose plants that have uses in addition to providing fuel

(b) Use of plants that adapt well to different sites, establish easily,and require little care
(c) Use of plants not comsumed by goats, cattle and wildlife
(d) Nitrogen-fixing ability
(e) Rapid growth
(f) Ability to coppice
(g) Ability to produce wood of high calorific value that burns without sparks or toxic smoke
(h) Ability to grow successfully in a wide range of environments, including different altitudes, soil types, rainfall regimes, amount of sunlight, and terrain.

Previous experiments show that :

Leguminous species such as *Leucaena Leucocephala, Acacia catechu, Acacia arabica, Cassia siamea and Albizzia lebbek* can be grown at the Dry Zone sites where almost neutral soil reaction was observed.

Eucalyptus plantations in the Dry Zone reforestation program were more successful than the native species in terms of survival rate and growth. Due to its inherent characteristics such as fast growing and high coppicing capability, evergreen leaves and low soil nutrient consumption, *Eucalyptus* may be recommended as the most suitable species for the Dry Zone area when fuelwood is scarce and climate and soil conditions are severe.

Acacia holosericea species has great potential in the Dry Zone area, next to *Eeucalyptus* species. Among the local Acacias and exotics so far tried, *Acacia holosericea* performs remarkably well. It is desirable to plant *Acacia holosericea* species in the Dry Zone especially for multipurpose woodlots and fuelwood plantations with poor soil formation.

Species selection trials for fuelwood plantations were carried out in 1980, using 14 different species at 3 different townships (Thazi, Meiktila and Hmawbi townships). Of the three locations, Inbinwa reserve forest (Meiktila Township) is the driest with the poorest soil, Yupataung reserve (Thazi Township) is slightly moister with slightly better soil, while Hmawbi reserve (Hmawbi township) is a high rainfall area but with poor clayey, lateritic soil.

Results of the survival rate at the fourth year in Yupataung.

Species	Survival rate (%)	Mean height	
		feet	meters
Acacia senegal	94.5	10.9	3.3
Acacia catechu	79.2 the best	10.8	3.3
Eucalyptus caMaldulencis	56.9	25.0	7.6
Acacia arabica	54.6 fair	10.8	3.3
Albizzia lebbek	18.1	4.4	1.3
Cassia siamea	16.0	11.4	3.5
Dalbergia sissoo	11.8 poor	2.4	0.7

Results of the survival rate at the fourth year in Inbinwa.

Species	Survival rate (%)	Mean height	
		feet	meters
Eucalyptus camaldulensis	91.7	12.4	3.8
Acacia senegal	90.3 the best	5.1	1.6
Cassia siamea	75.7	5.3	1.6
Albizzia lebbek	70.8 good	5.1	1.6
Acacia catechu	56.3	4.8	1.5
Dalbergia sisso	47.2 fair	2.5	0.8
Acacia arabica	14.6 poor	3.4	1.0

Results of the survival rate at the fourth year in Hmawbi.

Species	Survival rate (%)	Mean height	
		feet	meters
Leucaenia leucucephala	90.6	13.9	4.2
Cassia siamea	87.8 the best	7.2	2.2
Albizzia chinensis	74.4 good	6.1	1.9
Acacia catechu	64.7	5.8	1.8
Albizzia procera	63.7	6.0	1.8
Swietenia macrophylla	62.6	3.6	1.1
Acacia senegal	60.5	4.1	1.2
Albizzia falcataria	54.3 fair	8.8	2.7

Soil nutrient levels of most of the Dry Zone forest soils are not good enough for the normal growth of forest tree species. In order to establish successful fuelwood plantations in such areas, the selection of nitrogen-fixing tree (NFT) species which represent the legume subfamilies Caesalpinioidea, Mimosoidaea and Papilionoideae, as well as 10 other families, are of utmost importance.

Comparison of the some of the chemical properties of the surface soil of the study sites before and after planting with leguminous species are shown in the following table. The test showed that leguminous species improved the soil and maintained the nutrient levels of the surface soils.

Yeposa area

	Acidity pH	O.M %	Total N %	Av.P %	Av. K %
Before planting	7.0	1.35	0.0396	0.0004	0.0065
After planting with *Acacia catechu* (Sha)	7.2	1.70	0.0617	0.0006	0.0037
Leucaena leucocephala (Baw- zagaing)	6.7	1.67	0.0386	0.0008	0.0049
Albizzia lebbek (Kokko)	7.1	1.33	0.0489	0.0007	0.0044
Acacia senegal (Senegal sha)	6.9	1.95	0.0411	0.0011	0.0050

6.2.3 Seed collection, storage and pretreatment of some fuelwood species

(1) *Acacia auriculiformis* (Auriculiformis Sha)

Seed collection and processing: The ear-pod-wattles were collected in December and January. The pods were collected on the ground by means of an extended prune. Collected pods were spread out on a mat and placed in the sun for 3 days to dehisce. The seeds were than separated from the pods manually. Seed cleaning and drying were also done before storage.

Seed storage : The seeds of this species stored best in an air conditioned room rather than under refrigeration or at room temperature. The seeds stored in the air conditioned room responded appreciably well only up till the 5th month of storage.

Seed pretreatment and germination: Out of the three pretreatments applied, partial scarification was the best, and was followed by soaking in boiling water and control. The germination percent increased from the normal 8% to 40.3% and 60% respectively. Similarly, germination value (GV) also increased from the normal 0.09 to 2.37 and 21.6, respectively.

Number of seeds per kilogram : 60,000
Number of days required to reach plantable size : 151

(2) *Acacia senegal* (Senegal Sha)

Seed collection and processing: The pods were collected in January. The freshly collected pods were spread out and sun-dried for 3 days. The seeds were then separated from the pods manually. Purification was done by winnowing and the seeds were again sun-dried for one day after which the seeds were treated with insecticide and stored.

Seed storage: No differences were observed among the series of germination tests carried out for seeds stored in the air conditioned room and at room temperature. In both cases, the seeds stored appreciably well only up till the 5th month of storage.

Seed pretreatment and germination: Senegal Sha seeds, after being pretreated with soaking in boiling water increased in germination from the normal 46% to 75.3%. GV also increased from 16.17 to 44.43.

Number of seeds per kilogram : 14,600
Number of days required to reach plantable size : 121

(3) *Albizzia procera* (Sit)

Seed collection and processing: Collection of pods was carried out January to February before the pods dehisced. The pods were put in gunny bags and left in the sun for 5-7 days during which the pods dehisced and the seeds separated out. Most of the seeds were greatly infested with insects. In order to separate good seeds from these infested seeds and inert materials, the seeds were immersed in water. Those that sank were good seeds and they were immediately dried in the sun for 2 days before being treated with insecticide and stored.

Seed storage: No differences were observed among the series of germination tests carried out for the seeds stored in the air conditioned room and at room temperature.

Seed pretreatment and germination: After being pretreated with boiling water the seeds increased in germination from the normal 40% to 80%. GV also increased from 6.44 to 44.75.

Number of seeds per kilogram : 24700
Number of days required to reach plantable size : 89

(4) *Cassia siamea* (Mezali)

Seed collection and processing: Pods were collected and put in gunny bags. These gunny bags were left in the sun for approximately 5 days after which the bags were thrashed and the seeds were separated from the debris by winnowing. The pure seeds were dried again in the sun for 2-3 days. The seeds were then stored in the storage room.

Seed storage: Mezali stored better in an air conditioned room than at room temperature. Germination for the seeds stored in the air conditioned room was found to be appreciably good up to the 14th month of storage.

Seed pretreatment and germination: Mezali seeds increased in germination from the normal 45.2% to 59.5% after being soaked in cold water for 24 hours. GV also increased from 6.65 to 19.67.

Number of seeds per kilogram : 32,630
Number of days required to reach plantable size : 143

(5) *Eucalyptus camaldulensis*

Seed collection and processing: Collected capsules were spread out on canvas to dry for 2-3 days. Once the capsules were opened, they were shaken manually to remove the seeds. The viable seeds were extracted together with unfertilized ovules, known collectively as "chaff ". Large impurities such as the remains of twigs, capsules, and leaves were removed by separating. Smaller impurities were removed by sieving. The seeds were then dried in the sun for one day and stored.

Seed storage: Storage of the seed of this species was found to be best under refrigeration. Storage in an air-conditioned room was second best, and storage at room temperature third. However, the differences regarding the effect of storage under these three conditions were not very striking.

Seed pretreatment and germination: Eucalyptus is another fast growing species which grows reasonably fast in the nursery. Time for seed collection varies according to locality (FAO,1955). In Yezin, seed can be collected from June till July. Eucalyptus seed is reported to have germinated after being stored at room temperature for 30 years (Krugman, 1974). Germination, however, was slow. The present study showed that the seeds of this species germinate reasonably well after being stored for 29 months at room temperature. However, it stored best under refrigeration. No seed treatment is required.

Number of seeds per kilogram : 2.3 to 2.5 million
Number of days required to reach plantable size : 177

(6) *Leucaena leucocephala* (Bawzagaing)

Seed collection and processing: Mature fruits fallen from the tree were collected from the ground by sweeping. Seed were purified by winnowing after which they were sun dried for 3 days. Bawzagaing usually produces an enormous number of seeds.

Seed storage: No differences were observed among the series of germination tests carried out for seeds storage in the air conditioned room and at room temperature. In both cases the seeds stored appreciably well up till the 27th month of storage or more.

Seed pretreatment and germination: Out of the three pretreatments applied, partial scarification was the best and was followed by soaking in cold water and control. The germination percent increased from the normal 20% to 25.3 % and 95%, respectively. GV also increased from the normal 0.75 to 1.76 and 332.43, respectively.

Number of seeds per kilogram : 14,370
Number of days required to reach plantable size : 81

(7) *Samanea saman* (Thinbaw-kokko)

Seed collection and processing: Pod collection was carried out from March to May. The seeds were separated from the pods first by hammering the pods. These were then immersed in water and agitated until the seeds were clean. The seeds were then dried in the sun for 4 days before being stored.

Seed storage: Thinbaw-kokko seeds stored better in the air conditioned room than at room temperature. Germination of the seeds stored in the air conditioned room was appreciably good up till the end of the experiment on the 14th month.

Seed pretreatment and germination: After being partially scarified Thinbaw-kokko seeds increased in germination from the normal 65% to 100%. GV also increased drastically from 24.78 to 302.38.

Number of seeds per kilogram : 4,190
Number of days required to reach plantable size : 142

(8) *Sesbania grandiflora* (Paukpan-byu)

Seed collection and processing: Collection of pods was carried out from February to May. Unlike Mezali, the pods had to be gently hammered with a small hammer to split them open and extract the seed. Winnowing was done in order to separate the good seed from inert materials. After a proper sun drying for 2 days, the direct seeds were stored in the storage room

Seed storage: Paukpan-byu stored better in the air conditioned room than at room temperature. Germination of seeds stored in the air conditioned room was found to be appreciably good up to the end of the test, i.e. the 27th month.

Seed pretreatment and germination: Without being pretreated Paukpan-byu gave good germination of 95.3%. No pretreatment was required.

Number of seeds per kilogram : 32,020
Number of days required to reach plantable size : 61

(9) *Tectona hamiltoniana* (Dahat)

Seed collection and processing: Collection of seed was carried out usually in November. Collected seeds were put in gunny bags and taken to the seed laboratory at Yezin for cleaning, drying and storage. On arrival, seeds were dried in the sun for 3 days. Winnowing and cleaning were done manually to separate the sound seeds from inert materials. The seeds were then stored in the storage room.

Seed storage: No differences were observed among the series of germination tests carried out for seeds stored in the air conditioned room and at room temperature.

Seed pretreatment and germination: After being pretreated by heating in an oven at 85° C for two days, Dahat seeds increased in germination from the normal 16% to 30.5%. The GV also increased from 0.64 to 2.84.

Number of seeds per kilogram : 322,713
Number of days required to reach plantable size : 145

(10) *Terminalia oliveri* (Than)

Seed collection and processing: Seed collection was carried out in January and February. After collection, insect infested seeds and inert materials were picked out manually. The seeds were then sun dried for 2 days before storage.

Seed storage: Than seeds stored better in the air conditioned room than at room temperature. Germination of the seeds stored in the air conditioned room was appreciably good up till the 19th month.

Seed pretreatment and germination: After being soaked in cold water for 24 hours Than seeds increased in germination from the normal 35.3% to 50.3%. GV also increased from 1.88 to 4.25.

Number of seeds per kilogram : 7,510
Number of days required to reach plantable size : 97

6.2.4 Planting techniques for some fuelwood species applied by FRI

Method of transplanting: For the establishment of fuelwood plantations, the normal practice is to raise the seedlings in 3 inches × 7 inches polythene bags a few months prior to planting. However, there are problems in planting some large flat areas subject to high rainfall. Even though the seedlings could be raised in time, it is difficult to transport the tube seedlings t• the planting site because:

(a) the ground is too soft and boggy due to high rainfall for transportation with tractors.
(b) the time of transporting seedlings coincides with the time for planting paddy, consequently, bullocks and labour are scarce.

To solve this problem, either bare root planting or direct sowing methods can be used. Hence 6 planting methods were tried for 4 fuelwood species in Mergeri reserve, Taikkyi Township in 1986. The survival countings were carried out twice in December and May to determine if the seedlings can survive the dry hot season.

The species were *Albizzia procera* (Sit), *Samanea saman* (Thinbow-Kokko), *Cassia siamea* (Mezali) and *Leucaena leucocephala (*Bawzagaing). Different methods applied were seed sowing (with seed not pretreated or seed soaked in boiling water), planting with tube seedlings, bare root planting (same day or next morning) and puddled bare root planting. All the seedlings used were 8 inches tall and the spacing was 3 ft × 3 ft (0.9m). Three weedings were carried out, but patching was not done.

Albizzia procera: Planting with tube seedlings gave good results (survival rate:89.8% in December). Survival percent decreased to 53.5% in May 1987 due to high fungus and insect attack. Height growth was poor.

*Samanea saman: P*lanting with tube seedling, seed sowing (both seed partially scarified and seed not pretreated) were the best methods. (survival rates were 91.8%, 78.9% and 73.8% in

December, but dropped to 78.9%, 60.2% and 48.8%, respectively, in May 1987.) Height growth was poor.

Cassia siamea: All of the six treatments gave very good results with survival rates ranging from 71.1% to 87.0% in December 1986 but the survival rate of both bare root planting methods dropped down to about 50% in May 1987. Bare root (planted in same day), tube seedlings and puddled root planting methods gave reasonably good height growth (21.9", 17.l2"and 16.4" respectively).

*Leucaena leucocephala: B*oth bare root methods and puddled root method were the best (survival rates ranged from 89.5% to 94.1% in December 1986 and from 70.7% to 91.0% in May) and they could be considered very favorable.

Sizes of pits and refilling method: The effect of different sizes of pits and refilling methods of site preparation on growth and survival of *Eucalyptus camaldulensis* was tested in the Daungne area, the central Dry Zone of Myanmar in 1992.

The two different sizes of pits are:

1. 4'× 4'× 1' pit with 1'× 1' × 1' middle hole
2. 6' × 1.5 ' × 1.5 ' pit with 1.5 × 1.5' × 1.5 ' middle hole.

In refilling the pits the following methods were tried :

1. Half - flat refilling
2. Pyramid - shape refilling
3. Middle-hole refilling.

For all methods, the pits were dug at a spacing of 12'× 12' and weeding and soil working operations were carried out as practised in the Dry Zone area.

The studies showed that the survival rate and height growth of *Eucalyptus camaldulensis* planted in two pit sizes did not differ. But it appeared that half-flat refilling and middle-hole refilling methods were better than pyramid - shape refilling method in terms of survival in the first year.

Spacing: In forming the fuelwood plantation, spacing plays a very important role in maximizing the yield and hence it is necessary to know the correct spacing for a particular species. An experiment was carried out in Hmawbi reserve, Hmawbi Township using 7 species with 4 different spacings in 1983.

The species used were *Leucenia leucocephala, Albizzia procera, Acacia catechu, Cassia siama, Albizzia chinesis, Swietenia macrophylla and Acacia arabica.* Four types of spacings were 3'×5', 5'× 5', 7'×7' and 9' × 9' (i.e. 0.9 m × 1.5 m,, 1.5 m × 1.5 m , 2.1m×2.1m, and 2.7 m × 2.7 m). The area was clear felled and burned as usual and the seedlings were planted in the last week of June 1983. Three weedings were carried out in the first year, two in the second year, and two in the third year. The area was clear felled and harvested in April 1987. Total volume was computed by adding the volume of wood up to one inch diameter branches.

Total volume yield of some fuelwood species at different spacings

Species	Spacing							
	3'x5'		5'x5'		7'x7'		9'x9'	
	H.ton/ ac	m3/ha	H.ton /ac	m3/ha	H.ton /ac	m3/ha	H.ton /ac	m3/ha
1. *Leucaena leucocephala*	42.3	148	22.2	77.6	7.6	26.4	11.8	41.1
2. *Albizzia procera*	31.2	109	21.9	76.5	8.7	30.5	7.4	25.8
3. *Acacia catechu*	36.4	127.	13.6	47.5	6.4	22.5	6.9	24.3
4. *Cassia siamea*	12.2	42.8	15.8	55.3	9	31.5	9.6	33.6
5. *Albizzia chinensis*	3.3	11.6	0.7	2.4	0.4	1.2	0.4	1.2
6. *Swietenia macrophylla*	0.9	3.3	2.0	7.0	0.6	2.2	0.6	2.0
7. *Acacia arabica*	0.4	1.4	0.2	0.7	0.2	0.6	0.1	0.5

Note : 3' x 5' = 0.9 m x 1.5 m
5' x 5' = 1.5 m x 1.5 m
7' x 7' = 2.1 m x 2.1 m
9' x 9' = 2.7 m x 2.7 m
H. ton/ac = Hoppus tons per acre
m3/ha = Cubic meter per hectare

From the results obtained, it was clear that the two closer spacings (i.e. 3'×5' and 5'× 5') were the best for fuelwood plantations in that area, as they yielded the highest total volume of fuelwood.

6.3 General Discussion

In establishing large scale fuelwood plantations, proper planning is as equally important as the implementation, monitoring and evaluation stages. There are a few factors which should be thoroughly considered at the planning stage and some of which may require experimental research. As those research findings will be helpful as guidelines or at least as reference for future implementation programmes, it should be conducted jointly by researchers and territorial staff.

6.3.1 Improve awareness of the direct and indirect benefits of local supply fuelwood plantations

Extension services are needed to make the local people become convinced of the direct and indirect benefits of local supply fuelwood plantations providing fuelwood for daily cooking and heating, small timber, posts and poles for housing and making agricultural implements, job opportunities and additional income for upgrading their living standards, windbreak for protection and improvement of the production of agricultural crops. Cost benefit analysis of the fuelwood plantations and the impact of the fuelwood plantations on the social problems of the local people should be studied. The findings may help the extension services to gain the active participation and full cooperation of the local people in the implementation of the fuelwood plantations programme.

6.3.2 Selection of the planting site

There are vast amounts of denuded and degraded forest land, abandoned old *taungya* land and other bare lands which are to be rehabilitated again throughout the country. The site for the fuelwood plantations should, in general:

(a) be in the vicinity of the villages with acute fuelwood stortage problems
(b) be accessible to the villagers for their participation, implementation supervision, protection and harvesting at minimal cost
(c) have soil with at least the minimum quantity of physical and chemical properties required for forest tree growth.

Socio-economic surveys of the local area and studies of the soils to determine the physical and chemical properties of the sites should be carried out prior to any other activity.

6.3.3 Choice of species for a given site

It is of prime importance to choose the most suitable species for a given site taking into account the annual rainfall, rainfall distribution, temperature, soil conditions etc. Multi-purpose species are preferable so as to provide opportunities for the local users to meet their needs for wood ort trees for agriculture, fishing activities and handiworks. Site-species matching experimental research should be carried out in different localities and improved utilization of non-commercial tree species should also be practised.

6.3.4 Proper nursery practice, planting techniques and tending operations

The degree of success of a certain forest plantation partially depends on:

(a) availability of good quality seeds
(b) proper seed storage
(c) correct pretreatment of seeds for better germination (in terms of both quantity and quality)
(d) Proper planting techniques to raise the seedlings for better growth and good survival rate
(e) timely and efficient tending operations for faster growth and larger output.

In order to improve the degree of success regarding all these aspects, a proper research programme is required in consultation with the local territorial staff who will be the end users.

6.3.5 Application of proper silvicultural system and economic harvesting techniques with appropriate rotation ages

Silvicultural systems such as coppice system, coppice with standard or agro-forestry system and harvesting techniques such as clear felling, strip felling or felling on coppice with standard should be adopted beforehand depending on the site. Appropriate rotation age should also be fixed based on the objective of the plantation, utilization, species used, site quality, market demand etc. A long-term forestry research plan is needed for the improvement of plantation management.

6.4 References

Aung Naing Oo, Soe Myint Thein Kywe, 1995 — An investigation on morphological and anatomical characteristics of some Myanmar fuelwood timber species. (Forestry Science Research Paper FSRP, 1995.)

Central Statistical Organization, Myanmar, 1994 — Statistical Yearbook, 1993, CSO, Yangon, Myanmar, 1994.

FAO, 1993 — Regional Wood Energy Development Programme in Asia. Wood Energy Development: Planning, Policies & Strategies. May, 1993.

Forest Department, Myanmar, 1995 — Myanmar Forestry Action Programme, December, 1995.

Forest Department, Myanmar, 1995 — Forest fact sheets (July, 1996)

Ko Ko Gyi, Mehm, 1986 — Species trial for fuelwood production (FSRP-1986).

Ko Ko Gyi, Kyi Win & Zaw Win, 1988 — Species trial for fuelwood production (part 2) FSRP, 1988)

Kyaw Tint and Tun Hla, 1991 — Forest cover of Myanmar, the 1989 Appraisal, January, 1991.

Sann Lwin, Htin Kyaw, Win Lei Lei Than & Cho Cho Win, 1996 — The properties and utilization of soils in the greening project for the Nine Critical Districts of the Arid Zone of Central Myanmar (part 1). FSRP March, 1996.

Saw Win, 1986 — A Preliminary study on the coppicing of *Eucalyptus camaldulesis* and *Eucalyptus grandis* during the first growing season following clear cutting. FSRP, 1986.

Saw Win, 1987 — An assessment of the yield of *Eucalyptus camaldulensis* in Katha Forest area. FSRP, 1987.

Saw Win& Maung Maung Tint, 1995 — The effect on different refilling methods of site preparation on growth and survival of *Eucalyptus camaldulensis* in the central Dry Zone of Myanmar, FSRP, 1995.)

Sein Thet, 1986 — Soil - site requirements of tree species on Dry Zone adverse sites. (FSRP, 1986)

Sein Thet & Tin Tin Ohn, February, 1983	Some physical and chemical properties of Dry Zone forest soils. (FSRP, 1983)
Soe Myint Thein, February, 1986	Investigation on the suitability of Sit, Mezali, Bawzagaing and Paukpanbu for charcoal manufacture. (FSRP, 1985)
Soe Tint, February, 1984	Fuelwood outturn study in the Dry Zone. (FSRP, 1984)
Thein Kyi, Chis Hlaing & Mehm Ko Ko Gyi, 1987	Studies on seed storage, germination and growth during nursery stage of some indigenous and exotic species. (FSRP, 1987)
Thein Kyi & Mehm Ko Ko Gyi, 1991	Studies on seed storage, germination and growth during nursery stage of some indigenous and exotic species (part 2). (FSRP, 1991)
Tin Tin Ohn & Sein Thet, 1989	Physical and chemical properties of mangrove forest soils. (FSRP, 1989)
Tin Tin Ohn, 1993	Study on the physical and chemical properties of some laterite and lateritic forest soils. (FSRP, 1993)

7. THE ROLE OF NON-FOREST AREAS IN WOODFUEL PRODUCTION

by

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Introduction

Even though Myanmar is endowed with highly productive forest resources, the people from the densely populated areas now face the same problem --fuelwood shortages-- as another 1,052 million of the world's population as a result of the disappearance of once abundant forests due to increasing population pressure and agricultural expansion. The hardest hit area of Myanmar is the Central Dry Zone. The existing natural forests have been so depleted that the area cannot support even the minimum needs of the population of the Dry Zone for riomass energy .

The role of fuelwood is not expected to diminish until the next century as this traditional fuel is very popular among the local population because of its low cost, easy accessibility and convenience in handling. The demand for fuelwood is expected to rise as it represents about 85% of total energy use world wide, especially in the developing countries. It is projected that the demand for fuel by the year 2000 will be 12.28 million tonnes in the Dry Zone alone. About 90% of the requirement will be met by woodfuel.

Traditionally, rural people have collected fuelwood from the natural forests. In the case of the Dry Zone, as the natural forests have been out of easy reach for the local population, non-forest lands have played a major role in stabilizing fuelwood supplies.

7.1 Profile of Study Area

The Dry Zone is situated in the central part of Myanmar. The area is bounded by part of Sagaing Division in the north, Shan State in the east, Bago Division in the south and Rakhine mountain range in the west. It represents one-tenth of the total land area of Myanmar. It has a land area of about 27,000 sq. miles (69,930 sq. km) with nearly 10 million inhabitants, of which 81% is rural based.

The population density is 347 people per square mile which is above the national average of 119. It is one of the most important agricultural regions in the country, producing major cash crops such as various kinds of beans, cotton, groundnut, sesame and maize. It also supports the raising of half of the national cattle population. Agricultural land productivity is severely affected by population pressure, repeated cropping on poor and fragile soil, low input use and environmental deterioration due to deforestation for fuelwood and wood supplies.

The Dry Zone of Central Myanmar reaches temperatures of up to 110 degrees F (51 degrees C) in the summer with an annual precipitation of about 20 (500 mm) to 40 inches (1,000 mm) which is unevenly distributed. The area geographically and geologically supports sparse forest growth which has been cut intensively for fuelwood.

Due to repeated cutting and improper management of the natural forests, the population of the Dry Zone has been suffering from an acute shortage of fuelwood. The problem has been made worse by environmental degradation in critical areas.

The areas affected by forest degradation in the Dry Zone are 2.35 million acres (0.95 million ha) of reserved forests and 3.5 million acres (1.41 million ha) of public forests . These forest areas need to be rehabilitated so they can supply fuelwood to the rural population.

To compensate for the shortfall in the fuelwood supply, more plantations are being created using fast growing species, such as *E. Camaldulensis*. Such efforts began in 1963 and by 1995 the total plantation area in the Dry Zone was over 300,000 acres (121,700 ha).

7.2 Overall View of the Fuelwood Situation in the Dry Zone

The major human concern in the study area is the acute shortage of fuelwood for domestic cooking due to population pressure and the absence of affordable energy alternatives. A high degree of deforestation and consequent environmental degradation, made worse by the low productivity of agriculture and livestock, are causing great hardship to the rural population. Cottage industries and fuelwood trade that generate employment and income to many rural people are also badly affected.

Local supply reserves and public forests, which supply fuelwood and small timber to local communities, are seriously degraded due to overcutting and lack of effective protection and management: about 75% of the natural forests all over the Dry jone are affected.

The Central Dry Zone has a population of about 10 million with an area of 27,000 square miles and is assumed to be the country's most densely populated region. According to the current available data, the fuel consumption by all sectors is 8.01 million cubic tons (14 million cubic metres) per year. Fuelwood and charcoal take the major share accounting for 5.37 million cubic tons (9.7 million cubic metres) for both the rural and urban households. The deficit is made up by using crop residues.

Myanmar has one of the lowest per capita energy consumption rates in the world. Woodfuels and non-woody biomass contribute 86% of energy consumed in the household and small cottage industries. Alternative energy sources have always been unavailable. Fuelwood is used extensively for domestic purposes in the Dry Zone with agriculture residues acting as a supplement.

By the year 2,000 Dry Zone fuelwood consumption is projected to be 11 million air dry tons, which is 7.6 million tons above the sustainable level. To meet the demand, more forests are going to be destroyed and more agriculture residues will be utilized leading to severe pressure on the environment and farm productivity.

The annual current consumption of woodfuel is calculated to be 5.37 million cu tons (9.7 million cubic metres) produced from both forest and non-forest areas. Agriculture residues account for 2.64 million cubic tons. According to the trend of biomass fuel consumption, it is significant that woodfuel is taking the leading role with a 67% contribution, followed by agriculture residues with 33%.

7.2.1 Fuelwood production

According to the present situation, two sources can be identified as the major suppliers of fuelwood in the study area. These are the existing degraded natural forests and the non-forest lands. As mentioned above, the role of natural forests has declined over time due to increasing population pressure and over-cutting for fuelwood and wood supplies. The production from non-forest land is highlighted in this paper as it is playing an increasingly important role in stabilizing production. According to the data acquired from district forest departments, the annual fuelwood production is only 46,000 cubic tons (82,900 cubic metres).

7.2.2 Production from natural forests

The natural forests mainly consist of local supply, and fuel supply reserves and public forest land which cover about 5.85 million acres (2.37 million ha) widely distributed over 45 townships in the Dry Zone. In the past, the rural population totally relied on these forests for their daily fuelwood requirements as the forests because of their proximity to their settlements and because they had a reasonable production capacity.

Local supply and fuelwood supply reserved forests were formed to meet the village need for fuelwood, poles, posts, small timber, bamboo and roofing materials, etc. The villagers have for the right to use these products for agricultural and domestic purposes according to the Forest Act of 1992. The total area of the local supply and fuel supply reserves is 2.35 million acres (0.95 million ha) which, due to excessive extraction of firewood and charcoal for domestic consumption and trade, are completely denuded at present. As there is practically no more woodfuel available from the reserves, the local people rely on the public forests and other sources of biomass from non-forest lands to meet their daily fuel needs.

Public forests, however, are unreliable suppliers of fuelwood as they have been destroyed down to the soil subsurface due to up-rooting for firewood and agricultural expansion. The total area of public forests is assumed to be well over 2.65 million acres (1.07 million ha), of which about 75% is affected in this way.

According to the data supplied by the district forest offices, the annual production of firewood extracted from the natural forest land for the whole Dry Zone is 46,000 tons (82,900 cubic metres). However, the cutting of firewood from the natural forests is being restricted in the wake of the Nine Districts Greening Project which has encouraged regional and local authorities concerned to impose limitations and prohibitions regarding the extraction of fuelwood from the degraded natural forests. Fuelwood coming from public forest land will thus not play a very important role in the foreseeable future and the shortfall will have to be made up by communal plantations, woodlots and non-forest lands.

7.2.3 Production from plantations

In 1954, plantation activities were initiated as part of a Dry Zone rehabilitation project by the Agricultural and Rural Development Corporation in collaboration with the Forest Department. But their scope has widened and plantations are now being established for various purposes such as industrial and commercial use, village supply, and catchment area rehabilitation and protection.

Realizing the trend of fuelwood consumption, the Forest Department is increasing its capacity to establish more fuelwood plantations. Currently over 30,000 acres (12,140 ha) are being planted annually. The Greening Project for the Nine Critical Districts of the Arid Zone of Central Myanmar alone is planting of 18,000 acres (7,280 ha) annually. These plantations will be transferred to the communities concerned for protection, management and harvesting.

These village supply plantations are designed to supply firewood and small timber to meet local needs. They are usually established on denuded lands in local supply reserved forests and unclassified forests in the vicinity of the villages. Fast growing exotic species such as *E. camaldulensis* and *Acacia auriculifornis* are planted along with indigenous species such as Kokko (*Albizzia lebbek*), Mezali (*Cassia siamea*), Sha (*Acacia catechu*), Neem or Tamar (*Azadirachta indica*) and Sit (*albizzia procera*) which are good for multiple uses. Fuelwood plantations having a total area of 169,550 acres (68,600 ha) have so far been established during the 32 years of the plantation programme, representing 56% of the total planted area.

The total area under plantations, according to type, are as follows:

Commercial	66,595 Acres	22.15%
Village Supply	169,550 Acres	56.40%
Industrial	20,450 Acres	06.80%
Watershed Protection	35,784 Acres	11.90%
Woodlots	8,235 Acres	02.75%
Total	**300,614 Acres** (121,658) ha	**100.00%**

Up to now, plantations have not played a very important role in fuelwood supply as most village supply plantations are maintained for amenities and greening purposes.

7.2.4 Non-forest lands

The Land use pattern of the Dry Zone can be broadly classified as forested land, agricultural land, marginal land and other, as follows:

Forested land	9,139.01 sq. miles	34%
Agricultural land	11,092.21 sq. miles	41%
Marginal land	1,651.23 sq. miles	6%
Others	5,193.48 sq. miles	19%
Total	**27,075.93 sq. miles**	**100%**

The non-forest land area consists of agricultural, marginal and other lands which combine to cover a land area of about 17,936.92 sq. miles (46,457 sq km). From this, the available area for tree growing may be assumed to be 25% of the total land area, or about 4,480 sq miles. Traditionally, these lands are worked under private ownership. The owners of the land usually grow trees for multi-purposes such as fuel, shade, beautification, environmental balance, fodder, demarcation of plots etc. The land can be categorized as homegarden, farm boundary and marginal wasteland. The predominant species grown on these private lands are multipurpose tree species which can contribute multiple benefits to the owners. In this case, the species which can withstand adverse site conditions are preferred by the growers and include such species as *Eucalyptus camaldulensis, Acacia* and other indigenous species. This area contributes 3.2 million tons (40%) of the total consumption of fuel in the Dry Zone.

Homegarden (Homestead)

1.8 million rural households of the Dry Zone occupy about 0.8 million acres of land under traditional homegardens. The population is dependent on trees and bamboos grown mainly on these homegardens and on crop lands for their fuelwood, poles and posts. Although a typical homegarden or homestead is small compared to the forest land administered by the Forest Department, these homestead groves provide about 35% to 40% of fuelwood in the Dry Zone. High stocking density, good site and regular fertilization, good maintenance and effective protection ensure high productivity. So wood production from the homestead is a highly significant part of the country's non-traditional production base. Another point that makes the homegarden significant for woodfuel production is the fact that its proximity allows for easy access and convenient harvesting. Planting of trees in homegardens has become very popular among the rural population as they previously had to walk 10 to 15 miles to get to the nearest forests to gather firewoods. The Forest Department has been mobilizing the entire rural population to grow more trees in homegardens during the rainy season through community forestry activities.

Farm Boundary

In the Dry Zone, naturally grown trees are maintained on farm boundaries for multi-purposes such as wind-break, fodder and fuelwood and also for plot demarcation. In the areas where no trees occur naturally, the appropriate species are planted according to agroforestry practices. The species with light crown, fast growing and high coppicing and pollarding capacity are the most favoured for farm boundary planting. The predominant species found on agricultural lands are Sha *(Acacia catechu)*, Thabut *(Millioniusa velutina)*, Zi *(Zizyphus mauritiana)*, Kokko *(Albizzia lebbek)*, Gandasein *(Prosopis juliflora)*, Mezali *(Cassia siamea)*, Subyu *(acacia arabia)*, Eucalypt *(E. camaldulensis) etc*. Most of these species possess more or less the basic characteristics required for adaptability and suitability. According to the field survey, fuelwood production from these sources contributes about 33% of the total biomass energy consumption in the study area.

Marginal and Wasteland

The Dry Zone has a marginal and wasteland area of about 1.06 million acres which supports sparse tree growth with various species such as Sha (*Acacia catechu*), Thabut *(Millioniusa velutina),* Than *(Terminalia oliveri)*, Dahat (*Tectona hamiltoniana*), Nibase *(Morinda tinctoria)*, etc. Traditionally, rural people are in the habit of gathering firewood for domestic uses fr•m this type of land. Some farmers in the rural area have acquired marginal land and converted it into well-managed, productive land which provides fuelwood, poles and posts. They can even generate income from the sale of their surplus produce. The fuelwood produced from this type of land accounts for 7% of Dry Zone fuel consumption.

Village Woodlots

Even though the area under Village Supply Fuelwood plantations has increased, so far the production is negligible as these are being maintained primarily for aesthetic and greening purposes. But the woodlots which are under proper management on private lands can, to a certain extent, supply the day-to-day fuelwood needs of villagers. The benefits gained from these woodlots have been so much appreciated by the rural population that many rural households have established new woodlots on their own marginal lands. These intensively managed woodlots contribute part of the amount supplied from non-forest land-- which represents a 40% share of production.

Fuelwood Consumption

Woodfuel is used extensively by both the domestic and small industrial sectors. However, there have been periodic changes in the consumption pattern, due to the availability of other fuels. For example, kerosene stoves were used when that fuel was supplied at a low price before 1970. After that, gas stoves were introduced but later abandoned because of a supply problem Currently, both domestic and cottage industries totally depend on biomass energy, especially woodfuel in the form of fuelwood, bamboo fuel and charcoal. The cottage industries like jaggery boiling extensively use crop residues and fuelwood from toddy palm.

According to the data compiled from field study it is estimated that the total annual fuel consumption by 1.5 million households in the Dry Zone is 8 million cubic tons with woodfuel accounting for 5.37 million cubic tons, i.e. 67% of the total consumption. The balance is made up by crop residues.

The cottage industries that use biomass energy are brick manufacturers, sugar factories, pottery kilns , tobacco curing kilns and jaggery boiling , etc. The sugar factories are usually confined to Meiktila and Yamethin districts and mostly use bamboo fuel. Tobacco curing industries are especially active in Pakokku and Shwebo districts. This type of industry primarily uses woodfuel from outside the area.

Jaggery boiling which covers extensive areas in Magway, Pakokku, Monywa and Myingyan districts exclusively uses agriculture residues as the main source of energy. The deficit is made good with the addition of fuel collected from toddy palm.

The villagers confined to the banks of Ayeyarwaddy River collect drift wood during the rainy season and keep it for the whole year to be used as fuel.

7.3 Harvesting Systems

The fuelwood gathering systems traditionally practised by the rural people are pollarding, pruning, and coppicing, depending on the species harvested. Fuelwood gathering is usually carried out during the dry season which is convenient for transportation and handling. The different practices are briefly described below:

7.3.1 Pollarding

This is the method of cutting back the crown of a tree to produce a close head of shoots (a pollard) at a height that puts it beyond the reach of browsing animals. It is usually done in the dry season. By pollarding the trees, the intensity of shadow on agricultural crops can be reduced with the result of not impairing crop production. It is usually practised on the species which are not good for coppicing such as *Acacia* species and *Zizyphus mauritiana,* etc.

7.3.2 Coppicing

This is a method of cutting back the trees just about one foot above ground level. It is usually done during summer time. After cutting a tree, the stump is prepared by cutting off any damaged part to enable it to bring forth new shoots. Species like *E. camaldulensis* and *Leucaena leucocephala* which have high coppicing power are harvested by this method.

7.3.3 Pruning

This is the method of cutting the branches without doing any damage to the stem and crown of the tree. It is usually applied to those species which possess no reliable coppicing power such as Mezali (*Cassia siamea*) and other relevant species. This practice is beneficial to agricultural crops as shadow intensity can be reduced on the crop field.

7.4 Production Potential from Non-Forest Areas

At present, the production from non-forest lands meets about 40% of the total demand of 1.5 million households. The supplies come from homesteads, farm boundaries, fallow lands and wasteland. This fuelwood is derived from both planted and naturally grown trees. The future prospects for fuelwood production and supply are likely to be affected as described in the following paragraphs:

(a) The fuelwood plantations which were established in 1974, accounted for about 169,000 acres in 1996. These plantations are going to be transferred to the communities concerned in accordance with the Community Forestry Instruction as soon as possible. The potential yields are estimated to be 643,000 tons which are going to be liquidated within a 5 years period starting from 1997. The annual expected yield will be 128,600 cu tons which will contribute an additional quota to the supply side.

(b) More new plantations are being established under the Greening Project for the Nine Critical Districts of the Arid Zone of Central Myanmar with an annual planting programme of about 20,000 acres. Most of these plantations will also be transferred to the local communities one year after establishment. These plantations will start producing fuelwood at the end of the fifth year and will be harvested with a rotation of 5-7 years. This will make a significant contribution to the production capacity of non-forest lands.

(c) The new Community Forestry Instruction which has been set in motion will promote the participation of rural communities in the establishment of woodlots, conservation and the management of natural resources. The practice of agroforestry systems will be carried out along with the formation of community woodlots. This will contribute to the increase of tree populations in homegardens, on farm boundaries and on fallow lands with the significant result of raising the production capacity of non-forest areas.

7.5 Conclusion and Recommendations

7.5.1 Conclusion

(a) The lack of easy access to the Forest Department administered forests has stimulated the rural people to become more involved in planting, protection and management of tree resources on homesteads, farm boundaries and wastelands.

(b) In rural areas of the Dry Zone, household fuelwood needs are being met by harvesting stems and branches from trees on homesteads and farms -- these contribute 40% of the total fuelwood consumption.

(c) Realizing the need for easy access, convenient collection and the lack of restrictions on collecting firewood from non-forest areas, tree planting, protection and management on homesteads and farms are being carried out extensively.

(d) Public awareness has been raised for environmental protection and self-sufficiency in fuelwood by the Nine Critical Districts Greening Project and Community Multipurpose Fuelwood Woodlots Project. This has led to the increased establishment of woodlots on marginal lands undertaken with the active participation of villagers.

(e) Income generated by the sale of surplus fuelwood produced from homesteads and farm lands promotes the growing of more trees around the environs.

(f) The creation of woodlots on marginal lands, windbreaks on farm boundaries and planting of shade trees in homegardens is very common in rural landscapes and directly contributes to the increased supply of woodfuel from non-forest lands.

(g) An acute supply and demand imbalance is a driving force behind the use of crop residues as a substitute for fuelwood. At present these amount to a 33% share.

(h) Realizing the current trend of fuelwood consumption, the Forest Department is increasing its capacity to establish more fuelwood plantations, especially in the Dry Zone, with a target of over 20,000 acres per year.

7.5.2 Recommendations

(a) Existing local supply reserves and public forest resources are insufficient to meet the fuelwood demand. It is urgently necessary to rehabilitate degraded natural forests through proper management and with the participation of the rural population.

(b) The fuelwood supply-demand imbalance is going to worsen unless effective steps are taken to augment the supply of fuelwood through the establishment of community woodlots and agroforestry farm-lots by rural communities. Proven fast-growing indigenous multipurpose species should be given preference with the priority on site-species matching. Fuelwood production in non-forest areas has to be promoted through a participatory approach by introducing community forestry on a wider scale.

(c) The main problem of the Dry Zone should be addressed by making special efforts to meet the most essential and basic demands of the rural communities and urban dwellers for fuelwood or charcoal for domestic uses without impairing the forest environment. The rural inhabitants should be encouraged to undertake participatory fuelwood plantation programmes at grassroots level and the wider use of energy efficient stoves and other devices.

(d) The rural communities should be mobilized to support and establish multipurpose fuelwood woodlots and manage them in a sustainable manner on homesteads and farmlands.

(e) The rural population should be mobilized through community forestry endeavours and extension services, public awareness, and participation to establish fuelwood woodlots and manage degraded natural forest resources. This can be facilitated by seriously implementing the Community Forestry Instruction.

(f) The extension services should be strengthened to be more effective in disseminating information on the efficient use of natural resources and the conservation of forests.

(g) Re-vegetation of degraded forests and marginal lands in the resource scarce area will not be possible without the active participation of the local people. Community forestry is seen as a reliable means of rehabilitating the degraded forests, shrub and marginal land and of increasing the supply of fuelwood for the local people and should widely adopted.

(h) Plantation forestry is considered to be an important practising ground for community forestry. More fuelwood plantations should be established through the increased participation of rural communities and also through the extended activities of the Forest Department. These plantations, which can supply the needs of local people, can be usefully established on vacant and marginal areas, and on degraded and environmentally vulnerable sites.

(i) Community forestry needs to be extended to privately owned land. Private land forestry strategies should promote planting of multipurpose tree and shrub species for optimal use of land through increased production of fuelwood, fodder, fruits, pole and other biomass for local uses.

(j) Tree planting through private land forestry activities should be carried out in a wide range of contexts such as: homestead agroforestry, farm forestry, live hedges, living fence posts, farm boundary, windbreaks, shelterbelts, block and strip planting in long fallows, vacant areas, abandoned and wastelands, etc., so as to increase woodfuel production from non-forest lands.

7.6 References

National Academy of Science, n.d. — Firewood Crops: Shrub and Tree Species for Energy Production

Thein, 1959 — Fuelwood Situation in Burma Paper presented to the Asia Pacific Forestry Commission

Nyunt, K. Maung,1995	Fuelwood Situation in Myanmar
Aye, Tin, 1995	Fuelwood and Energy Situation in Myanmar
Khaing, S. Tun, 1993	Woodfuel Flows in the Dry Zone of Myanmar: A Case Study (FAO)
FAO, 1983	Fuelwood Supplies in the Developing Countries
FAO, 1993	Community Multipurpose Fuelwood Woodlots Project Document
Myint, Soe, 1995	Dry Zone: Zonal Report (STRAP)

8. USE OF WOODFUEL IN COTTAGE INDUSTRIES IN YAMETHIN DISTRICT

by

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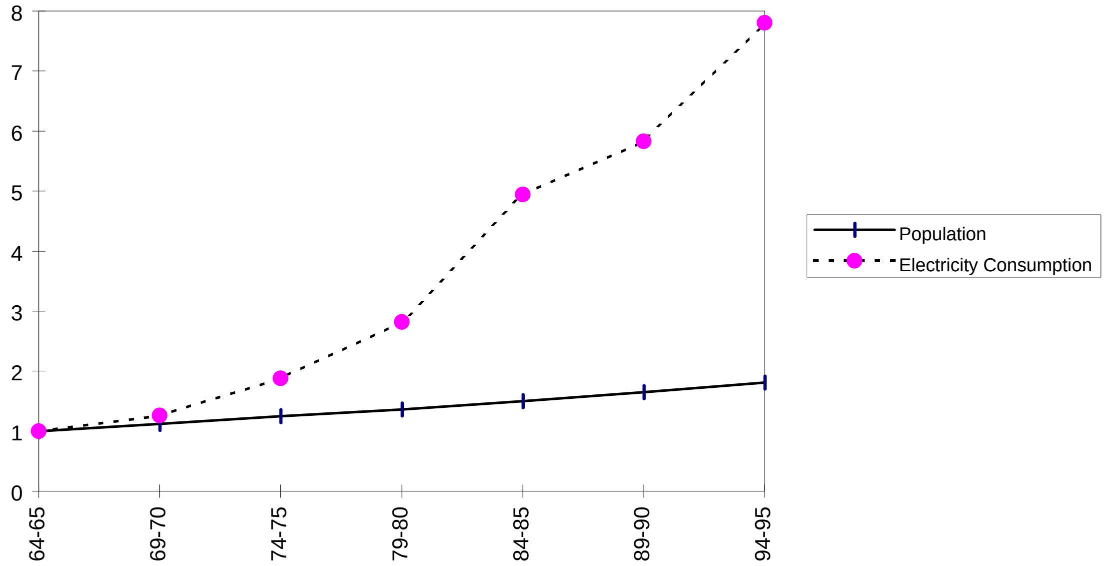
Introduction

While the population of Myanmar has been steadily increasing at an annual growth rate of around 2 percent, the energy requirement has been increasing even more dramatically. For instance, electricity consumption alone during the year 1994-95 was 7.8 times the amount consumed in 1964-65 compared to an increase in population of 1.81 times during that period (Figure 1).

Figure 1. Comparative growth between population and electricity consumption during the period 1964-65 and 1994-95. Basic year 1964-65=1



This comparison reflects the growing demand for energy to meet the needs associated with the changing pattern of living all over the country. Recent developments in urbanization also call for a greater use of building materials such as timber, cement, bricks, lime, tar, steel and so on which require large amounts of energy to produce. However, up till now these demands for energy have not been fully met.

8.1 Woodfuel Consumption

8.1.1 General

Charcoal consumption in Yangon, even in the capital city, is estimated to be about 3.18 million tons annually. The mangrove forests in the delta area are believed to have been depleted due to the fuel requirement of the city. Total charcoal and fuelwood production during the year 1994-95 was twice the amount produced in 1958-67 Gale, 1968 and CSO, 1996. This figure indicates the continuing reliance on woodfuel for household energy requirements despite the increased supply of electricity.

8.1.2 Cottage Industries

Unlike central energy systems, woodfuel can easily and relatively cheaply reach the scattered and isolated locations where most cottage industries are to be found. Thus, wood and biomassfuel are their only feasible sources of energy at present.

According to the Industrial Development Corporation, there were 17 different types of woodfuel based cottage industries registered during 1964-68 and their average annual woodfuel consumption was 0.763 million cubic tons (Gale, 1968). This excludes the use of woodfuel by railways, steamers and road transport by the government.

Although the current national position of woodfuel energy consumption has not yet been surveyed it would probably amount to not less than 3 times the amount consumed during 1964-68.

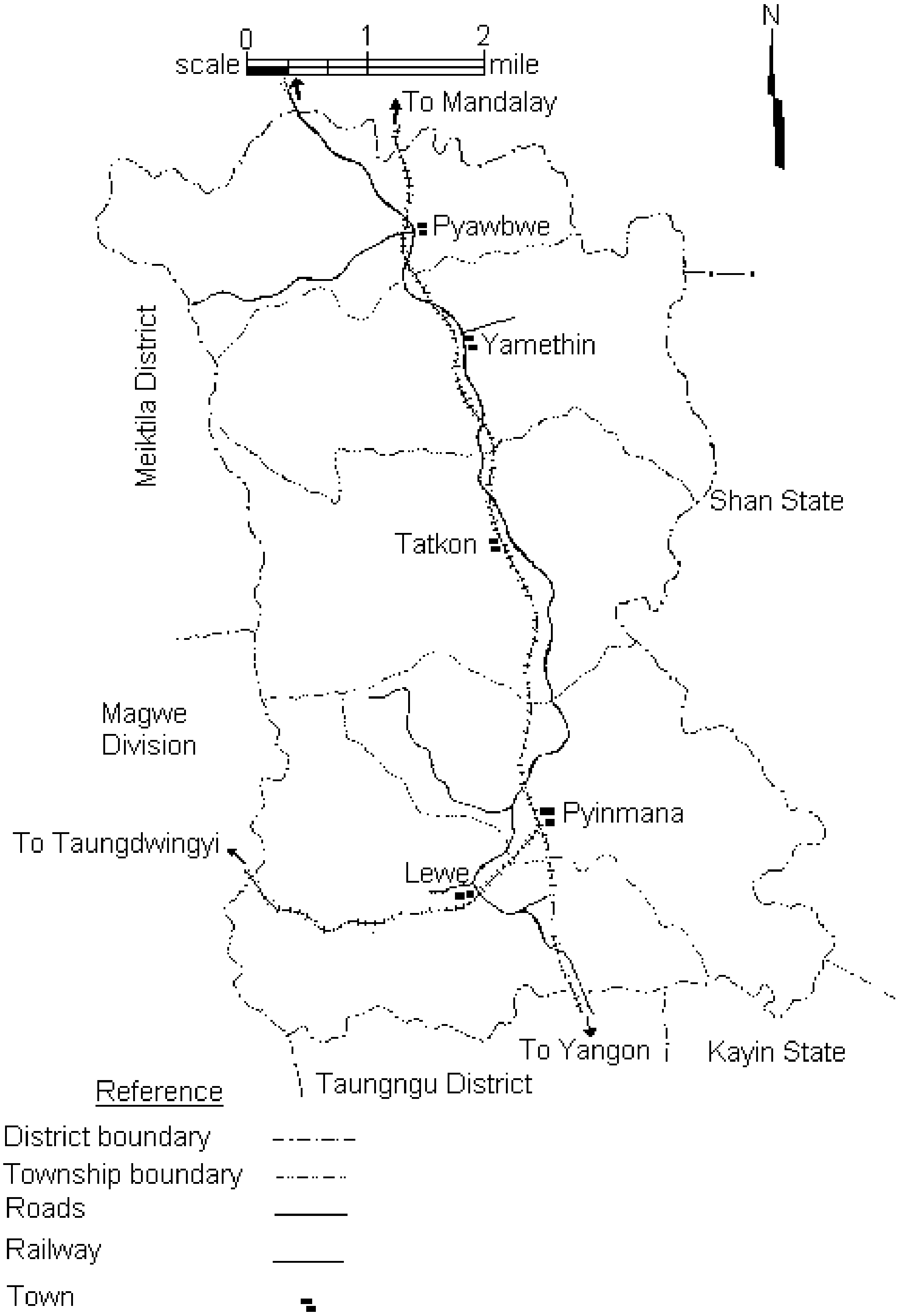
8.2 General Position and Forest Resources of Study Area

8.2.1 Location

Yamethin District covers various types of cottage industries using both woodfuel and other biomass fuels. The area stretches out from the south with abundant and valuable teak forests to a less dense forest in the middle part and a sparse, bush-like dry forest towards the north.

The area is situated in the middle part of Myanmar in between the road and railway connections of Yangon and Mandalay (Figure 2). It consists of 5 townships namely Pyawbwe, Yamethin, Tatkone, Pyinmana and Lewe. The total area is about 4,200 square miles.

Figure 2. Yamethin forest district



8.2.2 Forest resources

The area consists of various types of forest. The south western part is famous for its Pegu Yoma teak forests. The eastern part of the area, east of the Sittaung river, is hilly and thus less conducive to commercial exploitation. Therefore, Pyinmana and Lewe townships have become the main sources of timber extraction and other forest resources of the area both for local consumption and export.

8.2.3 Fuelwood plantations

During 1985-96 the Forest Department established 8,300 acres of fuelwood plantations as shown in table 1.

Table 1. Established fuelwood plantations in Yamethin district, 1985-96

Sr. No	Year	Area (acres)			Total
		Tatkon	Yamethin	Pyawbwe	
1	1985	-	400	300	700
2	1986	-	300	250	550
3	1987	-	300	300	600
4	1988	-	300	300	600
5	1989	-	-	300	300
6	1990	-	300	-	300
7	1991	-	300	300	600
8	1992	-	300	300	600
9	1993	-	100	100	200
10	1994	100	300	300	700
11	1995	400	500	500	1400
12	1996	1050	350	350	1750
	Total	1550	3450	3300	3800

Note: The area was included in the 9 districts greening operation.
Source: Yamethin Forest District

8.3 Woodfuel Cottage Industries in the Study Area

The major woodfuel cottage industries in the area are lime, sugar, condensed milk and alcohol distilleries which consume about 93 percent of the total woodfuel requirement for all woodfuel consuming cottage industries in the study area. The remaining woodfuel is used by brick, pottery, cook stoves and ceramic industries.

8.3.1 Lime industry

Pyinmana area is one of the major sources of limestone deposits in the country. Limestone is blasted and excavated by No.3 Mining Enterprise and used for sugar mills and steel mills. Part of the limestone produced is sold to local lime kiln owners. Roasting of limestone to produce lime requires a very high heat energy. Woodfuel is the only energy source used by local lime kiln owners. It is sold by fuel traders who collect it from Taungnyo area which is about 20-30 miles along the truck road west of Pyinmana. The fuelwood must be dry and consist of large size pieces of hardwood so as to be able to emit a continuous and intense flame. Lime kilns are located near Shwe Twin Kon and Shwe Kya villages in Pyinmana township.

At present, about 2,805 tons of lime are produced annually from 18 lime kilns belonging to 3 private owners. About 4,122.4 cubic tons of woodfuel are used for that purpose at an average cost of K 851.12 per ton of fuelwood. About half a ton of lime is recovered from roasting one ton of limestone. This process can be expressed by the following equation :

2 tons limestone + 1.5 cubic ton woodfuel = 1 ton lime

The work has to be suspended during the rainy season for about 4 months. A period of approximately 10 days is required for loading and discharging of a kiln. Therefore an average kiln can be run 20-25 times a year. The lime produced is sold mostly to state owned sugar mills at a current price of K 2,750 per ton and the rest is sold to the public. All data mentioned above consists of average figures. A set of financial statistics received from a typical kiln is as follows:

Investment	per kiln	per ton of lime produced
Fuelwood $1^1/_2$ truck load (10.69 cu ton)	K 9750	K 1625.00
Limestone 12 tons	K 1800	K 300.00
Labour charges	K 2500	K 416.67
Total	K 14050	K 2341.67
Return	K 16000	K 2666.67
Profit	K 1950	K 325.00

8.3.2 Sugar industry

The second largest consumer of woodfuel in the area is the sugar industry. In fact, the sugar industry alone requires more fuelwood than all other industries if state owned sugar mills are included. All seven privately owned sugar industries are located in Pyawbwe township situated in the northernmost part of the region. The sugar industry was established quite recently in this area. All industries, except for one, were established after 1990. Raw materials required for the production of sugar are sugar cane (or cane sugar slab and jaggery), lime and fuelwood.

Almost all fuelwood required for these industries is bought from fuelwood traders who transport it from Yinmabin, Pyinyaung and Kywetatson villages near the eastern fringes of the region. The cost of woodfuel per truck load (7.11 cubic tons) varies from K 10,000 to K 12,000. Annual requirement for all sugar industries is 3,411.36 cubic tons. Surprisingly, the cost of woodfuel in that part of the region is almost double that of Pyinmana (lime industry) where a truck load costs only K 6,500.

Due to the seasonal availability of raw materials, sugar cane and jaggery, the refineries run for only 8 months a year. Both day and night shifts are exercised in every refinery which run continuously during these months. The average output was calculated to be 3.84 tons of sugar per day. Besides sugar, about half a ton of molasses for every ton of sugar produced is obtained as a by-product. Total annual production of sugar is 6,455 tons.

8.3.3 Condensed milk industry

Only one condensed milk industry using woodfuel was found in the region and it is located at Pyawbwe township. It was established in 1996. In contrast to the imported canned condensed milk which is at present being produced by local heavy industries, domestic industries like the one mentioned here produce only non-canned condensed milk. It is sold in bulk at a price of K 200 per viss. Imported condensed milk costs about K 90 per can which is equivalent to K 370 per viss. Due to this big difference in retail price, a larger market is available for this local condensed milk than the imported variety. Production capacity is 840 viss per day. Woodfuel was transported from Yinmabin at a cost of K 12,000 per truck load (7.11 ton). One truck load lasts for 4 days and, therefore, the cost of woodfuel per day is around K 3,000.

8.3.4 Alcohol distillery

Shwe Zin Yaw (Golden Swallow) is the only alcohol industry in the area using woodfuel. It was established in Pyawbwe township in 1994. Jaggery is the major raw material for fermentation during the primary stage of the process which lasts for 3 days. Production capacity is 30 gallons of 96% alcohol per day. Woodfuel is bought from traders at a cost of K 12,000 per truckload (7.11 ton) which lasts for 5-7 days. Therefore, the cost of woodfuel is about K 2000 per day. The product is sold both as concentrated alcohol (96%) at K 90 per bottle (K 540/ gallon) and as diluted alcohol at K 33 per bottle (K 198/ gallon). The alcohol distillery seems to be one of the most remunerative enterprises of all the cottage industries in the study area.

8.3.5 Brick industry

Brick kilns of various sizes are found all over the study area. A total of 9 kilns is in operation. It is a seasonal industry, usually starting in October and ending in April. Occasional operations have been reported during the rainy season but the quality of brick is found to be unsatisfactory during that time. Woodfuel is obtained from local traders. Prices of woodfuel vary from K 350.88 at Lewe to K 1,333.33 at Yamethin per solid ton. The capacity of kilns vary from 10,000 to 50,000 bricks. The total amount of woodfuel required for this industry is 635.95 solid tons with a total cost of K 665,905.41 per year. Bricks are sold at K 1.60 to K 3.00 per piece. The total annual production of the area is 1.925 million which brings in K 3.766 million. It appears that some temporary kilns are operated for domestic consumption. Therefore, the woodfuel data mentioned here could be an underestimate. If the unreported kilns are included, the annual consumption of woodfuel might approach 1000 tons.

8.3.6 Ceramic industries

Altogether seven cottage ceramic industries are found in Sin- Oh - Pho ward of Pyinmana. Most of them are small and operate unsystematically. Therefore, it is difficult to collect data related to their woodfuel consumption. It is a traditional industry which usually produces ceramic ash trays, flower pots, vases, etc.

Reliable data was obtained from one systematic kiln owner. For an investment of K.10,000 per kiln, the overall production value would be around K 15,000. About 32 rounds of a kiln can be discharged a year. Usually, 4 kiln loads per month can be discharged during the open season (October to April) and 1 kiln load per month during the rainy season can be discharged.

The woodfuel required for this industry is obtained from local traders who collect it from saw mill off-cuts, residues from commercial extraction and from the nearby forest. One kiln load of fuel (in cart load) was found to be equivalent to 0.5 ton. Therefore, the total annual consumption per kiln is around 16 tons. The cost of woodfuel is K 946.97 per ton. Therefore, the total annual value of production and cost of fuelwood is K 480,000 and K 15,151.52 respectively. It is estimated that the total woodfuel consumption of all ceramic industries in the area is probably not more than 100 tons a year.

8.3.7 Cook stove industries

Due to the growing scarcity of woodfuel and the massive rehabilitation of the nine critical Dry Zone districts, the authorities concerned have exerted great efforts to conserve forest trees, especially in the denuded part of central Myanmar. One such effort calls for the production of efficient cook stoves. As a result of technology dissemination by the Forest Research Institute, Yezin, and in cooperation with UN project personnel, more than a dozen efficient A-1 cook stove industries were disseminated all over the country. There are two A-1 cook stove industries in the study area, one at Pyinmana and another at the FRI itself.

The total annual production of cookstoves in Pyinmana is 3,800 using 15.84 tons of woodfuel. Per kiln production is 190 stoves which requires 0.792 ton of fuelwood at a cost of K 750. Therefore, one ton of fuelwood costs K 946.97. Total consumption of woodfuel for both industries would be about 40 tons per year. The product is sold at K 100.

8.4 Biomass (other than wood)-based Cottage Industries

Alternative sources of non-wood biomass fuel such as rice husk, bagasse, saw dust, bamboo, and plum fruit kernel are available in some parts of the study area at reasonable cost. Therefore, a considerable number of cottage industries prefer such biomass fuel to woodfuel. Cottage industries of this types are described below according to the kind of material used as fuel.

8.4.1 Rice husk fuel

Although the industries in the southern part of the study area have the advantage of being able to use cheaper woodfuel than those in the north, some of these industries find rice husk even cheaper than woodfuel. It would be impracticable for those in the northern region to use rice husk fuel since there are no paddy fields in that part of the country. If imported, the cost of fuel would be far greater than the present woodfuel cost.

Three alcohol distilleries and two sugar mills which use rice husk as fuel are located in Lewe and Pyinmana townships. Usually, rice husk is brought by pony cart load. One cart load costs K

70 to K 80. Both seasonal and periodic variations in price might be expected due to fluctuations in rice prices. Compilation of data from 4 industries is shown in table 2.

Table 2. Cost of rice husk fuel and value of products per annum in some cottage industries.

Industry	Amount of rice husk (cart load)	Total cost of fuel (K)	Amount of product	Unit value (K)	Total value (K million)
Alcohol	4320	345,600	36,000 gal	600	19.44
Alcohol	4320	345,600	54,000 gal	540	32.40
Sugar	2500	175,000	540,000 viss	120	64.80
Sugar	3600	252,000	702,000 viss	95	66.69

8.4.2 Bamboo fuel

The only cottage industry using bamboo as fuel is an evaporated milk plant located at Pyawbwe township. Annual consumption of bamboo was recorded as 8-12 truck loads at a total cost of K 56,000 to K 84,000. One truck load of dry bamboo was able to boil 10,000 viss of milk. Bamboo was acquired from Shwe Myin Tin area of Yamethin township. Daily production of evaporated milk was 150 viss, thus the annual production would be about 45,000 viss. The product is sold at K 140 per viss. Therefore, the annual return would be about K 6.3 million. Evaporated milk is inferior to condensed milk which can last for 1-2 months without spoiling. However, the price of condensed milk is higher (K 200 per viss) than the evaporated milk by about K. 60.

8.4.3 Plum fruit kernel fuel

The commercial production of plum seeds allows industries in the fuel deficit area to utilize fruit kernel as fuel. One sugar Mill in Pyawbwe township consumes as much as 30 baskets of plum kernel per day at a cost of K 20 per basket. Daily production of sugar is 20-30 bags which is equivalent to 600 to 900 viss. The selling price of sugar is K 3000 to K 3,500 per bag (K 100-117 per viss). About 400 viss of mollasses per day is obtained from the process as a by-product. The selling price of mollasses was K 30 per viss. Therefore, daily production value is be about K 93,000 (K 81,000 for sugar and K 12,000 for molasses). Annual requirement for plum kernel is 9000 baskets at K 180,000 and annual production of sugar and molasses is 216,000 viss and 100,000 viss respectively. Therefore, the annual production value would is about K 24.6 million which give a considerable amount of profit after all other charges including labour charges have been deducted.

8.4.4 Bagasse and sawdust fuel

This kind of biomass fuel is found to be of minor importance in the study area. Bagasse is used in cane sugar slab boiling and pottery industries. Cane sugar boiling is no longer permitted in order to fulfil the sugarcane requirement of state owned sugar mills. Although the pottery industry, also uses bagasse fuel, no systematic collection of data was undertaken.

Sawdust fuel is mostly employed in tea shops. Little attention is given to this fuel by cottage industries. It is mainly utilized in alcohol distilleries and sugar mills as a supplementary energy source. Sawdust should be considered a potential and alternative source of fuel since there is a plentiful supply of sawdust in Lewe and Pyinmana townships.

8.5 Discussion

The total annual woodfuel consumption of cottage industries, other than food stalls and state owned industries, in the study area is about 9,179 tons which cost about K 11.5 million. If woodfuel consumption of state owned sugar mills is included it would be 18,418 tons and the cost would be K 20.996 million. Total production value of cottage industries would turn out to be K 588.271 million per year (table 3).

Table 3. Total annual consumption and cost of woodfuel by cottage industries in Yamethin District with corresponding production values.

Industry	Woodfuel consumption (ton)	Cost of woodfuel (K)	Total production	Units	Production value (K x 1000)	Remark
Lime	4122.40	3,508,657	2,805	ton	7,714	
Sugar	3411.36	5,757,557	6,455	ton	457,858	
			3,277	ton	60,235	Molasses
Condensed milk	533.25	899,998	252,000	viss	50,4000	
Alcohol	355.50	599,999	216,000	bottles	7,128	
					70	Ether
Brick	635.95	665,905	1,925,000	piece	3,766	
Ceramic	80.00	75,758	-	-	300	Production N.A
Cook Stove	40.00	37,879	8,000	piece	800	
Total	9178.46	11,545,753			588,271	
State sugar Mill (1)	6600.00	6,749,952	12,600	ton	893,278	
			7,200	ton	4,352	Molasses
State sugar Mill(2)	2640.00	2,699,981	15,000	ton		Supplement-ed with FO
Total	9240.00	9,449,933				
Grand Total	18418.46	20,995,686				

At present, the annual fuelwood production target for Yamethin District is fixed at 19,000 tons and actual production during 1995-96 was 15,925 tons of which about 3,886 tons of fuelwood were transported to Yangon (source: Yamethin Forest District). Therefore, it can be seen that woodfuel production cannot even meet the requirement of local industries. Except for Pyawbwe township, industries in other areas in the district seem to be self sufficient. However, the demand of industries in Pyawbwe township can only be met by importing fuelwood from nearby Thazi township which has to supply Pyawbwe as well as the still larger areas around Meiktila (Khaing, 1993).

Woodfuel requirements can vary for different types of industry. In order to compare the variations in this respect, a cost analysis was made as shown in table 4. In this table variations in the cost of fuel used for a unit value of each product were calculated. The results show that, the lime industry spent the highest proportion of the unit value produced on fuel (45.49 %) and the private and state sugar industries spent the least (1.11 % and 0.66 %), despite the big difference in woodfuel cost which favoured the lime industry. Moreover, the lime industry consumed the largest share (44.91%) of the total woodfuel requirement of all cottage industries.

A considerable proportion of the value produced was found to be invested in the woodfuel requirement of the ceramic (25.33%), brick (17.68%), alcohol (8.42 %) and cook stove (4.75%) industries.

Table 4. Comparison of costs of fuel among different types of industry

Type of industry	Annual production value (K. million)	Biomass fuel used	Unit cost of biomass fuel (K)	Total annual cost of fuel (K million)	Cost of fuel as a percentage of value produced
Lime	7.714	Wood	851.12 / ton	3.509	45.49
Sugar (private)	518.093	Wood	1687.76 / ton	5.758	1.11
Sugar (state)	1028.080	Wood	1687.76 / ton	6.750	0.66
Condensed milk	50.400	Wood	1687.76 / ton	0.900	1.79
Alcohol	7.128	Wood	1687.76 / ton	0.600	8.42
Brick	3.766	Wood	350.1333 / ton	0.666	17.68
Ceramic	0.300	Wood	946.97 / ton	0.076	25.33
Cook Stove	0.800	Wood	946.97 / ton	0.038	4.75
Alcohol	51.840	Rice husk	75.00 / cart	0.691	1.33
Sugar	131.490	Rice husk	75.00 / cart	0.427	0.32
Evaporated milk	6.300	Bamboo	7000.00 /truck	0.070	1.11
Sugar (private)	24.600	Plum kernel	20.00 /basket	0.180	0.73

Highly significant differences in cost of fuel as a percentage of output value were noticed in the alcohol and sugar industries using woodfuel and rice husk. The industries using rice husk invested much smaller proportion for fuel (1.33% and 0.32%) than those using woodfuel (8.42% and 1.11%). Even greater differences could be expected since total production values calculated for rice-husk industries excluded the values of by-products (molasses) and extra retail prices for alcohol. If these industries were woodfuel based, the woodfuel requirement would be 1,943.68 tons per year.

At a given equal unit fuelwood cost and product value, the private sugar industry consumed about double the amount of woodfuel of the state owned sugar mill for unit value produced (1.11% and 0.66%). This difference is probably due to differences in efficiency and production technology.

Comparing sugar mills using different biomass fuels, the plum kernel based sugar industry was found to invest less (0.73%) than the one using woodfuel (1.11%). Again another biomass fuel, bamboo, was found to be cheaper (1.11%) than woodfuel (1.79%) in two different milk industries. Thus, it was evident that woodfuel was more expensive than biomass fuels.

According to a 1968 report on the situation of firewood and charcoal (Gale, 1968) periodic industrial consumptions of woodfuel as a proportion of total woodfuel consumptions were 20.42% (1931-40), 14.62% (1948-57), and 14.31% (1958-67). For the projected period of 1968-77 it was expected to be 12.42%. It could be assumed that the overall woodfuel consumption for all industries in the study area might not be less than 20 thousand tons per annum if the unsurveyed portion (for domestic use) was included (table 3). Assuming the industrial requirement for woodfuel in the study area to be 10%, the total woodfuel consumption, including the household energy requirement, would be 0.2 million cubic tons per annum Besides, part of the requirement of woodfuel for Yangon was continuously supplied by this district.

The fuelwood requirement for the study area, therefore, could only be met by the non-permitted extraction of wood since the annual target was fixed at 19,000 tons of fuelwood and 27,000 tons of charcoal. It was reported that the denuded public forests were producing only about 0.2 tons per acre per annum (Han, 1990). If the area under study was assumed to be denuded land, then woodfuel consumption of 0.2 million tons can only be acquired from 1 million acres of forest every year.

The same report suggested the establishment of fuelwood plantations with fast growing Eucalyptus species which would yield 25 tons of fuelwood in 12 years rotation. In order to fulfil the requirement of the study area , more than 8000 acres of such plantation should be established annually. However, the annual target for fuelwood plantations was at most 1,750 acres in 1996 and much less in the previous years.

8.6 Conclusion

Although Myanmar is a timber exporting country the supply of timber and woodfuel has never satisfied the demand for domestic consumption. Unregulated cutting and illegal trade are the prevailing solutions to this unmet demand for timber and fuelwood. The result is, therefore, a continual degradation of the forests at a progressive rate. Hence, it is quite difficult to estimate the sustainable supply of woodfuel from the natural forests. Consumption, on the other hand, is almost constant for a given size of population. An ever widening gap between the fuelwood supply and demand is thus expected if no remedial measures are undertaken soon.

The Forest Department alone cannot handle the situation and should not, therefore, be responsible for the consequences. The strategic effort to combat the challenges must be a national concern. The concerted efforts of all national sectors dealing with energy, social economy, environment, industry and forestry is required in strategic planning and implementation to solve the looming national woodfuel crisis.

8.7 Recommendations

Since the woodfuel situation is recognized as a nationwide strategic issue, recommendations apply to the country as a whole and are summarized as follows:

1. More emphasis should be given to the establishment of extra-large scale fuelwood plantations. A separate body should be formed for proper planning, budgeting and execution of a plantation scheme larger than any seen before in the country.

2. Extension activities for the initiation of still inactive community forestry practices for self-sufficiency should be given a high priority.

3. Not all stands in the natural forest are marketable and some even interfere with the growth of valuable tree species. Research on these issues should be undertaken at selected sites in natural forests.

4. Research on ways of improving of now developing technology on efficient cook stoves and woodfuel substitutes should be carried out continuously.

5. Distribution of fuel efficient cook stoves should be subsidized by the government and issued free to the poorer communities.

6. An adequate supply of alternative energy sources such as natural gas should be ensured at least for citizens of all major cities and heavy fuel consuming industries as an increase in the urban population accelerates the rate of denudation of forests.

8.8 References

Gale, Maung, 1968	Report of an Investigation into the Energy Resources, Firewood and Charcoal Sector. Forest Department, Myanmar
Central Statistical Organization, 1996	Statistical Yearbook (1995)
Khaing, Saw Thun, 1993	Woodfuel Flows in the Dry Zone of Myanmar (A Case Study) FAO, Bangkok.
Han, Saw, 1990	Analysis of the Fuelwood Situation in Myanmar.
Ministry of Planning and Statistics, 1994	Review of the Financial, Economic and Social Conditions for 1979-80 to 1992-93.
Central Statistical and Economic Department, 1968	Statistical Yearbook (1967).

9. A FRAMEWORK FOR WOOD FUEL FLOW STUDIES

A Study of the Marketing and Distribution of Commercial Wood Energy

by

CONRADO S. HERUELA
Wood Energy Planning Expert, FAO/RWEDP

9.1 Commercial Wood Energy Systems

Wood fuels are still being used in many towns and cities in Asia in spite of the improvement in the supply of commercial fuels such as kerosene, LPG and electricity. In these places, wood fuels are not gathered or collected by the users but are bought from the market. Wood fuels have thus become like an agricultural commodity. The percentage of purchased wood fuels is still small compared to the volume "freely" collected and harvested for self-consumption. Nevertheless, the production, flow and use of purchased wood fuels (i.e., the commercial wood energy systems) can be significant enough to affect energy, forestry, agriculture and macro-economic policies and programmes. Such policies and programmes can in turn influence commercial wood energy systems which are sensitive to policy instruments. For example, the purchased wood fuels market can be readily affected by pricing and other market interventions such as investments, financing, subsidies and taxes.

Supplying the wood fuels market has created a "wood fuel business" in many towns and cities. This wood fuel business has developed its own network which involves such activities as tree production, wood fuel harvesting/ collection, "wood fuel processing" (this involves *“physical processing”* such as cutting, splitting, sizing and bundling of fuelwood, and *“thermochemical processing”* such as charcoal production), and the transportation and marketing of wood fuels. The series of activities involving processing, transportation and marketing of wood fuels is termed *“wood fuel flows”*.

Firewood and charcoal, like any other "cash crop", are sold by rural producers to traders, who then transport the “goods” from rural areas to urban markets and/or to large scale users. In urban markets, there are dealers who stock wood fuels for wholesale and/or retail them to end-users. The bulk of these users are households, particularly poor urban households who buy the wood fuels mostly in small quantities. Other significant users - thus buyers - are enterprises and industries, including many household-based livelihood activities. These users constitute the wood fuels market.

The employment generated by the wood fuel business can be considerable and the income earned by the people involved can be economically significant too.

9.2 Conceptual Framework for Wood Energy Flow Studies[1]

The broad objectives of any major wood energy flow study are: (a) to characterize the marketing channels, intermediaries, and other actors involved in the marketing process; (b) to describe the distribution pattern and practice of fuelwood and charcoal (if extensively used); (c) to evaluate the existing marketing and distribution pattern for its economic efficiency; and (d) to trace the sources and destinations of the traded wood and charcoal. Since secondary data for such studies is generally non-existent, it is advisable to launch exploratory/pilot surveys in potential wood consumption locations (urban, rural, commercial establishments on metalled roads, etc.) to gain basic information on supply sources, frequency of harvesting and transportation, volume of product transported, transit taxes and duties for transporting wood to the markets, species usually marketed, and the marketing practices and sales price/margins, etc. To carry out such pilot studies, formal structured survey instruments have to be developed to: (a) cover the wide spatial variations in production, distribution and consumption of fuelwood; (b) provide a broad framework for the existing fuelwood marketing system; and (c) to help develop a comprehensive and consistent woodfuel market data base, which is generally non-existent.

9.3 Elements of Wood Energy Flow Studies

- <u>Woodfuel Supply And Demand</u>. Woodfuels generally occupy a dominant role in the energy mix of a country, and it is important that the wood energy flow studies are conducted in their proper context. It is, therefore, important to highlight the role of wood energy, particularly in meeting rural energy needs. In this regard, sectoral demand projections for woodfuel and other wood-based products (wood residues, charcoal, etc), especially for the domestic and commercial sectors and agro-based industries must be included. The demand projections must clearly differentiate between urban and rural consumers, as the contributing factors and motivations are quite different for the two sets of consumers. Woodfuel supplies and projections should include natural/government controlled forests, woodlots, farm trees and other plantations. Brief descriptions of the accessibility, sustainability of production, volume and yield of wood resources must also be provided as background information. A complete description of wood and the wood-based products currently in use in a country, along with the identification of important tree species which contribute to the fuelwood trade, and a comparison of the characteristics of these and other competing fuels provides an appropriate basis for understanding the market structure and trading patterns.

- <u>Producer-Related Information</u>. A typical fuelwood marketing study should start with a description of the type of producers (government forests, farm trees, etc) and geographical distribution of these producers. This analysis must be carried out in the context of the level of firewood demand in different geographical regions, so that the linkages between supply and demand can be developed. It is also necessary to understand the organization of fuelwood production and the motivations of individual farmers, cooperatives or private enterprises in tree plantations need to be clearly defined. Coupled with a description of the production system a gender analysis must be included as the role of women in tree plantations can provide useful insights into the socio-economic pressures inherent in a particular location. Lastly, financial data on cost of production (seeds, diversion of water, labour allocated to caring for trees, etc), selling price of wood and income of the producer needs to be ascertained. However, direct

[1] This section has been excerpted from the training materials for the 2nd Regional Training on Wood Energy Planning titled “Collection of Wood Energy Data for Biomass Energy Supply Studies: Wood Fuel Flow Studies” prepared by Mr. Waqar Haider, WB, Islamabad, Pakistan

responses to such questions are generally not available, and indirect questioning on different elements of cost and prices can provide a framework within which the monthly/yearly income of the producers can be estimated. The analysis of producer activities should encompass a qualitative assessment of their problems/obstacles, and prospects for their resolution.

- Transport Systems. Transport systems play an extremely critical role in bringing firewood from the production centres to the firewood markets, both in the urban and rural centres. It is, therefore, important to identify different means of transportation, both mechanized and non-mechanized, and the extent of their usage in different parts of the country. While data on non-mechanized transport is very difficult to collect, representative sample surveys can provide useful indications on the characteristics of this mode of transportation. On the other hand, data on average distance covered, number of wood trips per month, cost of transportation, etc. is often generally available. Another hallmark of wood transportation in many developing countries is the incidence of *octroi*, permit fees and other transit taxes, which are paid by the transporter, and incorporated into his costs. These need to be identified separately.

- Trader and Distribution Systems. Firewood is generally traded by a host of traders (wholesalers, retailers, roadside sellers, etc), and these need to be identified and their respective roles understood. Since different types of traders trade in a variety of wood and wood-based products, it is important to identify traders with wood energy products. Movement of firewood from production to consumption centres then needs to be identified, i.e. direct transactions between producer and consumers, and consumers and middlemen, etc. If there are any storage stages (yards) and systems in the process, they need to be described in detail. The marketing practices of wholesalers and retailers in selling wood to either other traders or end-consumers also need to be described.

- Pricing Information. Crucial to the understanding of the wood trading structure is a knowledge of the pricing system in a market. In the development of the cost build-up, the following elements need to be considered: (a) production cost -- broken down by major items; (b) producer margin; (c) transportation charges; (d) transit taxes and other levies; (e) wholesaler margins; and (f) retail margins. Similarly, wood price data have to be collected over a long period of time to understand the price fluctuations in relation to price increases/decreases of competing fuels. Consideration has also to be given to wood collection, which meets the energy needs of a large proportion of the rural population. Such time-series price data, along with a number of socio-economic and demographic variables, can be correlated with energy consumptions and fuel shares can be developed. Such models can also be used for developing options for inter-fuel substitution in the household sector.

- Wood Energy Conversion/Processing Technologies. Woodfuel production systems should also be studied in terms of methods and technologies available (and practiced) for the conversion of wood-based products into energy. The most common of these is charcoal production, which is a popular fuel in most urban centres in developing countries. There are wood/charcoal gasification systems for mechanical power and electricity generation which need to be investigated. The firewood market and wood flow studies should also encompass the development and promotion of more efficient technologies for wood energy use like kilns, stoves, furnaces and gasification systems.

- Financial, Economic and Social Aspects. The financial, economic and social aspects of firewood use and the use of other alternative fuels need to be highlighted at the national level, and the benefits of firewood use from the viewpoint of different beneficiaries (producers, traders, transporters, and end-consumers) need to be clearly spelled out. Similarly, a comparison of locally-produced fuels viz-a-viz imported ones should be carried out. The firewood market structure has also to be seen in the context of employment, income generation and gender-issues.

- Environmental Aspects. The possible environmental degradation caused by the overwhelming dependence on forest/wood resources as a source of energy, and through dependence on other organic fuels (dung, agricultural residues, etc.) requires careful evaluation. Impacts on the environment through improved forest management, creation of new resources, adoption of efficient conversion technologies, and inter-fuel substitution, need to be evaluated.

9.4 Data Requirements for Wood Energy Flow Studies

A characterization of wood fuel flows involves a description of the following elements:

- General Features and Patterns of Wood Energy Flows - includes information on the types and number of traders, trading profiles - *"who sells to whom"*, socio-economic profile of traders, and operational and financial data of wood fuel trading; a *schematic diagram of the wood fuel flow* would be very useful

- Processing and Conversion Systems - includes information on types and number of processing and conversion systems, production rate and efficiency of charcoal producers and other processing/conversion systems (i.e., gasification, fermentation, etc.), and socio-economic profile of actors involved in processing/conversion of wood fuels

- Links in the Wood Fuels Distribution Chain - describes the supply sources and routes, distribution channels, and major catchment zones - *maps showing the distribution chain* can also be very useful

- Wood Fuels Price Structure - provides data on sale volumes, prices and mark-ups, and net margins

- Wood Fuel Transport - gives information on the types and characterestics of wood transport, transport costs, and hauling distances.

A format for a "Terms of Reference" (Wood Energy Planning Expert, RWEDP) for a wood energy flow study in an urban area is given in the annex for reference.

Annex

SUGGESTED FORMAT

Terms Of Reference For
A WOOD FUEL FLOW STUDY FOR URBAN AREAS

A STUDY FOR (name of area)

Rationale

Most studies on wood energy systems have been carried out in rural areas and wood fuel use in urban areas has received little attention in the past. Energy policies for urban areas have nearly always been supply driven in the expectation that urban economic development would allow for an upward fuel switching to fossil fuels or electricity within a relatively short period. However, there is increasing evidence that wood fuels, i.e. fuelwood and charcoal, will continue to be one of the main sources of energy in many of the cities and large towns of developing countries, particularly for the poorer segment of their populations. But unlike in rural areas, market forces will determine to a large extent the volumes and types of wood fuels to be used in the urban households and in many industrial, commercial and institutional establishments which have traditionally been wood fuel users.

In order to identify the need for interventions which will improve wood energy supply to the urban poor, and wood energy-using industries and establishments, and to plan for these interventions if they are found to be necessary, it is essential to assess current distribution systems for wood fuels for their present strengths and weaknesses and identify potential threats and opportunities for the continued use of wood fuels in urban areas in the future.

The distribution of wood fuels from source to the final end users can be complicated. Even though some information is now available on how the system works, there are still many unknown factors in the fuelwood and charcoal distribution process. This is generally an informal sector activity which makes its study quite difficult.

Scope of the Study

The study of wood fuel distribution systems or *wood fuel flows* for urban areas consists of studying the *transport and distribution network* for moving wood fuels from wood-producing areas to urban consumers and the *trading and marketing practices* for supplying urban markets with wood fuels.

However, there is a need to fully comprehend the workings of "urban wood energy systems" to be able to make appropriate recommendations for improving the systems for wood energy flow to urban areas. This means there is a need to look into the patterns of energy consumption of households, industries and other wood fuel-using commercial and institutional establishments to determine their future wood fuel demand. There is also a need to understand the wood production systems used, or in other words the ways in which wood energy resources are grown, managed and harvested for urban markets.

Objectives

The following are the objectives of the study:

1. To characterize the mode of transport and distribution of wood fuels from wood-producing areas to urban consumers and identify and describe the "actors" involved.

2. To describe the trading and marketing practices, such as procurement, inventory, retailing and pricing for wood fuels to be sold in urban markets.

3. To assess future demand for wood energy for the different wood-using sectors such as households, industrial, commercial and institutional establishments, and the informal sector (e.g. roadside eateries, ambulant food vendors, barbecue stands, etc.).

4. To determine how factors such as land, capital and labor inputs, and management practices will allow the economic and sustainable production of wood fuels.

Methodology

The following table lists the suggested techniques for data collection to be used in this study.

ACTIVITIES	TECHNIQUES			
	Literature Surveys	RRA Techniques	Interviews with Key Informants	Purposive Surveys
1. Identify constraints in the transport and distribution network for moving wood fuels from wood-producing areas to urban consumers and assess the effectiveness of such a network in supplying wood fuels to urban users.	- sources not usually available	- least cost for primary data collection	- also not costly but may yield better data	- if funds available, more interviews to form a survey
2. Describe the trading and marketing practices, such as the procurement, inventory, retailing and pricing of wood fuels (i.e. price build-up practices), and assess how such practices can distort or correct the price of wood fuels to consumers.	- same as above	- same as above	- same as above	- same as above
3. Identify other factors that influence the price of wood fuels, such as price of alternative fuels, seasonality, transportation, etc.	- same as above	- same as above	- same as above	- same as above
4. Identify and characterize the various "actors" involved in wood energy flows and assess the benefits they obtain from participating in the wood energy distribution systems for urban areas.	- same as above	- same as above	- same as above	- same as above
5. Assess future demand for wood energy for the different wood-using sectors such as households, industrial, commercial and institutional establishments, and the informal sector (e.g. roadside eateries, ambulant food vendors, barbecue stands, etc.).	- can be estimated from similar surveys/ studies	- least cost for verifying secondary data; necessary for the informal sector	- applicable only for industrial and other commercial users	- same as above
6. Determine how factors such as agro-ecological conditions, production inputs (land, capital and labor), tenurial systems, and management practices contribute or hamper the economic and sustainable production of wood fuels for urban markets.	- could be available from previous studies	- least cost for primary data collection	- also not costly but may yield better data	- if funds available, case studies will be better

PART III: ANNEXURES

Annexure 1

WORKSHOP PROGRAMME

(27 - 30 November 1996)

Wednesday, November 27

- Registration
- Opening Ceremony
- Inaugural Address by U Soe Tint, Director General, Planning and Statistics Department, Ministry of Forestry
- Statement by Mr. K. P. Upadhyay, FAO

- **Morning Session**
- Chaired by U Soe Tint, Director General, Planning and Statistics Department, Ministry of Forestry
- "A framework for woodfuel flow studies" prepared by Mr. Conrado S. Heruela, RWEDP
- "Wood energy in Myanmar" by U Khin Maung Nyunt and U Soe Tint
- "Woodfuel marketing at Pyinmana township: A case study" by U Saw Kelvin Keh

- **Afternoon Session**
- Chaired by U Aung Kyin, Rector, Institute of Forestry
- "The dissemination of A-1 fuelwood cookstoves" by U Win Kyi and U Win Oo Naing
- "Woodfuel position with particular reference to mangrove areas in Myanmar" by U Ohn
- "Output of fuelwood species and some experimental findings on fuelwood production" by U San Lwin , U Khin Maung Oo, U Kyaw Than and U Mya Win

Thursday, November 28

- **Morning Session**
- Chaired by U Shwe Kyaw, Director, FRI, Forest Department
- "The role of non-forest areas in woodfuel production" by U Soe Myint
- "Use of woodfuel in cottage industries in Yamethin district" by U Win Ky, U Kyaw Win Maung and U Win Oo Naing
- "Woodfuel flows in the Dry Zone of Myanmar" by U Saw Tun Khaing (presented by U Tin Tun)

	-	**Afternoon Session**
	-	Formation of groups
	-	Group discussion
	-	Group discussion
Friday, November 29	-	Field trip to Pyawbwe
	-	Preparation of group reports
Saturday, November 30	-	Plenary Session Chaired by Dr. Kyaw Tint, Director-General, Forest Department
	-	Group reports by corresponding rapporteurs
	-	Winding up discussion
	-	Recommendations
	-	Closing remarks by the chairman
	-	DG's Cup Golf Tournament at FRI recreational golf link

Annexure 2

INAUGURAL SESSION

INAUGURAL ADDRESS BY U SOE TINT, DIRECTOR GENERAL, PLANNING AND STATISTICS DEPARTMENT, MINISTRY OF FORESTRY

Distinguished Guests, Participants, Observers, Ladies and Gentlemen,

Allow me to extend my warmest welcome to all of you to this " National Training Workshop on Woodfuel Trade in Myanmar " being held today at this peaceful and pleasant environment of Yezin.

It is a great honour for me to address this significant National Workshop held by the Forest Department in collaboration with the Regional Wood Energy Development Programme (RWEDP) of the FAO. On this occasion, I would like to express my great appreciation to Mr. K. P. Upadhyay the Resident Representative of the FAO for his presence and to the RWEDP, for supporting this training workshop.

As you may be aware, woodfuel remains the dominant energy source for most people in the developing countries of Asia. Wood is being used not only to satisfy the daily requirements of the rural people in cooking and heating, but also to supply the energy for various cottage industries. It is estimated that about 30 to 80 %, or even more, of the domestic energy is still supplied by wood in some countries in Asia. A few countries are now trying to shift to the use of commercial fuels such as electricity and fossil fuels but most have to rely on other forms of fuel, like agri-residues and animal wastes or other traditional fuels.

According to the World Resources Institute, it is estimated that the use of wood for fuel has increased by 35 percent from 1976 to 1986. Since 1987, about 2.5 billion people, which is one half of the world's population, are using wood energy for their daily domestic cooking and heating and about 125 million people or 5 percent of the users have problems obtaining enough woodfuel to meet their needs, either because of woodfuel shortages in their vicinities or because of high prices. Besides, a further one billion people or 40 percent were in a deficit situation and could meet their needs only by exploiting the forest reserves. The size of the energy deficient population will continue to increase, especially in the developing countries in the tropics, as the population growth rate and the demand for energy is increasing at a very fast pace.

Like other developing countries in Asia, the main types of fuel used by the majority of people in Myanmar are woodfuel and charcoals. It was estimated that, in 1990 about 40 million people in both rural and urban areas consumed about 18 million cubic tons (26 million cubic meters) of woodfuel. With the present annual growth rate, the population will be about 50 million by the year 2000 and the annual woodfuel consumption is expected to be in the range of 22 million cubic tons (31 millions cubic meters).
Since the 1950s, the Forest Department has realized that, though the woodfuel shortage problem was at that time not yet acute, the annual consumption was very high and thus exerted a heavy drain on the forests, especially those located near the densely populated areas. It was

forecasted that the more accessible fuel reserves and public forests would be exhausted to the extent that the more remote and less accessible forests would have to be tapped in the foreseeable future, involving increased expenditure to the consumers. Although some remedial measures were recommended for immediate implementation, these were not successfully implemented due to weaknesses in terms of political awareness, forest policy, legal support and people's participation. Consequently, the densely populated areas are now facing a severe woodfuel shortage.

At present, the new Myanmar Forest Policy and the Forest Law have been promulgated in line with international forest principles and guidelines. These emphasize meeting the basic needs of the people for fuel, shelter, food and recreation through public awareness and people's participation in the conservation and utilization of the forests. To implement this policy, village plantations have been formed. These give priority to fulfilling the needs of the rural people and also to encouraging their participation. Before 1993, the percentage of village supply plantations was only 22 percent of the total number established plantations, but after 1993 the percentage increased to 44.

In order to partially solve the acute woodfuel shortage problem and to restore the forest ecosystem, a special Greening Project for the nine critical districts of the arid zone was launched in 1994, covering 9 districts in 3 Forest Divisions. About 9,400 ha. of woodfuel plantations have been established within 2 years with the active participation of the local communities and co-operation from non-government organizations. The woodfuel shortage problem can not be solved by means of increased production of woodfuel from forest resources alone. It is also necessary to reduce the annual consumption of woodfuel through improved technologies (such as efficient charcoal production technique, energy saving cooking stoves etc.) and finding substitutes for woodfuel. Recently, the Forest Department, in co-operation with Japan Domestic Fuel Dealers Association, conducted three training courses on wood/bamboo charcoal production technique in Pathein, Hmawbi, and Yezin, with the objective of saving woodfuel.

The Forest Research Institute, Yezin, has conducted research to develop appropriate energy saving cookstoves for charcoal as well as for woodfuel since 1985. As a result, the A-1 type of woodfuel cooking stoves has been developed. These can save up to 36 percent of woodfuel as compared to the traditional ones, and have been introduced and disseminated widely to the public in many parts of the country.

In 1994, the government formed a special committee to look for fuelwood substitutes. The Minister of Industry headed the committee and briquetting machines, low cost energy saving stoves, and solar energy stoves were developed and commerialized.

Although it may be too early to evaluate these activities and assess the impact on wood energy development in Myanmar, this workshop offers a good opportunity to collect the information and data so that we can draw some appropriate conclusions and recommendations for future development planning in woodfuel production.

In conclusion, I would like to urge all of the participants and observers to share your experiences and information, based upon your localized situation, freely, frankly and constructively. On behalf of the organizing committees, I am very grateful to all the distinguished guests, observers and participants for sharing your precious time and energy here at this workshop.

I wish you every success in all your deliberations.

Thank you.

SPEECH DELIVERED BY KUMAR P. UPADHYAY, FAO REPRESENTATIVE a.i. IN MYANMAR

Honorable Chairman , Distinguished Guests , Ladies and Gentlemen ,

I am very pleased to be amongst this august gathering and to be able to speak a few words on a very important subject " The Woodfuel Trade in Myanmar ".

Woodfuel is the major source of energy in Myanmar. It is estimated that roughly 80 percent of the total primary energy consumption in Myanmar is from biomass - fuelwood and agricultural crop residues included.

In many countries in the South and Southeast Asia, the share of traditional energy is decreasing. The increasing energy demand in these countries has been met through increased supply of commercial energy sources.

However , in Myanmar , for various reasons , the consumption and dependence on traditional sources of energy have been increasing over the years. For example , the share of traditional energy sources in 1972 was 72 percent and 74 percent in 1991.

Despite 48 percent of the nation's land being under forest and a significant production of crop residues from the agriculture sector, the supply and demand situation of biomass in Myanmar is alarming. For example, in the Dry Zone alone, the annual consumption of biomass is 11.19 million metric tons, whereas the sustainable supply is estimated to be only 5.62 million metric tons . This means that a total deficit of 5.57 million metric tons of biomass is presently being met through over cutting of forests, through the conversion of high value wood into woodfuel, or through unknown sources, including non-forest areas. If the present trend continues it is estimated that the biomass deficit could increase by 7.30 million metric tons in the year 2000.

It is obvious therefore, that integrated energy planning has become an urgent need if the sustainable use of natural resources endowment is to be ensured. This calls for a detailed analysis of different scenarios. At last three potential scenarios needs to be investigated. They are as follows:

Scenario 1: What could be done to ameliorate the adverse situation if the present heavy reliance on biomass as source of energy continues at the same rate until the year 2000 ?

Scenario 2: What would be the effect of the government taking action to meet the energy needs through diversification and the supply of a different energy mix by allowing a better functioning energy market ?

Scenario 3: What would be the effect of the Forest Department attempting to reduce the consumption of biomass through a massive conservation education programme and through the introduction of fuelwood efficient stoves.

Regarding the first scenario, one estimate reveals that 4.1 million acres of fuelwood plantation has to be established to eliminate the deficit in 2000. This would cost the treasury about US $ 203 million.

Is there a public sector capacity to establish such large plantation targets in the country? Can the government alone establish such a target without the help of the private sector? The answer to both questions is no. The involvement of the private sector is deemed essential.

The next challenge is how to attract the involvement of the private sector? Clearly it will not invest without adequate information and proper analysis. It is the responsibility of the forest department to provide adequate information to the private sector. The private sector will want several issues to be addressed before investing. It will want to know how developed/advanced or organized is the production system (availability of land and technical know how)? How are the present distribution and marketing systems organised? How large is the involvement of the local population in the collection/gathering/conservation of biomass? How are the fuels transported and what is the volume of the woodfuel trade?

The present information base on the production, distribution, and marketing of woodfuel is scanty and dispersed. Therefore, this workshop, which is designed to focus on the above mentioned issues, is timely and very important to ensure the sustainable use of forest resources in Myanmar. On behalf of FAO, I would like to wish you all a successful workshop and fruitful deliberations.

Thank you.

Annexure 3

ITINERARY OF FIELD TRIP

November 29, 1996

07:00 - 09:00	:	Travel by car from Yezin to Sibin forest nursery, Yamethin township.
09:00 - 09:15	:	Halt for refreshment.
09:15 - 09:45	:	Travel by car from Sibin to Pyawbwe.
09:45 - 11:30	:	Visit to some selected sugar mills, condensed milk industries and alcohol distillery in Pyawbwe to study the use of wood and biomassfuel.
11:30 - 12:00	:	Travel by car from Pyawbwe to Sibin forest nursery.
12:00 - 13:00	:	Lunch break at Sibin nursery.
13:00 - 13:30	:	Travel by car from Sibin to Shwe Min Wun fuelwood plantation.
13:30 - 14:00	:	Study 11 year old Bawzagaing plantation, primary growth, supply of woodfuel to the villagers, and secondary growth from coppice shoots.
14:00 - 16:00	:	Travel by car from Shwe Min Wun to Shwe Twin Kon v village, Pyinmana township.
16:00 - 16:15	:	Halt for refreshment
16:15 - 17:00	:	Visit to lime kilns and study woodfuel consumption.
17:00 - 17:30	:	Travel by car from Shwe Twin Kon back to Yezin.

Annexure 4

LIST OF PARTICIPANTS

U Soe Tint
Director General
Planning and Statistics Department
Ministry of Forestry

Dr. Kyaw Tint
Director General
Forest Department
Yangon

U Aung Kyin
Rector
Institute of Forestry
Yezin

U Ohn
General Secretary
FREDA
Yangon

U Thein Lwin
Advisor
Forest Department
Yangon

Dr. Ulrich Apel
Visiting Lecturer
Institute of Forestry
Yezin

U Shwe Kyaw
Director
Forest Research Institute
Yezin

U Mehm Ko Ko Gyi
Director
Training and Research Division
Forest Department, Yangon
U Saw Kelvin Keh
Professor
Institute of Forestry, Yezin

U Sein Tun
Director
Bago Division
Forest Department

U Win Kyi
Professor
Institute of Forestry
Yezin

U Soe Myint
Project Director
Nine District Greening Project
Forest Department, Sagaing

U Win Kyi
Deputy Director
Forest Research Institute
Yezin

U Sann Lwin
Deputy Director
Forest Research Institute
Yezin

U Myint Swe
Assistant Director
Eastern Shan State
Forest Department
Kyaing Tong

U Khin Maung Oo
Assistant Director
Forest Research Institute
Yezin

U Tin Aye
Assistant Director
Pakokku Division
Forest Department
Pakokku

U Tin Tun
Lecturer
Institute of Forestry
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U Mya Thaung
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Yamethin Division
Forest Department
Pyinmana

U Tin Win
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Daw Kyin Kyin Oo
Scientist
Myanmar Scientific and Technological
Research DeparDment
Ya^gon

U Khin Maung Nyunt
Staff Officer
Planning and Statistics Division
Forest Department
Yangon

U Myo Htun
Staff Officer
Planning and Statistics Division
Forest Department
Yangon

U Kyaw Than
Staff Officer
Forest Research Institute
Yezin

U Myo Tint
Staff Officer
Shan State
Taungyi

U Myint Aung
Staff Officer
TatKone Township
Forest Department

U Tin Yein
Staff Officer
Forest Department
Lashio

U Ohn Pe
Staff Officer
Forest Department
Shwebo

U Tin Htun
Staff Officer
Watershed Management Division
Forest Department
Yangon

U Than Htay
Range Officer
CFDTC
Forest Department
Hmawbi

U Aung Kyaw Linn
Range Officer
Forest Department
Letpattan

U Win Maw
Range Officer
Forest Department
Kyangin

U Kyaw Win
Range Officer
Forest Department
Monywa

U Khin Maung Kyaw
Range Officer
Planning and Statistics Division
Forest Department
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U Aung Thant Zin
Tutor
Institute of Forestry
Yezin

U Hla Oo
Range Officer
Forest Department
Sagaing

U Kyaw Thu
Range Officer
Forest Department
Shinmataung Project
Pakokku

U Zaw Min Htut
Range Officer
Forest Department
Thapaung

U Moe Zaw
Range Officer
Forest Department
Kyaukpadaung

U Win Naing
Range Officer
(Mangrove Project)
Forest Department
Laputta

U Kyaw Win Maung
Research Assistant (2)
Forest Research Institute
Yezin

U Win Oo Naing
Research Assistant (2)
Forest Research Institute
Yezin

LIST OF OBSERVERS

No.	Name	Occupation	Organization	Location
1.	Mr. Kumar Upadhyay	Regional Representative	FAO	YANGON
2.	U Maug Maung	Deputy General Manager	MTE	TAUNGOO
3.	U Myint Lwin	Assistant Manager	MTE	TAUNGOO
4.	U Hla Kyaw	for General Manger	MTE	YANGON
5.	U Hla Kyaw	Manager	MTE	
6.	U Tun Kyi	Manager	MTE	PYINMANA
7.	U Aung San Htay	Director	FD	SAGAING
8.	U Tun Tun	Director	FD	MANDALAY
9.	U Sein Thet	Director	FD	YANGON
10.	U Ye Tint	Director	FD	HQ. YANGON
11.	U Htun Than	Director	FD	MAGWE
12.	Dr. Nyan Tun	Professor	IOF	YEZIN
13.	U Maung Maung Tin	Manager	MTE	
14.	U Sann Lwin(2)	Deputy Director	FRI	YEZIN
15.	U Aung Hlaing	Deputy Director	FD	HQ. YANGON
16.	U Myo Myint	Assistant General Manager	MTE	TAUNGOO
17.	U Win Myint	Assistant General Manager	MTE	PYINMANA
18.	U Sein Htun	Assistant Director	FRI	YEZIN
19.	Daw Khin Win Myint	Research Officer	FRI	YEZIN
20.	U Tin Htwe	Assistant Director	FD	THAYET
21.	U Khin Maung Oo	Assistant Director	FD	MINBU
22.	U Zaw Win	Assistant Director	FD	MAGWE
23.	U Kyaw Soe Khaing	Assistant Director	FD	MYINGYAN
24.	U Aye Cho	Assistant Director	FD	MEIKTILA
25.	U Aye Maung	Assistant Director	FD	MONYWA
26.	U Htay Sint	Assistant Director	FD	SHWEBO
27.	U Soe Myint	Assistant Director	FD	KYAUKSE
28.	U Soe Hla	Lecturer	IOF	YEZIN
29.	U Ohn Win	Lecturer	IOF	YEZIN
30.	U Khin Maung Lwin	Lecturer	IOF	YEZIN
31.	Daw Win Win Myint	Lecturer	IOF	YEZIN
32.	U Zaw Win	Assistant Lecturer	IOF	YEZIN
33.	U Pe Chit	Tutor	IOF	YEZIN
34.	U Myint Soe	Tutor	IOF	YEZIN
35.	U Min Htut Yin	Tutor	IOF	YEZIN
36.	U Saw Ba Hein	Tutor	IOF	YEZIN
37.	U Tin Win			
38.	U Nay Win			
39.	U Nyein Oo	Staff Officer	FRI	YEZIN
40.	U Thant Zin	Staff Officer	FD	PYINMANA
41.	U Saw Shwe Hla	Staff Officer	FRI	YEZIN
42.	Daw Khin May Lwin	Assistant Research Officer	FRI	YEZIN
43.	U Tun Tun Wai	Range Officer		MONYWA
44.	U Aung Naing Oo	Demonstrator	IOF	YEZIN
45.	U Chit Hlaing Win	Range Officer	FRI	YEZIN
46.	U Kyaw Lwin	Range Officer	FRI	YEZIN

47.	U Hlaing Myint Maung	Range Officer	FRI	YEZIN
48.	Daw Aye Aye Thein	Librarian	FRI	YEZIN
49.	Daw Tin Tin Mu	Research Assistant(2)	FRI	YEZIN
50.	Daw Wai Wai Than	Research Assistant(2)	FRI	YEZIN
51.	U Htin Kyaw	Research Assistant(2)	FRI	YEZIN
52.	Daw Aye Aye Kyu	Research Assistant(2)	FRI	YEZIN
53.	U Aung Zaw Moe	Research Assistant(2)	FRI	YEZIN
54.	Daw Mu Mu Aung	Research Assistant(2)	FRI	YEZIN
55.	Daw Thida Mundt	Research Assistant(2)	FRI	YEZIN
56.	U Aung Soe	Research Assistant(2)	FRI	YEZIN
57.	U Htay Aung	Research Assistant(2)	FRI	YEZIN
58.	Daw Christy Ne Win	Research Assistant(3)	FRI	YEZIN
59.	Daw Cho Cho Win	Research Assistant(3)	FRI	YEZIN
60.	Daw Kyu Kyu Thin	Research Assistant(3)	FRI	YEZIN
61.	U Billy Ne Win	Research Assistant(3)	FRI	YEZIN
62.	U Shwe Thein	Registrar/Lecturer	IOF	YEZIN
64.	U Than Aye	Staff Officer	FRI	YEZIN
65.	U Khin Maung	Asst. Lecturer	IOF	YEZIN
66.	U Myint Oo	Range Officer	H.Q	YANGON
67.	U Hla Htun	Range Officer	FRI	YEZIN
68.	Daw Khin Win Myint	Assistant Researcher(2)	FRI	YEZIN

* FRI = Forest Research Institute
IOF = Institute of Forestry
FD = Forest Department
MTE = Myanmar Timber Enterprise
H.Q = Headquarters of Forest Department

4. COMMERCIAL TRANSPORTATION OF WOODFUEL

Boat transport

Transport by truck

5. WOODFUEL STORAGE

Commercial/domestic storage

Commercial woodfuel depot

6. ***UTILIZATION WOODFUEL IN COTTAGE INDUSTRIES***

Lime burning

Brick baking