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REGIONAL WOOD ENERGY DEVELOPMENT PROGRAMME IN ASIA
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REPORT
TRAINING WORKSHOP

Integrating Woodfuel Production into the Implementation of Agriculture, Forestry and Rural Extension Programs in South Asia

Dhaka, Bangladesh
24-30 October 1995

BANGLADESH FORESTRY DEPARTMENT
BANGLADESH AGRICULTURAL RESEARCH COUNCIL
AND
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FOREWORD

Developing countries in the Asia-Pacific region, especially the South-Asian countries, are confronted with a population explosion, poverty, malnutrition, illiteracy and environmental hazards. The pressures on these countries' subsistence farmers and on meagre natural resources have reached unprecedented levels. As most of these countries are still pre- dominantly rural various rural development programmes are being implemented for economic emancipation and for improving the quality of life of the people. However, in this process natural resources like forests and rural tree groves are dwindling. One of the burning issues concerning rural development in this region is rural energy. Against the backdrop of rapid degradation of biomass sources of both forest and homestead origin, the energy issue is becoming one of the most serious concerns of all countries in the region .

Developing countries in the Asia-Pacific region meet 30-80 percent of their energy needs with biomass fuels of which wood plays the dominant role. Most of these fuels are consumed for domestic cooking and heating, especially in the rural areas. As wood fuels are, and likely to continue to remain so for quite sometimes in the future, the principal source of energy for the rural population, all strategies toward sustainable land based resource management should integrate wood fuel production as a strategy for resource building and ensuring environmental equilibrium. Such an integrated approach offers great potential for rural employment and for enhancing the incomes of the rural populace.

Implementation of such a gigantic task in the field calls for a concerted effort from both government and non-government organisations, as well as individuals. Proper documentation of country experiences in planning and implementation of wood fuel production programmes, and exchange of those experiences is yet another major area which needs national and international support.

For effective dissemination and exchange of views, regional workshops, seminars and symposiums are extremely important. With these objectives in view, the Regional Wood Energy Development Programme (RWEDP) organized a training workshop in Bangladesh focusing on integration of wood fuel production with other land uses including forestry/agroforestry, agriculture and rural extension programmes. The Bangladesh Forest Department and the Bangladesh Agricultural Research Council jointly collaborated in organizing the workshop at Rajendrapur, Dhaka.

The Workshop aimed at identifying the current status of rural energy, its problems and possible solutions. Participants from different South Asian countries representing government and non-government sectors worked together in identifying the problems and suggesting measures for enhanced production and improved distribution and marketing of wood fuel through integration of wood fuel production in forestry/agroforestry, agriculture and rural extension programmes.

One of the most important outputs of this workshop was the formulation of country specific strategic training plans to develop human resources to address the problem of wood energy. I am sure, this will enhance each country's capability to plan, design, implement, monitor and develop the human resources involved in wood fuel production. Through this workshop the participants learned about the experiences of their neighbouring countries and were able to exchange ideas regarding fuel production plans, programmes and projects.

Regional Wood Energy Development Programme (RWEDP) deserves special thanks and appreciation for expert help and financial support in organizing the workshop and in publishing this proceedings. I extend my sincere thanks to the organizers, resource persons and participants of the workshop who made a very valuable contribution through their earnest deliberations. I believe the proceedings of the workshop will be useful in planning and formulating wood energy policies and programmes, and will contribute to integrating wood fuel production in forestry/agroforestry, agriculture and rural extension programmes in South Asia for enhanced resource building and for forestalling environmental hazards.

Dr. Shamsur Rahman
Chief Conservator of Forests
Bangladesh

PREFACE

In several countries in Asia, promising strategies in support of community-, farm- and agro-forestry practices are being developed to encourage private and community participation in forestry development. Historically, the introduction of multipurpose trees and other woody perennials into the farming systems has been the common survival strategy of farmers in diverse agro-ecological zones, such as densely populated lowland humid tropical areas and mountain areas. Their strategy served primarily for meeting the household requirements of food and wood, and also to a limited extent, for cash income from the sale of surplus marketable products. More recently, the multiple production potentials of private and community lands are being increasingly recognized, and a large amount of wood(fuel) is being supplied from non-forest areas. As a result, new policy initiatives have been taken to enable the active involvement of rural people in the management of forest and tree resources. Besides the responsible government agencies, participation of non-government organizations and private individuals are being sought increasingly for this. A review of forestry related development in selected RWEDP member countries indicates that the incorporation of multipurpose trees into the farming systems by rural people may well be the most feasible strategy for the immediate future, particularly from the point of view of ensuring a sustainable supply of wood(fuel) to the people.

It is now widely accepted that most traditional policies, administrative structures and legislative measures have become obsolete for the development of the forestry sector. The need for a re-orientation of foresters, to accommodate the new role of extension agent rather than the regular policing role, is receiving increasing support from all major parties concerned with development in the forestry sector. This task still needs to be pursued further in order to motivate private sector participation, and calls for regular monitoring of the situation during the course of implementation of the revised, improved instruments.

Therefore, one of the objectives of the Regional Wood Energy Development Programme in Asia is to cooperate with member countries in strengthening the capabilities of government, private and community based organizations in implementing wood energy strategies and programmes. The ultimate target groups are woodfuel producers who will benefit from generating additional income. The woodfuel producers can be farmers and the additional income will arise from involvement in the wood energy sector and related forest and tree products. In order to achieve this goal, it is necessary to integrate woodfuel production into the wider scope of programmes for agriculture, forestry and rural extension.

RWEDP is fortunate in having had the co-operation of the Bangladesh Forest Department and the Bangladesh Agricultural Research Council, in organising a Sub-regional Training Workshop for enhancing the above-stated objective. The Workshop at Dhaka, October 1995, drew 17 participants and 6 resource persons from South Asia and overviewed the current status of integrating woodfuel production into agriculture, forestry and rural extension in the region. The results prepared the grounds for national follow-up activities to further develop policies, institutions and human resources in related subjects. A summary of the programme and papers presented at Dhaka is published in the present report. RWEDP is grateful to the Government of Bangladesh and the co-organizers for their valuable contribution to this important sub-regional activity.

Dr. Willem S. Hulscher
Chief Technical Adviser

TABLE OF CONTENTS

BANGLADESH

WOOD ENERGY RESOURCES AROUND DHAKA

“Agroforestry production system: A farmer observing the fruits of his hard work”

“NGO sponsored community plantation of mixed tree species”

Agroforestry Production System

“Large and meidium scale farmers tend to choose high value commercial tree species like Switenia macrophylla for planting under an agroforestry system”

“Small farmers tend to favour multipurpose trees including fruit trees for agroforestry practice”

Transportation of Firewood

“River transport by ships/large boats near Dhaka and riverside firewood depot in the foreground”

Firewood transportation using a special tricycle

Firewood Trade

Wholesale firewood depot

Mixed products for sale: firewood, animal residue and bricks in a smaller depot

Firewood Utilization

Local soap manufacturer using firewood for heating

Households use whatever biomass is available for domestic cooking

PART I: MAIN REPORT

1. BACKGROUND

In the Asia-Pacific region, developing countries meet 30 - 80 percent of their energy needs from woodfuels (biomass and charcoal). In the past, woodfuel has been obtained freely from natural vegetation. With the growth of population and the acquisition of forest lands for other uses a drastic change has taken place. Due to increase in population pressure forest lands are being cleared for agricultural expansion, the fallow period of traditional shifting cultivation has been shortened and steep slopes are being cultivated disregarding the dangers of catastrophic soil erosion and land slides. Moreover, agricultural residues and animal dung are burnt to meet fuel needs at the expense of crop land fertility. All these factors contribute to land degradation.

In developing countries most of the development activities revolve around 'low-tech' land based production systems. But if the resource base is degraded, the development cannot be sustainable. With forests declining, farm land and homesteads are the main sources of woodfuel. To improve and sustain farming practices against climatic and environmental deterioration the integration of woodfuel production into land management systems is essential. To this effect, different models of agroforestry systems have proven their productive potentials as viable alternatives in areas with high landuse pressure. The Regional Wood Energy Development Program (RWEDP) provides support for improving the land management systems of member countries in order to improve the availability of wood energy resources and for creating the awareness that woodfuel availability is a prime factor for sustainability of both forest and farm land productivity. Realizing that the integration of woodfuel production in the implementation of agriculture, forestry and rural extension programs in South Asia would strongly support efforts at sustainable development, it was felt that a training workshop would help to create awareness of the importance of such a strategy among the developing countries of this region.

1.1. Organizing Institutions

The organizing institutions of the workshop were Bangladesh Forest Department (FD), Bangladesh Agricultural Research Council (BARC) and the Regional Wood Energy Development Program (RWEDP), FAO/RAPA. The Forest Department in Bangladesh is engaged in forestry development and extension. Forestry development is not limited to government forest land alone but extends to rural private and community lands. For forestry extension in rural areas, FD provides seedlings at a subsidized rate to all. For sustainability of forestry initiatives manpower are also trained in nursery raising and rural afforestation. As Bangladesh has a predominantly agrarian economy and farming systems are also multidisciplinary in nature, the training rendered by FD is very useful for integrated management of rural resources. FD is also the forestry focal point for RWEDP activities in Bangladesh.

Bangladesh Agricultural Research Council (BARC) is the apex body for coordinating agricultural research, development and extension activities in Bangladesh. Forestry is an integrated part of agriculture and hence in BARC there is a forest department to look after the forestry and agroforestry research and development activities. Realizing the importance of agroforestry many organizations, in addition to the Forest Department, have initiated agroforestry research and development activities. However, most of the activities have been carried out on *an ad-hoc* basis. To co-ordinate the efforts, the National Agroforestry Working Group (NAWG) was formed in the

country with members from all institutes involved in agroforestry research, development, education and extension including non-governmental organizations (NGOs). BARC is acting as the secretariat for NAWG and a Member-Director (Forestry) is working as its Convenor. The members of NAWG meet at least twice a year to review the progress and develop future programs. In addition, the NAWG secretariat arranges training workshops and study visits for the members to exchange ideas among the member organizations.

RWEDP is involved in the development of woodfuel in its fifteen member countries in Asia. The project is funded by the Government of the Netherlands. Through meetings, workshops, study tours and other training activities it has helped key personnel of the region's energy and forest departments, NGOs, and research institutions to initiate and strengthen their own activities on wood energy related issues. It has resulted in the creation of an informal network of wood energy specialists in the region. The RWEDP activities have contributed significantly to increasing awareness of the wood energy situation in most of the member countries. RWEDP provided funds for this workshop.

1.2. Participants

A total of 17 participants from all SAARC countries except Maldives attended the training workshop. Participants were from different disciplines but most of them had some exposure to forestry. Of the participants, three had a Ph.D., five had a B.Sc. (Forestry) and seven had M.Sc. degrees. Twelve participants were from government organization, two from non-governmental organizations, two from universities and one from an international organization. The age range of the participants was 24-55 with an average of 39 years. A full list of all prarticipants and resource persons can be found in Annexure 2.

1.3. Objectives of the Workshop

The overall objectives of the workshop were to assess the state of woodfuel production in the region and develop management strategies including the integration of woodfuel production in forestry, agriculture, and other land based production systems. The specific objectives of the workshop were:

- To network participants from governmental, non-governmental and private organizations and academics who can contribute to integrating woodfuel production in forestry/agroforestry, agriculture and rural extension programs in South Asia.

- To enhance the capacity to plan and implement integrated forestry/agroforestry, agriculture and rural extension programs in RWEDP member countries in South Asia through the exchange of information and experiences on integrating woodfuel production, distribution and marketing under different production systems.

- To develop country capability to design and implement national workshops/training courses that aim to integrate wood energy production, distribution and marketing in forestry/agroforestry, agriculture and rural extension programs, also from the view point of enhancing economic development by promoting sustainable landuse practices.

- To identify and plan a follow-up training activity at the national level, within the scope of RWEDP.

1.4. Production and Utilization of Woodfuel in the SAARC Countries

Introduction

In the SAARC (South Asian Association for Regional Cooperation) region woodfuel is the main source of energy. The traditional energy consumption range varies from 22 to 93 percent. The natural forests are however, over utilized with consequent deforestation (table 1). The rate of deforestation of natural forests varies from 0.57 percent in Bhutan to a maximum of 4.95 percent in Bangladesh (FAO 1995).

Table 1. Rate of deforestation of natural forests and rate of plantation

Country	Rate of deforestation of natural forests (percent)	Rate of Plantation (percent)
Bangladesh	4.95	5.23
Bhutan	0.57	5
India	0.66	7.63
Nepal	1.08	7.68
Pakistan	4.15	2.5
Sri Lanka	1.55	4.32

Source: FAO (1995)

Alarmed by the high rate of deforestation, massive programs of afforestation have been undertaken by the respective countries of this region (table 1). It is interesting to note that forests in the region no longer play the major role in the supply of woodfuel. Most of the woodfuel supplies come from non-forest sources such as home gardens, village woodlots and farm lands.

There exists a wide gap in the overall demand and supply situation of woodfuel. With rapid population growth the gap between demand and supply is widening. Precise data on demand and supply are also difficult to get because of the fact that until recently woodfuel was not considered as a tradable commodity. As people had free access to the forests for forage, leaves, twigs etc. data on the amount of woodfuel collected from forests are lacking, although data on growing stock are available.

The forest cover and biomass (in million tons) of the region is given in table 2.

Table 2. Forest cover and biomass in the SAARC region

Country	Forest and other wood land (1000 ha)	Percent of land under tree cover	Biomass (million tons)
Bangladesh	1472	8	104
Bhutan	3168	60	508
India	82648	22	4806
Nepal	5751	37	549
Pakistan	3128	3	203
Sri Lanka	3998	29	198

It appears from table 2 that Bhutan has the most pronounced tree coverage (60 percent) followed by Nepal (37 percent); Pakistan and Bangladesh have the lowest. As Bangladesh is a densely populated country, the fact that the per capita forest land is the lowest in the region (0.01 ha), is no surprise.

Increased tree planting in forests and non-forest areas should be the strategy for enhancing the tree cover of the country in order to meet the woodfuel demand as well as to maintain the country's environmental equilibrium. This should be followed by improving the conversion efficiency of woodfuel by introducing energy saving cooking stoves and planning energy efficient woodfuel production and distribution systems.

Woodfuel Production and Agroforestry

As mentioned earlier, the contribution of non forestry sources to energy supply still dominates the energy balance of most of the countries of the region. In the future, the focus for woodfuel production should be in the rural home gardens, village and farm lands. In this context agroforestry in private and public lands could be a potential production strategy in this region. The countries of this region would be much better-off if they could integrate woodfuel production into agroforestry and other land based production programs.

Marketing

Any marketing effort starts with a needs analysis of the beneficiaries/customers. In woodfuel marketing the first step is to assess the needs of the target group. Again the need for fuelwood depends on many factors such as consumption pattern i.e. domestic or industrial use, climatic factors and socio-cultural aspects etc. In this region most of the woodfuel is utilized for domestic use, that is, for cooking and heating. The channel of distribution and pricing is also a very important factor in marketing. In most cases the producers do not get a reasonable price for their products because the channel is mostly controlled by intermediaries.

2. TRAINING PROCESS

The training workshop was designed for six days and started with an appraisal of the general woodfuel situation and policy in the region followed by presentations of case studies of participating countries. These are summarized in Section 5 and the complete papers can be found in part 2 of this proceedings. These were followed by a one day field visit to see the agroforestry initiatives of government and non-governmental organizations and a visit to the wood based cottage and small scale industries to appraise the utilization and marketing situation. The next part of the workshop was structured to present the findings of the field visit in terms of current situation, constraints and possible solutions of problems connected with woodfuel production, utilization, marketing, training and extension aspects. The technical session of the workshop ended with a training need assessment of the participating countries for increased and sustainable woodfuel production.

All the presentations by resource persons were followed by open discussions among the participants.

3. PARTICIPANTS EXPECTATIONS

The technical session of the workshop was preceded by an exercise designed to identify the expectations of the participants. The participants spelt out the following expectations from the training workshops:

- Assess wood fuel production and consumption pattern in the region and determine immediate actions needed for sustainability of wood fuel production and supply
- Identify training requirements for sustainability of wood fuel production
- Transfer of techniques/methods for optimizing woodfuel production from non-forest areas
- Review experience of wood energy planning of SAARC countries
- Develop a data base for woodfuel for the region
- Assess the role of wood energy in the socio-economic fabric of the region
- Develop strategy for increasing wood fuel production in the region
- Develop management strategy for both degraded forest land and non-forest land for production of wood fuel
- Explore plausible processing of woodfuel for increasing energy efficiency
- Find out pragmatic alternative energy sources to woodfuel
- Ascertain the education and extension services needed to support enhanced wood fuel production

Coincidentally, the sponsors' objectives of the workshop are more or less congruent with the expectations of the workshop participants.

4. BRIEF COUNTRY REPORTS

The participants presented their experiences of woodfuel production programs in their own countries. The presentations were mostly based on particular localities rather than the countries as a whole. Summaries of the presentations are provided below:

India (Haryana)

India is a country of 329 million hectares, of which Haryana State comprises 4.4 million ha. Agriculture is the mainstay of the economy of this state with 82 percent of the population engaged in agriculture. Forest cover, including plantation strips, is only 3.8 percent, while 7 percent of the total land area is community land. Wood is primarily used as the major fuel and wood fuel is the main source of energy. There is a wide gap in wood supply and demand, and supply comes from home gardens and farm forests. Production from state forests is unusually low only 1.0 - 1.5 m^3/ ha/ yr. However, the yields from community land (3.0 - 4.0 m^3/ ha/ yr) and farm forestry (7.0 -12.0 m^3/ ha/ yr) are higher. Haryana is dry and semi-arid in nature. Tree growth is constrained by water scarcity. Lack of efficient marketing systems result in an unequal supply and some areas have a wood surplus while others have a deficit.

Due to the introduction of a state sponsored extension network in both the forestry and agriculture sectors, as well as similar activities of the non-governmental organizations, tree growing in all possible land is increasing. Further strengthening of the extension system is needed to cover the whole state and introduce superior quality planting stock to replace the low yielding one. Farmers will continue planting trees or integrate trees in the farming systems as long as they accrue short, medium and long term benefits. Due to the lack of dynamic marketing systems the farmers are not receiving an appropriate price. A buy-back guarantee for the produce is, therefore, essential. Haryana Forest Development Corporation is contemplating taking steps to develop the marketing system to ensure proper distribution and marketing of the produce at a reasonable price to growers.

Nepal

Nepal is 147,181 km^2 in area with average rainfall of 1,500 mm/ yr. Forest produce supply comes from state forests, private forests,community forests, lease holds (households and cottage industries). Due to the absence of a sound forest policy, lack of a system of effective monitoring and evaluation of the existing plantation program, and non-supportive research back up, most of the forestry activities are done on an ad hoc basis and the land can not be utilized to its maximum potential. The current yield is extremely low and most of the species are poor in terms of genotype. Moreover, the prices of forest products are controlled by the government and the producers are not receiving proper prices. Forestry research and the country's extension systems desperately need to be strengthened and the yield from forests should be enhanced. Agroforestry and farm forestry should be introduced to integrate food and wood production to ensure sustainability of agriculture as well as to sustain farmers with short, medium and long

term production. The farmers should be provided with technical support in terms of quality planting materials, technical know-how for planting and upkeep and a marketing system should be developed so that farmers can get an appropriate price which may also include a buy-back guarantee.

Bangladesh

Bangladesh is a densely populated country having over 755 people/km. There exists a wide gap between the demand for and the supply of wood and wood products. Forests supply a rather insignificant amount of forest produce with the majority of the products coming from non-forest areas such as home gardens and marginal land. It is argued that the lands under forests are not utilized to their maximum potential. Forest yields are unacceptably low due to over-exploitation of the growing stock and conversion of land for non-forest activities. Home gardens are more fertile and per unit production is higher than state forests. Forest management policies to combat encroachment and degradation of forests have been implemented since the early 1980s. A participatory forestry program has proved successful in rehabilitating degraded and encroached forest land.

Forestry research in the country is inadequate to meet the current needs for forestry development. Most of the forest plantations are raised without proper knowledge of matching species to site and consequently most of the forest plantations are performing poorly compared to their potential. A shift in traditional forest management is the need of the hour to generate short, medium and long-term benefits to the resource poor farmers. As in other developing countries, there exists no co-ordinated marketing systems for forest produce. In certain areas, there is an acute shortage of fuelwood while in other areas there is a surplus. Attempts are being made to increase fuelwood production but the overall activity is deemed inadequate compared to the growing demand.

Most of the farmers are poor, and need short, medium and long term output for their sustenance. Because of the natural gestation period needed to produce wood of utilizable dimensions, they need to retain trees for a longer period (more than 5 years), but due to financial stringencies, they harvest the trees at the prime growing stage. This problem can be overcome only through developing a suitable credit facility so that trees could be offered as collateral and the loan paid back after harvest of the trees at the desired maturity which will benefit both financial institutions and farmers.

It is believed that forestry activities can be strengthened by strengthening technical support, providing land use management training to the farmers, adopting long-term participatory forestry programs with tenurial guarantee, and intensification of tree planting in all available vacant lands which is in accordance with National Forest Policy and Forestry Master Plan recommendations. A marketing system should also be developed to ensure a fair price for the forest produce.

Pakistan

The site described in the Pakistan presentation was D.I. Khan District of the North West Frontier Province. The area is basically a non-forest zone. Climate is hot and dry. The topography is characterised by a plain and agricultural practice is mostly irrigation based. Forestry development in the district was initiated with the introduction of a USAID funded forestry project which

distributed 113 million seedlings to the farmers for planting in their farm land and marginal land. The main species was Eucalyptus. Though the project achieved success in terms of tree plantation, survival and growth rate, the total effort as yet is inadequate to cater to the needs of people of the area.

People of the district are in general poor and illiterate. There is lack of initiative in tree plantation among the people. They are not conversant with planting techniques, social benefit of planting trees and the extent of return from planting eucalypts.

After the planted trees attained pole size at the age of 5-7 years, the trees were harvested and used for construction works, mostly as roofing frame materials . Recently, the produce has been sold to the wood based industries for making chip board. Biomass of eucalypts is being used as household fuel.

As in other developing countries, marketing is not properly developed. The produce are purchased by middlemen at a low price and sold to the traders at a higher price. This system deprives resource poor farmers from getting their due share of profits.

It is envisaged that for wide scale adoption of forestry activities in the area, extension and management support is essential. A marketing system, including a buy-back guarantee, is needed for maximizing the benefit to the farmers. Training of the farmers is also needed for nursery establishment and management techniques.

Sri Lanka

Forest cover of Sri Lanka is 11 percent of which 7 percent is natural forest and 4 percent is plantation. Non-forest area covers 71 percent and 17 percent is land under other uses. Home gardens constitute 26 percent, crop land 19 percent, land under coconut is 19 percent, and rubber 7 percent. Home gardens produce the majority of forestry products (61 percent) and the remaining 39 percent comes from other sources.

Availability of land has been identified as the major limiting factor for a forestry production system. Lack of appropriate forest policy and linkage with other land uses is also important. Most of the land is owned by a few rich people. Such lands are leased to the resource poor farmers on an annual basis. Tenurial uncertainties discourage farmers from investing their maximum potential in production systems. Most of the lands are therefore underutilized. The yields are low. A well defined land use policy is lacking.

Forestry activities by the Forest Department are limited to state forests. There is virtually no forestry extension service. Home gardens and farm forestry are age old practices. Though the yield of such home gardens and farm forestry is higher than state forests there still exists great potential for improvement and yield increase.

Marketing of forest produce is a real problem in forestry development. Forest Plans are developed to cater to the needs of the forest dwellers and people living in the periphery of the forests but when the crops mature, the products are sold to big consumers, mostly urban based, through contractors ignoring the needs of the local inhabitants. Trees grown in home gardens are sold by the farmers to the local industries but through middle man which deprives farmers of due financial

return. A transportation permit is needed from the Government (Forest Department) for movement of forest products which discourages people from planting trees as selling of net products is cumbersome. Similarly, tree plantations are also raised by the contractors. Unless a sustainable infrastructure is developed, forestry activities will not be attractive to the resource poor.

It is therefore envisaged that to improve the forestry situation, extension services should be strengthened and intersectoral linkages should be established. A land use policy should be formulated and land management system should be developed. All marginal and vacant land, including lands of common interests, should be brought under tree cover, and landless and marginal farmers should be integrated into the production systems through benefit sharing. A good marketing system, including buy-back guarantees, is needed to encourage people to grow trees.

As forestry is a long term activity, a credit system should be developed to sustain resource poor farmers. Such a credit system should allow farmers to use trees as collateral for loans. Subsidies for tree plantation inputs, including the cost of seedlings, are essential. Contradictory state policies such as encouraging people to plant trees and at the same time imposing an intricate transit pass system for the movement of produce should be done away with. All land based development programs should be launched in an integrated manner so that the interests of one sector does not conflict with the interests of others.

Bhutan

Bhutan is a predominantly agrarian country and 80 percent of its population stay in the rural areas. The Bhutanese farming system is heavily dependent on fuelwood, timber, fodder, leaves and other minor forest products. Out of a total of 4 million hectares land, 2.3 million hectares are under forest cover, including 0.232 million hectares designated as degraded forests. The annual domestic need for fuelwood is estimated as 1.12 million cubic meters.

More than 80 percent of the country's energy needs are met by wood energy. This is used for cooking, heating, agro-industries and other purposes. The main source of fuelwood is natural forests. Wood energy from agri-residues and private woodlots is insignificant. However, it is difficult to get data on utilization because no report is kept as to how much wood and fuel wood or litters are taken from the forest. Because 90 percent of the settlements are adjacent to forest areas and the people can take whatever forest products they need without any restrictions, marketing and extension services in Bhutan are still rudimentary.

5. Participatory Approach in Extension Methods

An overview of various extension methods and the advantages of participatory decision making in household decisions was presented by Rene Koppelman (APAN). This is summarized below.

In most of the countries of the region the major share of woodfuel currently comes from non-forest areas (rural homestead and farm land boundary situations). Land use practices in non-forestry situations should thus incorporate woodfuel production so as to ensure its sustainability. This could best be achieved through farm extension activities. The more the extension programs are based on an understanding of the local needs, edaphic and socio-cultural backgrounds, technical suitability, market situations, support services, etc., the higher is the rate of success likely to be. This suggests the need for appropriate participatory mechanisms. To help design appropriate participatory interventions in a woodfuel development program, a framework has been developed for analyzing farmers household decision making (Fig. 1).

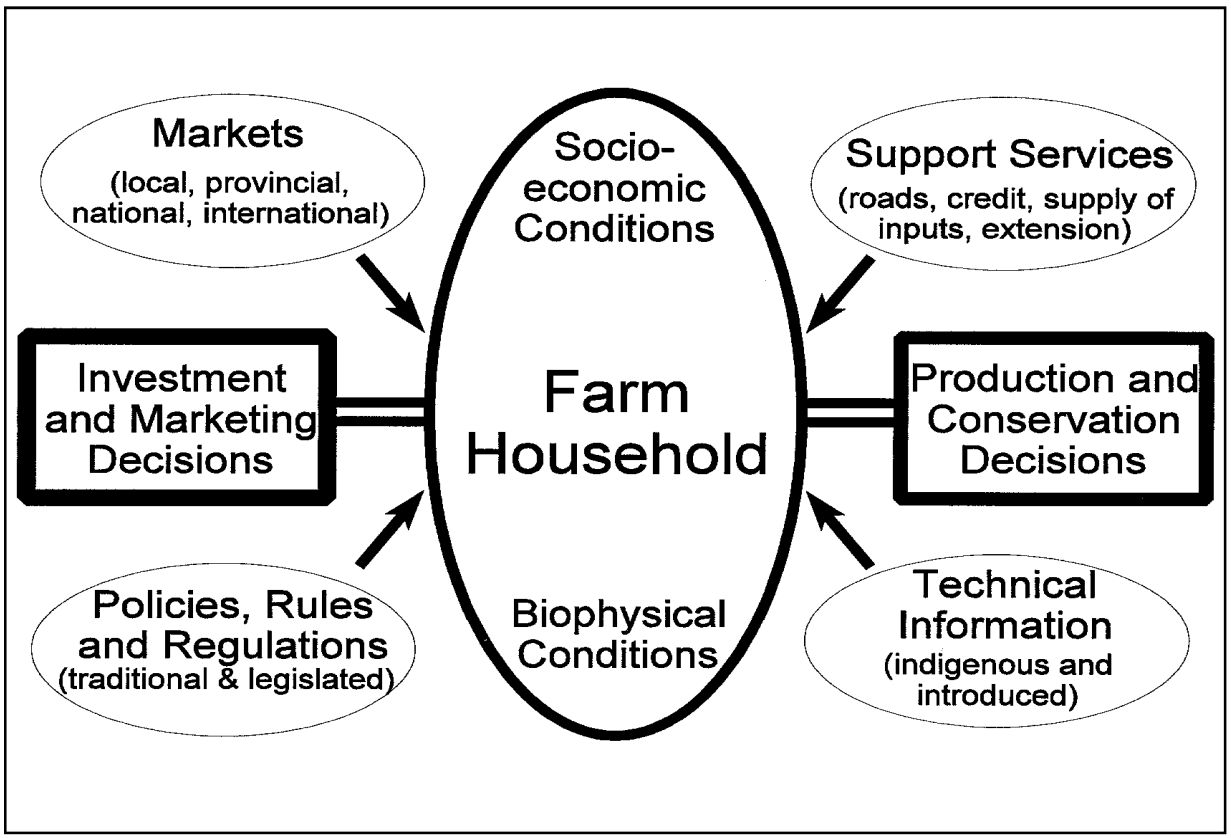


Fig. 1: Interactions Between All Factors Influencing Household Decisions

6. FIELD EXERCISE

Field visits were made to Bhannara agroforestry plots, Chandra woodlot plantation center and Mirzapur participatory forestry program.

In order to organize the participants' observations a framework (see Annexure 4) was prepared in advance by RWEDP and distributed to each participant. This framework indentified 3 major aspects/issues for consideration:

- Production and utilization
- Marketing
- Extension and Training

After the field trips the participants were split into three groups to identify current situation, constraints and suggest possible solutions in respect of each of the above identified issues. The results of the field exercise are summarized below:

6.1. Production and Utilization

Current Situation

Production

Most of the timber and fuelwood in the region come from non-forest lands such as home gardens and farm lands. The major timber and fuelwood species from these sources are mango and jackfruit. Sal and mangrove forests are the major sources of timber and fuelwood coming from the public forests. Furthermore, agroforestry and wood lot production programs in state forests also supply timber and fuelwood. Eucalyptus and acacias are the major species in the agroforestry and wood lot programs.

Utilization

Wood based industries consume timber. Households, cottage and agro-based industries (pottery, soap and brick), and restaurants are the main consumers of fuelwood and non-commercial timber.

Constraints

Technical

In the recent past, the spacing used in forestry plantations was 2 x 2 m, disregarding the growth characteristics of the species. Forestry Working Plans were not based on site suitability for species; rather selection of species was based mostly on the demand of the industries and market for maximization of profit from land. Thinning regime and rotation were also not decided on the basis of growth pattern. Consequently, either the crops were harvested before they produced maximum wood over time or beyond economic production time.

Financial

Because of the high investment requirement most forestry operations in the past remained a state affair, except for homegardens which provide significant forest produce and are managed for fruits and fencing around the living quarters. In most cases, after the harvest of a given crop, the same crop is repeated which, in certain cases, tends to threaten the sustainability of the forests. However, in some situations, it is economical if the successive crops originate from coppices.

Managerial and organizational

The involvement of people in forestry activities is a recent phenomenon. Traditional forestry did not acknowledge the need for peoples' participation in forest management. Consequently, the state forest service is not geared to motivate and organize people for community participation in forest management. Attempts, however, are now being made by the government and non-governmental organizations to involve people, including women, in forest management. Different models are being tested in the region and some success stories have emerged which are directing changes in traditional forest management systems.

Solution

A long term sectoral plan is a pre-requisite for forestry development and this should integrate people's participation into land based production systems. Monitoring of development activities will help modify a program, should such modification become necessary, to cater to the peoples' needs. Multipurpose tree species should be given priority over only timber or fuelwood producing species. Research should be strengthened to develop quick growing, high yielding varieties suitable to the site, and biotechnology should applied to improve genetic constituents including genetic conservation. Governments should increase the budget allocation to strengthen forestry activities.

6.2. Marketing

Current Situation

Forests produce not only timber or fuelwood but also a host of other products and play a vital role in environmental conservation. The consumers of forest products are also diverse. Common tree species that produce multiple products are mango, jackfruit, raintree, koroi, and palms. The wood products are sold in different sizes and quantities such as small logs, branch wood, billets, twigs, leaves, root-stocks, split woods, planks, bole and pole. Prices vary with the season and with consumers. Resource poor farmers are involved in marketing the produce from home gardens but the legal requirement for transit passes or permission for felling makes the whole system cumbersome and tends to be counter-productive. Though there are arguments both for and against the existing system a change in the system is likely to increase forestry development and enhance tree plantation activities in the region.

The wood marketing system prevalent in the region is depicted below:

Marketing Channel

Tree Owner	Tree Owner	Tree Owner	Tree Owner
Fuelwood Collector (Primary Supplier)	Fuelwood Collector (Primary Supplier)	Broker	Purchaser (Villagers)
Sub-urban/Urban Fuelwood Depot	Sawmill Complex	Fuelwood Collector (Primary Supplier)	Twigs and branches are collected by the poor
Consumer	Furniture or Fuelwood Depot	Secondary Supplier	
		Big Consumers/ Industries	

Constraints

Though there exists a fuelwood scarcity throughout the region, the existing marketing system is consumer governed. There exists no opportunity to receive a price advance against tree ownership. Purchasers take advantage of the growers' poverty and pay as little as possible for the produce. Middlemen play a vital role in the marketing system and gain the maximum benefit. There is no marketing assistance from any organization, governmental or NGO. Growers are not aware of the price development in the consumption centers. The fuelwood thus produced goes to the traders mostly for urban supplies while shortage of fuelwood exists in the rural areas. Due to the acute shortage of fuelwood people are switching over to poor quality fuels such as leaf litter and animal dung. Lack of infrastructure development, interference and harassment by law enforcment agencies while in transit also hinders free transportation and affects marketing systems.

Possible Solution

As most of the farmers are poor, they try to reap immediate benefits by selling trees instead of retaining them till maturity when they could fetch more money. Credit facilities would ameliorate the situation and help to change farmers' attitudes and increase incomes as well. Infrastructure development is a prerequisite for marketing. Unless infrastructure development takes place, transportation, marketing information and an appropriate distribution system will be affected. Legal restrictions on the in-country movement of forest produce should be eased or removed altogether. There should be no subsidy on modern fuels. Attempts should be made to select fast growing fuelwood trees and plant them around all vacant spaces.

6.3. Extension and Training Services

Current Situation

It has been observed that throughout the region, the forestry extension system is inadequate. Forestry research and extension does not receive due attention in national development plans. Research, development and extension should go hand-in-hand to achieve maximum results. Though there are organized agricultural extension services throughout the region, interactions between the forestry and agricultural sectors is lacking. Home gardens and farm land are the

major sources of forest produce and these are primarily the arena of agriculture. For substantial improvements in the current situation the integration of forestry and agriculture is essential.

Constraints

Traditional forest conservation and management is policing in nature. Such policing practices are nowadays constrained by man-power limitations. Only recently has the integration of local people in forest management received proper attention. To intervene at the grassroots level, particularly in home gardens and farm land situations, the involvement of both agricultural extension services and non-governmental organizations is essential.

Research in forestry is inadequate and ineffective. Hence, in most cases it does not provide site specific production technology. Moreover, forestry research is limited to forest areas only and research on home gardens and farm land is either non-existent or extremely limited.

Possible Solutions

Forestry research should be strengthened and extended to home gardens and farm lands. Forestry and agricultural extension services should be integrated into forestry projects in home gardens and farm lands. Farmers should be trained in forestry technology to increase per unit area of production of wood as much as for sustaining agricultural production. Appropriate management strategies for combined food and wood production at farm level should be developed.

7. MINI PROPOSALS FOR NATIONAL LEVEL TRAINING PROGRAM

The participants agreed on the importance of creating awareness among planners and resource producers of the need to integrate wood fuel production into other sectoral programs in order to meet the people's demand for woodfuel. In order to achieve this goal the participants developed mini proposals for in-country training programs in their respective countries. The proposals are reproduced below:

India

Title: Training program on wood fuel production techniques for key persons

Justification

Currently, the benefits of agroforestry are not effectively percolating to farmers. It is imperative to have an integrated approach to achieve the goal of enhancing the capabilities of farmers to produce sufficient quantities of wood fuel to meet the demand. A training program for key persons would be an appropriate means to disseminate information on agroforestry.

Objectives

- To train key persons in agroforestry models so as to boost woodfuel productivity.
- To identify possible constraints and remedial measures
- To establish a direct link between producer and user for affording maximum benefit to the tree growers.

Success criteria

- A list of constraints and remedial measures
- Participants develop capability to organize training programs at local level

Activity Work Plan

What	When	Where	Who
Training program for key persons	February 96, 4 days	NBRI, Lucknow (UP), India in collaboration with State Forest Department	i) Key persons from various organizations (30) ii) Resource persons (5)

Inputs required

Internal: Resource persons and facilities of the host organization, communication materials.

External : US$ 4000 for extension material, travel, honoraria and publications

Expected outcome

- Participants will be able to disseminate locally developed specific agroforestry models.
- Participants will be able to organize local training and arrange training materials
- Participants will be able to list constraints and design possible solutions for these

Bangladesh

Title: Proposal for national training workshop on wood fuel production, utilization, marketing and extension services

Justification

There exists a big gap between the production of and the demand for forest products. Efforts are being made to increase forest production using indigenous and exotic tree species suitable for different dendroecological regions. Studies are also being conducted to find out indigenous wood fuel production technology which can sustain agricultural production as well. There is an urgent need for dissemination of technology in order to extend wood fuel production in fuel deficit areas. As a first step, professionals in agriculture and forestry need to be trained to effect such a widespread dissemination.

Objectives

- To train 30 professionals from research, development, education and extension agencies, including non-governmental organizations on production, utilization, marketing and extension
- To share experiences and knowledge of wood fuel production.
- To develop sound methodologies for field level extension through participatory approaches

Success criteria

- Selection of appropriate trainers and ensuring their participation
- Appropriate combination of theoretical knowledge and practical demonstration
- Development of sound training methodologies

Activity work plan

What	When	Where	Who
Organize Workshop	March 1996	Comilla (BARD)	Forest Department and BARC

Inputs required

- Internal
  - Resource persons
  - Training facilities/aids
  - Energy saving devices for demonstration
- External

Financial support of US$ 4,000 to cover the costs including field visit for case study, production of training materials, and publications.

Expected output and applications

- Enhancement of capability of trainers to disseminate knowledge and skills
- Development of methodology for assessment of wood fuel situation and related problems of a particular locality and for proposing possible solutions

Pakistan

Title: Training of the trainers in wood fuel production under different agroforestry systems in Pakistan

Justification

In Thal and Hurry districts of Sind province, wood fuel production has become an integral part of the farming systems. Such production systems are very important for the sustainability of agriculture and meeting wood fuel needs. In order to disseminate the technology, training of forestry extension staff is essential.

Objectives

- To improve insight and understanding among the extension staff of wood fuel production and marketing systems.
- To help forestry extension staff to replicate the success stories to other parts of the country.

Success criteria

- A list of the resource persons/trainers from government departments and elsewhere who are actively contributing to wood fuel production systems in central and southern areas of the country
- Sound recommendations for improving wood fuel training methodologies and curricula

Activity plan

What	When	Where	Who
Organize a training program for trainers from central and southern areas in wood fuel production	March 1996 for 7 days	Pakistan Forest Institute Field Station at Ratta Kalachi in Dera Ismail Khan in NWFP	About 20 participants from the whole country

Input required

- Internal
  - Trainers/resource persons, training facilities, woodfuel workers and production models
- External support required
  - US$ 3000 to cover meals, night halts, travel expenses for participants, training materials and other expenses besides the expected US$ 2000 contribution of Government of Pakistan

Expected outputs and applications

Twenty persons will be trained from various line agencies and NGOs who will help in further training of the extension agents and farmers.

This human resources development program is likely to go a long way in accelerating wood fuel production systems in the country.

Nepal

Title: Training for DFO, TCN and Officers in the Field of Forest Utilization (Wood Fuel and Timber)

Justification

The Timber Corporation of Nepal (TCN) is the main supplier of fuel wood and timber in Nepal. This organization and Forest Department (FD) are working under separate ministries. There is a need to train both TCN and FD officials in the field of forest utilization.

Objective

- To enhance the capability of TCN and FD in the field of forest utilization

Activity work plan

What	Where	When	Who
Organize a training course for FD and TCN officials in the field of forest utilization	Kathmandu/Hetauda	December 1995 for 3 days	WECS and Ministry of Forests

Input required

RWEDP will be requested to supply a grant of US$ 4000 to defray the cost of food, lodging, honoraria and transportation

Expected output

Officers of TCN and the forest department will be able to interact and coordinate their work to promote effective solutions to timber and fuelwood utilization problems.

Sri Lanka

Title: Integration of wood fuel production into land use systems

Justification

Up to the present, no training workshop has been conducted on wood fuel development in Sri Lanka. There is a need to prepare wood fuel specific training materials and conduct training workshops to enhance the capacity of the staff of forestry, agriculture, IRDPs, to identify, plan and integrate wood fuel production strategies.

Objectives

- To strengthen the capacity of senior officers in woodfuel sectoral development
- Open up opportunities to share, discuss and identify potentials for integrating wood fuel production into sectoral planning
- Develop methodology, materials, and programs that can be adapted to local conditions.

Success criteria

- Successive local level training programe
- Contributions and work outputs of trained staff

Activity workplan

What	When	Where	Who
National Training Workshop (including study tour)	1996 March/April	University of Peradenya (Kandy)	33 Trainers; 10 Forestry, 13 Provincial Agriculture and 10 IRDP personnel

Inputs required

- Internal
    - Training facilities, trainers/resource persons, materials (case studies), production models
- External
    - US $ 4,000 to cover meals, travel, training material development

Expected outputs

- Intersectoral collaboration among responsible sectors
- Identification of issues to be addressed in provincial development
- Mechanism for executing programs
- Future training programs

Bhutan

Title: Training of extension staff

Justification

Bhutan has a very limited number of forestry extension staff. The geographical areas the extension staff have to cover are currently too large and the staff are not adequately trained. There is an urgent need for training to disseminate the technical know-how developed in the recent past in Bhutan and neighboring countries.

Objectives

- To upgrade the technical know-how of the forest extensionists (selected farmers)
- To improve the degraded fragile mountain areas and meet domestic needs for woodfuel
- To train and recruit more extensionists to meet forestry development needs.
- To cover degraded private land with forest cover

Activity work plan

What	When	Where	Who
Training Workshop	November -December 1995	Trashigong (District)	Jointly by ISD and external agents
Training Workshop	Jan-Feb 1996	Yongtsi (District)	Jointly by ISD and external agents
Training Workshop	April-May 1996	Punakha (District)	Jointly by ISD and external agents

Inputs required

- Extension specialists
- Extension materials

External

US $ 3500 for each program. This budget includes DSA for specialists, resource persons, participants, transports and extension materials.

Expected outputs

45 forest extensionists will be trained in various aspects of community forestry that have been developed in Bhutan as well as elsewhere.
Trained extensionists will spread the benefits of their training to the key areas under the Dzongkhags (districts).

8. COURSE EVALUTION

8.1. Overall Evaluation

In general all technical aspects of the course were evaluated positively, although some participants suggested that marketing of woodfuels should have been covered in greater depth and the field trip would have benefited from being lengthier and from covering non-forest areas as well. It was also felt that more case studies would have been valuable.

There was wide satisfaction regarding logistics, course infrastructure and the organization of the course, but some participants suggested that it would have been better if they had been informed of their expected roles in the workshop prior to attending. This, they believed, would have enabled them to make fuller and more effective preparations.

The majority of participants expressed the opinion that the first two objectives of the workshop, namely those related to networking and integrating woodfuel production into sectoral planning, had been achieved but they were equally divided over the third objective regarding developing the country capability to design national workshops or training courses.

8.2. Skill Assessment

To assess the impact of training on the skill development of the participants, a set of questionnaires was supplied to them at the beginning of the course. The responses of the participants on the pre-course questionnaire was compared with their responses at the end of the course on the same set of questionnaires. The questionnaires included three major aspects, namely, production of woodfuel, rural extension and training. In the case of each of the aspects the participants showed marked positive change in their state of knowledge at the close of the workshop. The rate of improvement is graphically represented in the following charts:

Chart 1. Change in state of knowledge on the production of woodfuel

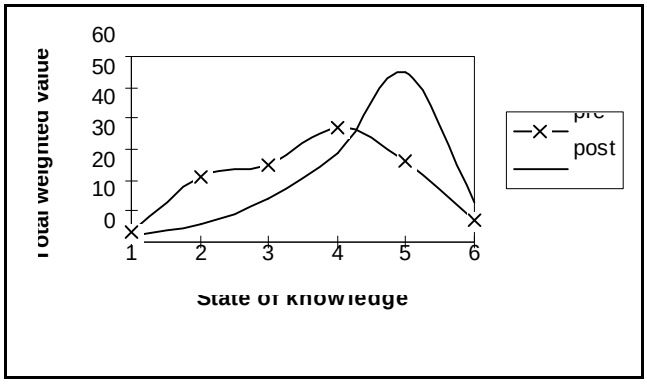


Chart 2. Change in state of knowledge on rural extension

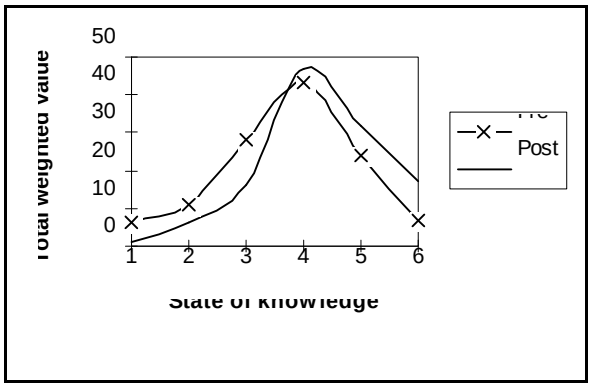
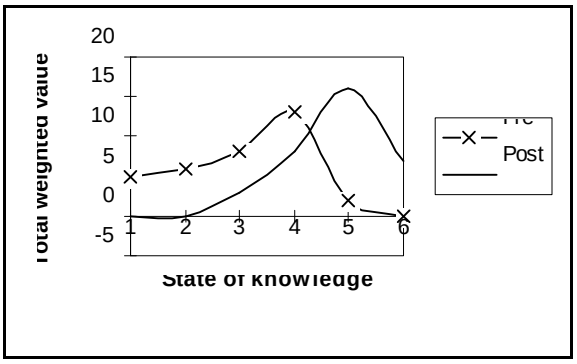


Chart 3. Change in state of knowledge on training



Annexure 1

INAUGURAL SESSION

Speech of the Representative of the Regional Wood Energy Development Programme in Asia (RWEDP) Mr. Tara N. Bhattarai

Chief Guest and Secretary of the Ministry of Environment and Forests, Deputy Chief Conservator of Forests Mr. Syed Salamat Ali, Officials of the Workshop Preparatory Committee, Distinguished Delegates and Guests

First of all let me welcome you all on behalf of the Regional Wood Energy Development Programme (RWEDP) in Asia to this inaugural session of "The Training Workshop on Integrating Woodfuel Production in the Implementation of Agriculture, Forestry and Rural Extension Programmes in South Asia", in Rajendrapur, Dhaka.

This occasion has provided a pleasant opportunity to RWEDP to congratulate the Government of Bangladesh which has generously accepted our proposal to host this sub-regional workshop for the seven countries of South Asia, who also belong to the common regional group SAARC.

FAO recognizes the important role played by wood energy, including different types of biomass, in providing domestic energy for a majority of the population, particularly in South Asia. Therefore, the development of wood energy has been given a high priority within the energy and power sectors in this region. In this effort the Government of Netherlands has been playing a crucial role by providing uninterrupted financial assistance since 1984.

RWEDP aims to assist in the integration of wood energy into the policies, plans and programmes of its 15 member countries in Asia, and this particular workshop is the second in the series dealing with the prospects and problems on the resources side. The first of its kind was held in Bogor , Indonesia, in April, for the eight member countries of RWEDP in the South East Asia region.

During the past two phases of the programme, RWEDP concentrated more on looking into the issues which were either completely unknown, or mostly ignored as unimportant and insignificant, as the interest and priority of most counties was, and continues to be, biased towards the development of the so called "modern energy" sources (i.e. hydro-, thermal-, nuclear power, etc.). This thinking should be changed in the developing countries of Asia since traditional sources contribute significantly to total energy consumption in virtually all countries as far as the majority of the rural population and small scale processing industries and commercial activities are concerned. However, it has to be admitted that this situation is unlikely to change very soon. Therefore, this particular workshop aims to improve the capabilities of governments and, private and community based organizations in implementing wood energy strategies and programmes that will assist woodfuel producers (e.g.farmers) to generate additional income from involvement in the wood energy sector and in producing forest and tree products.

Studies indicate that, up to 50-70 percent of woodfuels consumed by local people comes from non-forest areas, which include fallow lands, scrub and grass lands, agricultural lands, trees on homesteads, home gardens, along roads, river and canal banks, etc. Although important from many different point of views, forests only contribute between 25-50percent of the total wood fuel consumed and this portion of the supply is primarily used by urban populations, and in traditional processing and manufacturing industries and numerous other commercial activities, where woodfuel is considered as a traded item. For the poor and landless, non-traded woodfuels from less desirable tree species and other easily available inferior biomass are the common energy sources, which are invariably collected free of cost. The people of South Asia present a typical example of this type of energy user, whose attempts to meet the energy needs from freely collected sources are, to some extent, conditioned by population growth, deforestation and degradation of land.

Therefore, the key issue now is, how to harmonize woodfuel production for the market and the rural poor? The former as a commercial undertaking, and the latter as a social programme for the poor and landless who cannot afford to purchase woodfuel for domestic use.

Most of the countries in South Asia have a tradition of raising trees in private lands. Woodfuel produced in non-forest lands already constitutes a major share in Bangladesh (87 percent), Pakistan (90percent) and Sri Lanka (75 percent). The importance of trees grown in non-forest lands is gaining wider recognition in virtually all countries in the sub-region. In this context the present training workshop provides an opportunity to network participants who can contribute to integrating woodfuel production into farming systems; to enhance their understanding and capacity to plan and implement integrated programmes; to develop their capability to design and implement national workshops/training that aim to integrate programmes of wood energy development into other sectoral plans.

I sincerely hope that the meetings and field observations planned for the next five days will provide an unique opportunity to participants to interact with one another and identify follow-up regional, as well as country-specific, activities within the scope of RWEDP meetings.

Before I conclude, once again I would like to extend my warm welcome to the Chief Guest and other dignitaries to this inaugural session of the workshop. And to all distinguished participants and resource persons, I extend my best wishes for a successful workshop and a happy and memorable time in Dhaka.

Thank you all!

Inaugural Address by Chief Guest Mr. Syed Marghub Murshed, Secretary, Ministry of Environment and Forests

Mr. President, distinguished resource persons, colleagues, distinguished guests, ladies and gentlemen:

I consider it to be a great privilege to be able to take part in the inaugural ceremony of this very important Sub-Regional Training Workshop.

I take this opportunity to thank the RWEDP for selecting Bangladesh,where wood is the main source of energy supply for a great majority of the population in the rural, as well as, urban areas, as the venue of this important workshop.

While estimates vary on the quantity and type of bio-mass energy fuel used in the country, reviews of these estimates by the World Bank and FAO indicate that fuel energy is derived 66 percent from wood, 18 percent from leaf litters, 6 percent from dried cow dung and the remainder from commercial energy sources. From these figures the importance of fuel wood in the rural economy of Bangladesh is obvious. Through afforestation, agroforestry plantation schemes, strip plantations, afforestation on vacant tea garden lands and massive coastal afforestation which have been undertaken by the government under the forestry sector master plan and other project plans, we may be able to deal with supply shortages in an adequate manner. Homesteads in villages also under the afforestation programme are one of the most promising sources of fuel wood production.

Wood, in its raw form, has a long history of use as fuel all over the world. Problems, like the greenhouse effect, have caused concern among environmentalists and others and have led to a serious search for a cleaner and less polluting energy source than forest fuels. As such there is a need for technological innovations in the production and supply of wood fuel in converted/reconstituted forms, that are less harmful to the environment. I expect technical and research organizations to come forward to provide us with a viable solution. While elaborate plans have been prepared, the task of implementation and technical supervision lies with the concerned agencies, especially the Forest Department. I urge the professional foresters to take up this challenge to implement programmes in an effective manner.

I understand that distinguished delegates from a number of foreign countries are attending this workshop. Their Bangladeshi counterparts will gain valuable experiences while working with them. I wish to express my gratitude to the RWEDP for financing this workshop.

I am confident that this workshop will be able to meet the objectives for which it was organised and will recommend implementable measures to ameliorate the wood fuel situation in our region.

This inaugural session, I am confident, will be followed by lively and highly interesting professional sessions. Before I return to my seat, let me wish the foreign participants attending this workshop a pleasant and enjoyable stay in Bangladesh.

With these words, I declare the workshop open. Thank you, Ladies and gentlemen for listening to me so patiently.

Inaugural Address by Special Guest Mr. A. Latif Mondal, Joint Secretary, Ministry of Environment and Forests

Mr. Chairman; Honourable Chief Guest and Secretary, Ministry of Environment and Forests, Government of Bangladesh; Mr. Bhattarai of the Regional Wood Energy Development Programme (RWEDP); our honoured guests and resource persons from home and abroad; distinguished workshop participants from the SAARC countries; ladies and gentlemen,

Assala-mu-Alikum.

I deem it a great honour to be present here this morning in your midst for the inaugural ceremony of this sub-regional training workshop on "Integrating Wood Fuel Production in the implementation of Agriculture, Forestry and Rural Extension Programme in South Asia".

Never before has the world community as a whole so overwhelmingly become aware of the consequences of human activities on the environment and so strenuously voiced global concern about the need for conscientious management of mother earth as at the UNCED, 1992. On this account, we owe a special thanks to the organizers of that far sighted and truly effective Earth Summit. In the context of most of the developing countries of Asia, Africa and Latin America, biomass energy, of which wood fuel is the foremost component, still continues to dominate as the major energy source for domestic cooking and heating, food processing and agro-industrial energy supply. The biomass, having its origin from trees, herbs, shrubs and agricultural crops, is also responsible in a big way for the maintenance of ecological balance and environmental equilibrium of the planet earth. The biomass is, however, under the serious threat of humans and their domestic animals. Many countries are in serious trouble, facing biomass destruction for essential energy supply. The present training workshop thus has a special focus on the environmental situation facing mankind. I, therefore, attach special importance to the holding of this training workshop, so timely for our region, and eagerly await its outcome and recommendations.

Ladies and Gentlemen,

Our region has a very old history, as old as the history of mankind. Mythologically, the first man on earth, Adam, is said to have been dropped from heaven to Srilanka, which is in our region, and that is how we have Adam's bridge there. The Indus valleys civilization with its hub at Mohenjodaro and Harappa, one of the oldest in the world, is located in this region. We have the world's loftiest mountain, the Himalayas. In terms of population, our region supports about one fourth of the world population, a combined strength of about 1.2 billion men, women and children. Geographically and politically its situation is strategic, while economically its importance is highly significant.

I have chosen to cite these credentials only to impress upon you that this region is a very old habitation with its resources exploited on a greater scale than during the pre-historic ages. Now our land is constantly cleared of forests for spatial expansion of agriculture and our wood harvested *inter alia* for domestic and industrial energy supply for the ever increasing population until it is almost non-existent in the form of natural forest cover. As a result we now have a country with as low as 4 percent land area under forest cover (Pakistan) and advancing desertification.

Reversing the wood and fuel wood supply scenario by creating traditional forests out of the land cleared for agriculture would be rather an impracticable and idle thought. But at the same time, there is an urgent need to increase the supply of wood, especially fuel wood, for satisfying the daily needs of the citizens, and also the coverage of forests and tree growing areas for environmental equilibrium. Foresters, agriculturists and other scientists should therefore explore the best possible strategy and action programme to solve the wood energy problems of our peoples and look for traditional as well as non-traditional approaches to augment wood energy supply in our respective countries.

I particularly like the title of the workshop "Integrating wood fuel production into the implementation of agriculture, forestry and rural extension programs". Under the aegis of modern land use techniques like agroforestry and farm forestry, just as we can have food produced on forest land, we can also have wood energy grown on farm land without much detriment to either of the two, usually exclusive, production systems. All that is needed is the evolution of right technology, the appropriate blending of forests and agricultural crops, and the attitudinal re-orientation of the professionals of both the disciplines. I am confident that the professionals of the region, under the moderating leadership of the RWEDP experts, who have assembled here to discuss these important issues will have due regard to the constraints of the land and financial resources vis-a-vis people's demands, and come up with pragmatic recommendations.

I also take this opportunity of impressing upon you, the distinguished professionals and resource persons, the need to bear in mind that this issue concerns the human community living in the neighbourhood of the resource which you are seeking to develop. For any resource to be sustainable in this densely populated, poverty stricken region, the development effort must involve the local people in the production process. I believe, a major effort in wood fuel production should be directed to marginal public and private lands, encroached forest lands, homesteads etc. Without people's sincere participation in the production process and active support in protection, the sustainability of the efforts will remain unrealized whatever appropriate technology may be adopted. The idea of policing to guard such vast open-air property like forests and trees must give way to one of willing cooperation and participation based on some sort of benefit sharing mechanism. I would therefore urge upon the participants to work out the most appropriate and pragmatic mode of securing local participation in resource building and its upkeep, guaranteeing the security of the investment itself as well as of the resources created in consequence of such investment.

The government of Bangladesh has demonstrated its sagacity in taking some momentous decisions in recent years in matters of wood energy production, its sustainability and environmental impacts. These are contained in the National Environmental Policy, 1993, the National Forest Policy, 1994 and National Energy Policy, 1995 --a series of state policy documents approved by the government and currently being implemented. We hope, when these policies are fully implemented, we will have achieved a reasonably comfortable position with respect to the sustainable supply of wood fuel consistent with environmental equilibrium.

I must thank the organizers of the workshop for having chosen such an appropriate venue with its cosy and solitary environment of forest surroundings, away from the hustle and bustle of the busy city life. I am sure, the participants will be more able to concentrate on the workshop issues and come up with worthwhile findings and recommendations. I wish all of you a comfortable stay and God speed with your assignments. Finally, I thank the organizers of the workshop for inviting me as the special guest of the inaugural session.

Thank you all Ladies and Gentlemen, for patiently listening to me.

Bangladesh-Zinda-bad.

Speech of the Chairman (Syed Salamat Ali, Deputy Chief Conservator of Forests) of the Inaugural Session

Honourable Chief Guest and Secretary, Ministry of Environment and Forests, the Special Guest, Mr. Bhattarai of the Regional Wood Energy Development Programme, esteemed guests and resource persons from home and abroad, workshop participants from the South-Asian countries, ladies and gentlemen.

Assala-mu-Alaikum

It is my great pleasure and profound privilege to welcome you all here this morning on behalf of the Organizing Committee. The Regional Wood Energy Development Programme in cooperation with the Bangladesh Forest Department and the Bangladesh Agricultural Research Council has organized this sub-regional training workshop on "Integrating Wood Fuel Production into the Implementation of Agriculture, Forestry and Rural Extension Programmes in South-Asia". This is another laudable initiative taken by the WEDP in this region.

Until the industrial revolution forests were the major source of energy. Even to-day more than half of the removals from forests on a world a wide basis are used for energy production. In Asia more than 85 percent of wood removed from forests is used for energy. Out of the per capita fuel consumption in rural Bangladesh, fuel wood branches and tree waste constitute 44.5 percent.

The energy harvest per unit area from forests can be 20 times more than that for annual crops because it represents many year's accumulated growth. This has important implications for management and transportation. Different rural industries e.g., brick burning, road tarring, tea-leaf processing, tobacco curing, soap making, and confectionery, are the important users of wood fuels, besides the restaurants, hotels, tea shop establishments and households in the sub-urban, urban and rural areas of Bangladesh rely on woodfuel for energy.

The sources of these renewable wood fuels are forests and non-forest lands. Of the non-forest lands, homesteads make the greatest contribution to the overall supply of wood fuel in the country.

In order to improve fuel wood production, it is important to understand the existing wood fuel production situation and to identify those factors which play an important role in the production process.

Wood fuel occupies a very important place in meeting the energy demands of the country, particularly considering the roles of domestic, industrial and commercial consumption in the energy balance of the country. A good number of rural industries in the rural and sub-urban areas are dependent on wood fuels.

Despite its contribution to the energy balance, the need to develop wood fuel has rarely been recognized. In order to solve fuel wood problems priorities for action should be identified in the workshop. The technical session of this workshop will be attended by participants representing the forestry sector, the energy sector and non-government organizations who are involved in extension activities. I hope that their brainstorming efforts will produce pragmatic recommendations.

I am grateful to the Ministry of Environment & Forests who has kindly graced this occasion as Chief Guest. Thanks are due also to the members of the organizing committee representing different ministries, departments, educational and research organizations and non-government organizations for their assistance in organizing this workshop.

I would also like to extend my gratitude to Prof. Wim Hulscher, CTA, RWEDP for his initiative and support in conducting this training workshop.

Finally, I hope that the deliberations and field exercises of this training workshop will bring about valuable recommendations which could serve as a tool for solving energy problems in the region.

Thank you all.

Annexure 2

WORKSHOP PROGRAMME

(24 - 30 October 1995)

Tuesday, October 24	-	Arrival of participants
Wednesday, October 25	-	Opening Ceremony
	-	Introductions
	-	Participants introductions and expectations
	-	Introduction to RWEDP
	-	Workshop objectives
	-	Overview of woodfuel demand and supply in the region
	-	Woodfuel production in participatory programmes (community and private)
Thursday, October 26	-	Use of PRA in designing and implementing extension programmes (forestry/agroforestry, agriculture and rural development programmes)
	-	Woodfuel production, processing and utilization
	-	Woodfuel planning and marketing in Bangladesh
	-	Group work to develop framework for field exercises
	-	Presentations of working groups
	-	Guidelines for field visits
Friday, October 27	-	Field visit to cover: production, harvesting, distribution, trade and utilization of woodfuels; use of woodfuels in small-scale industry (e.g. ceramic industry, brick making, and others); and charcoal making
Saturday, October 28	-	Group work: Finalize synthesis of field observations into framework
	-	Presentation of results of different groups
	-	Country working groups: Discuss field observations and framework within national contexts
	-	Country working group presentaion
Sunday, October 29	-	Introduction to national follow up training activities
	-	Country working groups to plan follow-up national training activities
	-	Presentation of country working groups
	-	Evaluation of workshop
	-	Workshop closure
Monday, October 30	-	Departure

Annexure 3

LIST OF PARTICIPANTS

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Annexure 4

POSSIBLE FRAMEWORK TO ORGANIZE FIELD OBSERVATIONS

	Production and Utilization	Marketing	Extension and Support Services (extension, credit, policies, etc.)
Current Situation			
Constraints			
Possible Solutions			

Annexure 5

BRIEF ITINERARY OF FIELD EXCURSION

October 27, 1995

08:00	:	Leave CDM by Minibus
08:15	:	Visit small scale soap manufacturing factory at Bhawal, Mirzapur, using woodfuel as heating energy source.
09:00	:	Visit Bhannara Agroforestry Centre where woodfuel and small wood production programmes are undertaken by the Forest Department under a participatory mechanism.
10:00	:	Visit Chandra Forest Beat Woodlot Plantation raised under a participatory forestry programme.
11:00	:	Visit Pottery Manufacture Centre at Kaliakoir.
11:45	:	Visit NGO assisted participatory plantation on private land.
12:45 to 14:00	:	Lunch Break at National Mousoleum Compound, Savar.
14:00 to 16:00	:	Visit to wholesale woodfuel market: the Mirpur River bank depot.
16:00 to 19:00	:	Free time in Dhaka City.
19:00	:	Leave Dhaka for CDM.

Annexure 6

Training Workshop
on
Integrating Woodfuel Production in the Implementation of
Agriculture, Forestry and Rural Extension Programmes in South Asia
24-30 October 1995, Dhaka, Bangladesh

COURSE EVALUATION FORM

At the end of the course we need your general comments to improve our future training activities.

Please take sufficient time to reflect upon the course and complete the following evaluation form. The evaluation covers course structure, logistics, objectives, and content.

1. Pre-Course Information

a) Was the information sufficient for you to prepare yourself for this course?

[ ] yes
[ ] no If no, why not?

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b) When did you receive the pre-course information: how many days before you departed for the course?

. . . . . .

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c) Do you have any suggestions to improve the pre-course information and logistical arrangements?

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2. Training Course Structure

Please tick mark [ ] the box which best matches your impression of the following items:

		Too Long	Appropriate	Too Short
a)	Overall length of the course	[ ]	[ ]	[ ]
b)	Regional overviews	[ ]	[ ]	[ ]
c)	Participatory approaches to extension	[ ]	[ ]	[ ]
d)	Introduction to woodfuel production, flow and utilization practices/programmes in RWEDP member countries in South Asia	[ ]	[ ]	[ ]
e)	Role of participatory forestry development programmes in woodfuel production	[ ]	[ ]	[ ]
f)	Role of non-forest land in woodfuel production, flow and utilization in RWEDP member countries in South Asia	[ ]	[ ]	[ ]
g)	Introduction to planning and marketing of woodfuel in RWEDP member countries in South Asia	[ ]	[ ]	[ ]
h)	Introduction to curricula content of woodfuel related training courses	[ ]	[ ]	[ ]
i)	Field visit	[ ]	[ ]	[ ]
j)	Working groups	[ ]	[ ]	[ ]
k)	Free time	[ ]	[ ]	[ ]

Your comments/suggestions:

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3. Training Course Objectives

Please place an "X" in the box which best describes your impressions of how successfully the course has achieved its objectives.

Course Objectives	Fully achieved	Partially achieved	Not achieved
a) To network participants from governmental, non-governmental and private organizations who can contribute to integrating woodfuel production in forestry agroforestry, agriculture and rural extension programmes in South Asia			
b) To enhance the capacity to plan and implement integrated forestry/agroforestry, agriculture and rural extension programmes in RWEDP member countries in South Asia through the exchange of information and experiences on integrating woodfuel production, distribution and marketing under different production systems.			
c) To develop country capability to design and implement national workshops/training courses that aim to integrate wood energy production, distribution and marketing in forestry/agroforestry, agriculture and rural extension programmes, and to enhance economic development through promoting sustainable landuse practices.			
d) To identify and plan a follow-up training activity at the national level, within the scope of RWEDP.			

Your comments/suggestions:

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4. Logistics,infrastructure and organization

Please place an "X" in the box which best matches your impression of the following items:

	Excellent	Good	Fair	Poor
a) Meeting rooms				
b) Resource persons				
c) Secretarial services				
d) Payment of allowances				
e) International travel arrangements				
f) Transportation within Bangladesh				
g) Boarding and lodging arrangements				
h) Other aspects (specify):				

Your comments/suggestions:

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5. Participant Interaction

Please indicate your views on the appropriateness of the following items using a scale from 1 to 5 (1 = NOT appropriate, 5 = VERY appropriate).

ITEMS TO BE EVALUTED	APPROPRIATENESS				
	1	2	3	4	5
a) The total number of participants					
b) The interaction between participants					
c) The interaction between participants and resource persons/course organizers					
d) Other aspects (specify):					

Your comments/suggestion:

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6. Overall Evaluation

Considering all of the above, what would you say were the STRONG or GOOD points of this training course?

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Considering the same, what would you say were the WEAKER points or AREAS FOR IMPROVEMENT of this training course?

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PART II: PAPERS PRESENTED

1. INTEGRATING WOODFUEL PRODUCTION IN THE IMPLEMENTATION OF AGRICULTURE, FORESTRY AND RURAL EXTENSION PROGRAMMES IN SOUTH ASIA

Tara N. Bhattarai

1.1. Introduction

The seven countries of South Asia which are members of the Regional Wood Energy Development Programme (RWEDP) in Asia during its current third-phase (1994-1999) are Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. Collectively, they form a common regional group of South Asian countries called the South Asian Association for Regional Cooperation (SAARC). Except for the Maldives, which joined the RWEDP during its current phase only, the other six countries are continuing their participation in RWEDP activities, since 1985. (The formal endorsement of Bhutan is, however, still awaited).

Although WRI (1992) does not present a case of severe soil degradation for Asia (total degraded area only 19.8% of the vegetated land compared to 23.1% and 22.1% in Europe and Africa respectively), water and wind erosion, which strip away the nutrient-rich topsoil and make the land less productive, and soil degradation by physical (e.g. compaction, waterlogging,etc) and chemical processes (e.g., salinization, acidification, pollution, etc) have been reducing the productivity of soils in situ, virtually in all countries in South Asia.

The Global Assessment of Soil Degradation (GLASOD), a three year study sponsored by the United Nations Environment Programme (UNEP) and coordinated by the International Soil Reference and Information Centre (ISRIC), Netherlands, identifies unsustainable livestock grazing, agriculture and forestry practices as the main causes of soil degradation in virtually all developing countries- a common problem in South Asia. The other common causes of soil degradation in most developing countries which the study identifies include over exploitation of forests for fuelwood collection (primarily in dry areas), and some industrial activities (i.e., waste disposal, excessive pesticide use).

The Food and Agriculture Organization of the United Nations (FAO) published a report entitled "Forest Resources Assessment 1990: Tropical Countries", in 1993. It presents the most recent and comprehensive assessment of forest resources in the developing countries of the world, including the SAARC members. In this report, the term deforestation has been defined as the "permanent depletion of the crown cover of trees to less than 10 %", below which it can not qualify as a forest estate any more. FAO's forest resources assessment methodology compares the changes in biomass by forest ecosystem type - determined on the basis of ecofloristic zone and vegetation map, to present the trend in deforestation over the period 1981-90.

Most of the data used in FAO's assessment are derived from national forest inventory reports provided by its member countries, complemented by new data obtained from satellite remote sensing images. Country specific data have been grouped or reorganized to present a common classification, format and reference date at the aggregate level. Therefore, reliability of the statistics presented in this report, to a great extent, will depend on the accuracy of primary data collected/supplied by different national agencies. Table 1 presents the landuse patterns in seven RWEDP member countries and Table 2, land area, population, and forest and ecosystem change in South Asia.

Woodfuel (fuelwood and charcoal) contribute positively to the national economy and energy balance of all seven countries in South Asia. RAPA/FAO (1994) projected a population of about 1,164 million people in 1992, average annual growth rate 2.4% between 1982-92. See table 2.

In these countries, a majority of the people and many different industrial and commercial activities in rural areas rely solely on woodfuels and other biomass (i.e., animal and crop residues, industrial waste, etc.) for meeting their energy requirements. Besides processing of agro-products for markets at the household level to generate cash income, small scale industrial and commercial activities such as brick and lime kilns, pottery and ceramics, sugar making, fish drying, foodstalls, bakeries, etc are other important activities contributing to rural employment and income generation. This informal, but important sector of the rural socio-economy cannot thrive in the absence of traditional energy supplies over a long period of time, particularly in South Asian countries where rapid population growth and the non-availability of low cost energy substitutes limit the opportunity for energy transformation. Therefore, traditional sources have been, and shall continue to be, the most feasible form of energy in these countries for many years to come.

In most rural and peri-urban areas, traditional sources (mostly woodfuels and other biomass) are the most preferred types of energy, where commercial or conventional energy sources (i.e., kerosine, coal, electricity, LPG, etc) do not yet play any significant role. Woodfuels are still comparatively less costly than other conventional energy sources in many peri-urban and rural areas due to low royalty rate and/or other state provided subsidies. This may be the reason why a large number of rural industrial/commercial activities, some in urban centres too (e.g., eateries, bakeries, smitheries, etc), still rely heavily on woodfuels for energy.

The energy balance of all seven RWEDP member countries in the subregion show a mix of both traditional and conventional energy in varying proportions (Table 3). Although the share of traditional energy in total consumption has decreased in recent years in four out of seven countries of South Asia (e.g., Bhutan from 98 to 82%, India 31 to 26%, Nepal 97 to 93%, Sri Lanka 61 to 57%), its share has increased from 0% in 1971 to 51% and 22% in 1991 in Bangladesh and Pakistan, respectively. No data was available for the Maldives.

Table 1: Land Use in 1992 in RWEDP Member Countries, South Asia

Country Area[1] (million ha)*	Arable Land and Permanent Crops Land		Forest and Wooded Land		Permanent Meadows and Pastures		Other Land	
	Area (million ha)	(%)	Area (million ha)	(%)	Area (million Ha)	(%)	Area (million Ha)	(%)
Bangladesh (13.017)	9.044	69.0	1.890	15.0	0.600	5.0	1.483	11.0
Bhutan (4.700)	0.134	3.0	(2.560)**	54.0	0.273	6.0	1.733	37.0
India (297.319)	169.650	57.0	68.500	23.0	11.400	4.0	47.769	16.0
Maldives (0.030)	0.003	10.0	0.001	3.0	0.001	3.0	0.025	83.0
Nepal (13.680)	2.354	17.0	5.350	39.0	2.000	15.0	3.976	29.0
Pakistan (77.088)	21.110	27.0	4.050	5.0	5.000	6.0	46.928	61.0
Sri Lanka (6.463)	1.905	29.0	2.100	32.0	0.439	7.0	2.019	31.0
Total (412.297)	204.200	49.5	84.451	20.5	19.713	4.8	103.931	25.2

Source: World Resources 1994-1995 (WRI, 1994); RAPA/FAO (1994)Selected Indicators of Food and Agriculture Development in Asia-Pacific Region, 1983-93.

Note: * Figure in parentheses indicate total area of a country rounded to nearest ten thousand ha.
** There is a discrepancy in area figure between FAO (1993) and RAPA/FAO (1994). The figure provided by the latter for the area of natural forest alone (i.e. excluding plantations and other wooded land) is 2.809 million ha.

NA Denotes data not available.

[1]Area rounded to nearest thousand hectare.

Table 2: Land Area, Population, and Forest and Ecosystem Change In South Asia

Country	Land Area (million ha)	Population (million)		Natural Forest Area[2] (million ha)			Forest Ecosystem Type in 1990 (thousand ha)*					
		1982	1992	1980	1990*	Av. Annual Loss 1981-90 (%)	Rain	Moist Deciduous	Hill & Montane	Dry Deciduous	Very Dry	Desert
Bangladesh	13.017	93.222	119.228	1.145	0.769 (5.9)	3.3	572(3.6)	197(2.1)	0	0	0	0
Bhutan	4.700	1.294	1.612	2.973	2.809 (59.8)	0.6	176(0.5)	0	2,230(0.6)	0	0	403(0.6)
India	297.319	719.151	879.548	55.119	51.729 (17.4)	0.6	8,248(0.6)	7,042(0.5)	8,917(0.4)	26,242(0.8)	0	1,283(0.2)
Maldives	0.030	0.168	0.227	NA	0.001(3)	NA	NA	NA	NA	NA	NA	NA
Nepal	13.680	15.731	20.577	5.567	5.023 (36.7)	1.0	609(0.6)	1,300(0.6)	2,361(1.2)	37(0.5)	0	716 (1.1)
Pakistan	77.088	90.944	124.773	2.623	1.855 (2.4)	2.9	0	11(3.1)	1,423(2.9)	4(3.3)	37(2.9)	380(2.9)
Sri Lanka	6.463	15.342	17.666	2.015	1.746 (27)	1.3	247(0.6)	605(1.4)	57(0.0)	836(1.5)	0	0
Total	412.297	935.852	1,163.631(2.4%)**	69.443	63.931 (15.5)	0.8	9852	9155	14988	27119	37	2782

Source: Population, Land and Forest Area change from RAPA/FAO (1994): Selected Indicators of Food and Agriculture Development in Asia-Pacific Region, 1983-93 ; WRI (1994) for Tropical Forest Extent in 1990 and Loss by Ecosystem in 1981-90.

Note: * Figure in parentheses represents percent land area.
** Figure in parentheses represents percent population growth.

[2] Country and Forest area rounded to nearest thousand hectare.

Although a declining share of traditional energy consumption is clearly noticeable in Table 4, it may not be true that there is a massive transformation taking place in the energy sector. It may only be true that, wherever alternative commercial sources are easily available at affordable cost some degree of energy transformation is automatically taking place. But the decline may also be partly due to the increasing industrial and commercial activities which most often are based on imported technologies using commercial energy sources. In reality, the absolute level of traditional energy consumption has not declined at all in many areas covered by different energy related studies which included traditional energy use. On the contrary it has probably increased in most of the seven RWEDP member countries in South Asia.

The current effort here, is not to assess and/or compare the economic status between the countries within the sub-region in terms of their respective level of commercial energy consumption but to highlight the role and importance of traditional energy sources in the national economy of these countries and to suggest how best they can be integrated into future energy sector plans and programmes. Most modern technologies and processing facilities tend to favour the use of commercial energy, hence to some extent this provides the proxy indicators required for assessing the status of industrial/commercial development in a particular country. The energy balances of most South Asian countries invariably show a sharp growth in the share of commercial energy over the years. However, there is also a gap of information related to the types, volume, and sources of traditional energy, particularly due to the large and dispersed group of users, an informal supply mechanism, a lack of a sole agency responsible for centrally managing all energy related information, etc. Lack of basic information about the extent of a country's dependency on traditional energy sources, even to support its current level of social and economic activities, has hampered the task of reliably assessing the demand/supply position by sources- an indispensable tool for supply enhancement. Therefore, in the absence of basic information, the potential of different countries remains unmet and the alternatives which they should have been pursuing in order to develop their respective energy sector for sustainable development are far from being realized. These issues are being increasingly recognized, and the national development policies, strategies and programmes of all these countries now emphasize, to a greater extent than hitherto, the production and efficient use of renewable energy sources, including biomass and other non-conventional sources (i.e. woodfuels, residues, solar and wind power, etc).

In recent years, concerns have been raised globally about the sustainable production and use of renewable natural resources, including biomass energy resources. Most programmes, particularly the extension programmes of the forestry and agriculture sectors, now, place more emphasis on meeting the basic needs of the people, and ensuring the preservation of the environment. If the scope of such programmes is carefully defined, it will definitely include woodfuel production to promote the attainment of sustainable development objectives. Most sectoral programmes in the field of natural resource management in South Asian countries include some kinds of extension packages, developed and implemented by the agencies concerned, which aim to promote people's participation. The main thrust of these programmes is better management of natural resources, primarily, the forestry, agriculture, and the livestock sectors. Thus far, most of these programmes have been confined to planting of trees and, only to a limited extent the protection of newly planted seedlings. To be more precise, so far they have been only partially successful. Although numerous cases of successful community and private forestry development have been registered in the sub-region, the arduous task of natural forest management has not received the attention it needs to fully develop and utilize its massive production potential; and this could best be done through peoples' participation. Until recently, there have been only a limited number of exemplary achievements in participatory forest management in South Asia, for example: the

experience of Bangladesh in the management of degraded sal forest with enrichment planting and agroforestry; the progress made by the West Bengal forestry department, India, in the management of degraded sal forests under benefit sharing arrangements with the local people; the user group managed natural forests in the hills of Nepal, etc.

Factors that affect individual decisions regarding tree planting and/or protection of naturally grown trees in private/government lands; choice of tree species for planting, for self consumption and/or for the market, are likely to be affected by a complex interrelationship involving the physical, environmental, social and economic conditions of the area to be planted, as well as by the institutional and technical support services available to people in support of their endeavour in tree planting/forest management. In a traditional landuse system, decisions regarding choice of species, cropping patterns, crop mixes, allocation of planting site by importance/value of tree products, etc is determined by the people out of their long-time experience of subsistence farming. It most cases, it is found to be directly affected by the potential contribution farmers expect from raising trees or protecting forests (i.e. unipurpose versus multipurpose species; scattered versus group/block planting, planting around homesteads, home gardens or in marginal lands, etc). Similarly, prevailing local socio-cultural practices of tree planting also play a significant role, both positively as well as adversely. Therefore, all these factors are equally important in determining the type, scope of extension programmes aimed at promoting woodfuel production (i.e. whether scattered trees planting around homesteads, or development of fruit orchards and home gardens, or establishment of rubber and oil palm plantations, or planting for shelterbelts, hedgerows, etc). Government efforts, so far, have been more effective in managing larger and consolidated blocks of plantations rather than scattered, variable size plots, primarily due to the difficulties of protecting them from fire, grazing and/or encroachment.

Trees from forests, community lands and privately owned lands - grown under the labels National, Agro-, Community, Farm or Social Forestry development programmes, or other similar schemes that incorporate tree planting into agriculture, livestock and/or fishery development schemes, for uni- or multiple purposes - have been the common production sources of wood energy. These schemes are implemented with investments, either from the public or the private sector, depending upon its ownership status and/or right of use of final products/harvests. It may also depend upon the type of management agreement between the state and local communities and private individuals. Ownership of the land is the clearly factor most influencing development (for public, private or leasehold arrangement of forest management). All these different approaches of forestry development have been pursued simultaneously in recent years in different countries of South Asia, primarily to sustain wood production. Although a particular scheme in a specific area (or location) may prioritize certain objectives, depending upon the needs of the people in that area (e.g., watershed management, preservation of the environment, etc), most ongoing forestry development programmes also seem to include the objective of enhanced wood production, either explicitly or implicitly. Most schemes seem to include a component of private tree planting, or make provision for allowing participatory forest management, for meeting the basic fuelwood and construction timber needs of the people.

1.2. Forest Resources in Member Countries

Natural Forest:

FAO (1993) shows all forests in the South Asia region under a broad classification "tropical forests". The terminology encompasses all existing forest types in the humid and semiarid/arid areas of South Asia, and for that matter all forests of the developing countries of the tropics fall under it, including forest formations ranging from moist (or closed) tropical to dry (or open) woodlands. WRI (1985) states that, in a few instances, it also includes the temperate forests of some developing countries.

Tropical forests have been divided into numerous ecological zones: "Rain", "Moist Deciduous", "Hill and Montane", "Dry Deciduous", "Very Dry", and "Desert", each representating distinct forest ecosystems on the basis of specific ecofloristic zones and vegetation maps. FAO (1993) identifies four broad forest formations to present these ecofloristic zones in the tropics: one upland (the hill and montane forests) and three lowland (the tropical rainforest, the moist deciduous forest, and the dry and very dry zone forest). These different forest ecosystems are the outcome of a delicate balance between site factors and the natural vegetation in a particular geographic area.

Total forest area in the seven RWEDP member countries in South Asia is about 63.9 million ha. Out of which only 9.8 million ha (or 15%) is "Tropical Rain Forest", and one single country, India alone has over 8.2 million ha of it. The tropical forest in general, and the tropical rain forest in particular, is considered the richest ecosystem in the world in terms of its biological diversity. This aspect of the tropical rainforest ecosystem is gaining increasing recognition for its importance to present as well as future generations of humans and efforts are in place wherever tropical rainforests are found to ensure their conservation through sustainable management and use. However, it is also argued that their potential contribution to owner states and to the human society at large is yet to be fully established in commonly understandable terms (social, economic, etc). Yet for some our current knowledge, based on the limited use of selected genetic materials of known importance, only from some species, already reveals the enormous contributions the tropical forest has made in the development efforts of mankind. Out of this enormous resource pool, only a few plant species have been recognized in terms of their application/utility in development, so far. As more research and development is being directed to this new field of biological science (through the development and application of bio-technology and bio-engineering) their potential additional benefits will be recognized more and more in the coming years. These, plus the new uses which are being recognized daily will increase the priority of biodiversity conservation in the future too. The loud call and universal concern raised for the sustainable management of tropical forest ecosystems is a clear manifestation of the recognition of these vast, important resources. This has been increasingly reflected at the country level by the incorporation of tropical forest conservation concerns into the national policies, management objectives and sectoral plans of member countries in the region. This new role of forests has also been recognized and endorsed at the highest political level during UNCED-1992 in Rio, and the Biodiversity Convention, already ratified by a majority of UN member countries (including countries of South Asia).

Table 3: Production and Consumption of Energy in South Asia

Country	Commercial Energy				Traditional Energy	
	Total Consumption in 1991 (Petajoulus)	Per Capita Consumption in 1993 (kg oil equivalent)*	Av. Annual Growth in Production 1980-93 (%)	Energy Imports as percent of Merchandise Exports	Consumption in 1991 (Petajoules)**	Fuelwood & Charcoal[3] Production in 1992 (million m^3)***
Bangladesh	262	59 (7.9)	12.2	26	277 (51%)	31.014 (2.5)
Bhutan	3	NA	NA	NA	12 (82%)	1.332 (2.2)
India	8,011	242 (6.7)	6.6	36	2,824 (26%)	NA
Maldives	NA	NA	NA	NA	NA	257.789 (2.0)
Nepal	15	22 (8.1)	14.1	NA	206 (93%)	18.971 (2.7)
Pakistan	1,032	209 (6.8)	7.3	24	296 (22%)	24.379 (3.2)
Sri Lanka	67	110 (1.9)	6.7	13	89 (57%)	8.566 (1.1)
Total	9,390	642			3704	342.051

Source: Energy Consumption in 1991 from WRI (1994); Per Capita Energy Consumption in 1993, Average Annual Growth Rate in Production/Consumption, and Energy Imports as a percent of Merchandise Exports from the World Development Report 1995, WB (1995); Fuelwood and Charcoal production figures from RAPA/FAO (1994).

Note: * Figure in parentheses indicate average annual growth percent in consumption between 1980-93.
** Figure in parentheses indicate percent share in total consumption in 1991.
*** Figure in parentheses indicate percent growth between 1982-92.

[3] **Includes roundwood equivalent of charcoal which uses a factor of 6.0 to convert from metric ton to solid volume in m^3.**

The other international instrument which was agreed at Rio, also having direct implications to future forestry development, is the World Climate Change Convention which is designed to reduce greenhouse gas emission into the atmosphere to check global warming. Both of these conventions are now effective (after the first meeting, or conference of parties of the former in 1993 and the latter in March 1995). These new instruments, and the arrangements reached thereafter, will, to a great extent, direct/guide the changes to be initiated in the existing policies, priorities and programmes of the forestry sector in all member countries. In the future, the global environment related priority of the donor community may be primarily influencing the allocation to forestry development at the international level and among the major donors. Their interest and priority is bound to deviate drastically from the immediate forestry development priorities of the owner states. Further, it is being suggested by the major industrialized countries that the non-legally binding principles on forests (also agreed during UNCED, 1992) be replaced with a new convention on forests. The argument put forward in favour of this replacement is that it will better enable tropical deforestation to be nalted, and the justification for it is that the arrangements made (or the instruments agreed upon) so far, are not sufficient to make member countries strictly adhere to the principles of sustainable management of tropical forests. The recent ministerial meeting on forestry at FAO, Rome (March 1995) also adopted a "Rome Statement on Forestry" by affirming the determination of 121 countries to apply their political will to attain the Earth Summit's objectives in the shortest time possible.

But on the other hand, the problems of growing population, lingering poverty and further marginalization of the poor call most South Asian countries to pursue rapid economic development. If launched unsystematically, it will exert additional pressure on the remaining natural resource base and add to further deforestation and environmental hazards. Although the rate of deforestation has been stabilized at an annual average of 1.2% in the Asia Pacific region, the problem may be extremely severe at specific locations in the countries of South Asia. During the period 1980-1990 about 5.512 million ha (or 15.5%) of forests have been lost in the seven member countries of South Asia.

Plantations:

Although the area devoted to tree plantations has been increasing in the sub-region (this includes all new plantations under different schemes, such as agroforestry, community forestry, social forestry national afforestation/reforestation, etc) the bulk of it is confined to one single country, India. Out of a total plantation area of 19.759 million ha in the region, India alone accounts for 18.9 million ha, and the others share the remaining 0.859 million ha. The second and third ranking countries in terms of plantation area are Bangladesh and Pakistan, but the plantation area there does not exceed over 0.335 and 0.240 million ha, respectively. Table 5.

Further, the success rate of most of these plantations has been repeatedly questioned by different interest groups. The latest figures on survival rates at global level, based on FAO's inventories of 56 plantations and reported in WRI, 1994, stands at 70% only. The annual ratio of deforestation to established plantations for South Asia as a whole stands at 1: 2.7, which is much better compared to Asia as a whole, which stands at 2:1 (Latin America 6:1, Africa 32:1). But this ratio at the country level other than India (where it stands at a ratio of 1:4) is just the opposite with deforestation far exceeding the area of annual reforestation (i.e., Bangladesh 2:1, Nepal 9:1, Pakistan 13:1, Sri Lanka 3:1). This trend needs to be checked/controlled as quickly as possible.

Agroforestry Practices:

Agroforestry, a system of land use recognized as a separate discipline since the 1970's, is a new multidisciplinary sector. It requires the integration of the activities affecting sustainable agriculture, which in the past used to be carried out independently by different sectoral line agencies in the field. As a system, it is gaining wider recognition among policy makers and planners, as the productivity of agricultural lands is declining year by year (more prominently in hilly areas), as the forest cover is continually shrinking, and as the national forest/environment policies of member countries are increasingly demanding the extension in forest coverage all over South Asia. Virtually all countries in the region are severely stressed with the need for agricultural land expansion (for increasing food production), and at the same time, for the extension of forest cover to produce additional wood and to conserve the environment- two conflicting needs. Besides, forest management to- day has to embrace the essential components of biodiversity conservation, help check world climate change by conserving forest area to continue acting as a carbon sequester. How these conflicting demands can be met without further degradation of the remaining forests poses a great challenge. Furthermore, the nonexistence of alternative commercial energy which can be a reliable, affordable and cost effective substitute to woodfuel (biomass) is exacerbating the problem of the forestry sector. This is the issue which forestry extension in general and agroforestry in particular can contribute positively by providing immediate strategic management options. A properly planned and effectively implemented agroforestry system can contribute to both the production of wood and the promotion of sustainable landuse practices.

As forest encroachment and squatting is a common feature of most South Asian countries, primarily for the expansion of the agricultural area to grow more food to feed the increasing population the remaining primary and/or secondary forests of immense social, economic and environmental value are being further depleted. Deforestation in catchment areas is contributing to the process of desertification in hilly areas. As a preventive action against soil erosion from farm lands, local communities in catchment areas have incorporated tree crops into the traditional farming systems. Besides the protective function of trees, the multipurpose utilization potentials inherent in numerous tree species also inspire the farmers to diversify production from farm lands, both for their own consumption as well as for the market (e.g., fruit and other trees which yield products of cash value plus the wood). This practice in reality is the early model of agroforestry. ICIMOD (1991) describes agroforestry as:

" The intentional manipulation of a land unit to satisfy subsistence needs for food, fodder, fuelwood timber and soil protection, through the practice of cultivating annual and perennial crops, is today known as agroforestry."

It argues that, even if agroforestry as a public intervention may be of recent origin, historically the system has evolved over a much longer time. Two key factors have been presented as the contributors to the evolution of the system: first, the crucial role of biomass derived from perennials, both in farming systems and in the subsistence strategies of hill farmers; and second, the changing patterns of availability and access to tree products following increased pressure on lands producing perennials (common property lands).

Today, tree planting (or artificial regeneration) has became an important strategy of forestry development in areas where existing vegetation of economic significance have already passed the stage where it can no longer propagate naturally to re-establish itself in the area. Under this method of forest regeneration, many countries have incorporated different models of agroforestry practices at varying scales. The main thrust of the forestry sector led programmes is to lower the cost of plantation establishment, and also to ensure better protection of newly planted saplings from fires and grazing. The early initiatives of Myanmar in establishing teak plantation under the "Taungya" system of reforestation is a classical model of this cost saving/protection enhancement strategy. On the other hand, the experience of China in shelter belt and forest network establishment, in intercropping of agricultural crops with trees, in tree planting around houses, along roadside and river banks, etc is an example of multipurpose forestry development schemes/strategies, also from the point of view of product types and potential of future marketing. Similarly, most countries in the South Asia region have also initiated different strategies for the integration of agroforestry practices in land resource management programmes. Forestry development programmes have integrated agroforestry strategies primarily to ensure better protection of newly planted trees and to reduce plantation establishment costs.

1.3. Energy Consumption in Member Countries

WRI (1994) showed a declining trend in the proportion of traditional energy use between 1989 and 1991, particularly in Bangladesh from 54 to 51%, and in Bhutan from 95 to 82%. In India, Nepal and Pakistan, there is no noticeable reduction in its share in total energy consumption. In Sri Lanka, on the other hand, there was a rise from 52 to 57% during this period. Table 3 and 4.

Koopmans (1993) identifies non-availability of accurate data as the main problem affecting proper assessment and planning of biomass energy resources. To overcome this deficiency, RWEDP, during its current third phase (1994-99) programme, aims to establish a regional wood energy database to assist and guide wood energy planning and development functions in its 15 member countries in Asia. Available data on production and consumption of woodfuels is vague (broad), most present only the total consumption at the country level and are useful only to guide policy formulation at national levels. Due to the possibility of enormous variations in energy consumption and mixes between users in different geographical areas even for a particular use (i.e., cooking or heating), and due to the diversity in technology adopted by different industries of a particular type and between industries of different types, there is a wide variation in the woodfuel demands of both specific or different types of users according to their respective end use efficiency. Such detailed information by activity or type of use, based on predetermined standards is still lacking and/or unknown, despite the fact that numerous case studies have unveiled many new elements that need to be incorporated into energy accounting during the previous two phases of RWEDP (1985-93).

Country or global level statistics available to-date do not give a reliable breakdown of wood energy production or consumption. In most cases, available country level information does not even recognize the sources of supply for woodfuels (i.e., whether the source is sustainably managed national forests, community woodlots or private trees). Most information also tends to group the different sources of biomass energy into one broad group called "traditional energy", without explaining its supply situation or sources. Besides, the high but locally concentrated population patterns in many countries make the work of wood energy planning difficult, as population density in heavily populated areas may vary drastically from national average in many countries. Such a generalized figure may adversely affect the plan which aims to solve local level problems. For example, Bangladesh, India and Sri Lanka had an average population density of

about 939, 302 and 277 people per square kilometre respectively as against 35, 154 and 166 people per square kilometre, respectively, in Bhutan, Nepal and Pakistan in 1993. If interpreted in terms of cropped land, the average density of population per square kilometre changes drastically: more than 1300 in Bangladesh, 1200 in Bhutan, and close to 900 in Sri Lanka and Nepal. This is an important issue to be addressed while planning wood energy development. The share of woodfuel in total roundwood production in the seven countries of South Asia comes to about 86% on an average. There is not much variation in its share between countries, Bhutan and Sri Lanka had 83% and 86% respectively, in other five countries its share exceeded 90% (Bangladesh and Nepal ranked highest, both 97%). Table 5.

1.4. Wood Energy Demand/Supply

Wood Energy Demand:

The seven countries in South Asia, together showed an average population growth rate of 2.4% per annum between 1981-90. The lowest rate was in Sri Lanka, 1.5%; the highest in Pakistan, 3.7%; and Nepal and Bangladesh lying in-between, 2.6 and 2.7 respectively.

Although the energy use statistics in most of these countries depict a declining trend of traditional energy uses in total energy consumption over the past years, in absolute terms however, use of woodfuels has not decreased, and perhaps has even increased simultaneously with the growth in population. Table 5. Despite the fact of rapid urbanization in the countries of South Asia (average annual urban population growth rate 7.7% in Nepal, 5.3% in Bangladesh, 4.2% in Pakistan, 3.0% in India, and 1.6% in Sri Lanka) promoting a rapid transformation in energy use, a mixed pattern in favour of commercial energy sources for various reasons (i.e., perceived as modern, healthy, clean, easy to use, saves cooking time, etc.), traditional energy sources, and more particularly wood fuels, still hold an important position in the national energy balance of all of the countries of the region.

Energy consumption in most of these countries has increased on a per capita basis, due to their rapid industrialization and also partly due to the improved living and economic conditions in recent years. But on the other hand, there has been hardly a single case showing solid evidence of reduced woodfuel consumption in absolute terms. As a matter of fact, the demand for all types of energy might still have been increasing simultaneously with the growth in population.

Table 4: Energy Consumption and Transformation in South Asian Countries

Country	Total Energy Consumption in 1991 (petajoules)	Commercial Energy Consumption (petajoules)			Traditional Energy Consumption			Av. Annual Consumption Growth (%) (1980-93) Commercial Energy	Av. Annual Population Growth (%) 1990-95
		1989*	1991**	Growth in Consumption*** (1989-91)	1991 (petajoules)	%age of Total Consumption			
						1989	1991		
Bangladesh	539	227 (125)	262 (3,945)	35 (7.7)	277	54	51	7.9	2.41
Bhutan	15	NA (155)	3 (2474)	3 (NA)	12	-	82	NA	2.33
India	10,835	7,528 (94)	8,011 (107)	483 (3.2)	2,824	25 (31%in '71)	26	6.7	1.91
Maldives	NA	NA	NA	NA	NA	NA	NA	NA	3.5[4]
Nepal	221	13 (80)	15 (318)	221 (7.7)	206	92 (97%in '71)	93	8.1	2.45
Pakistan	1,328	930 (119)	1,032 (1629)	102 (5.5)	296	21	22	6.8	2.67
Sri Lanka	156	55 (17)	67 (72)	-12 (-8.9)	89	52 (61%in '71)	57	1.9	1.27
Total**	13,094	8,753	9,390	832 (7.2)	3,704		30		2.4

Source: Energy Consumption from WRI (1992) and WRI (1994); Average Annual Growth in Commercial Energy Consumption from WB (1994); Av. Annual Population Growth (1990-95) from WRI (1994).

Note: * Figure in parentheses indicate percent change over 1979.
** Figure in parentheses indicate percent change since 1971.
*** Figure in parentheses indicate average annual growth percent

[4] Population growth rate for Maldives derived from RAPA/FAO (1994), and for other countries directly taken from WRI (1995) from its growth projection for 1990-95.

Moreover, as infrastructure and institutions are two important aspects of commercial energy distribution, inadequate and/or non-existance of basic facilities, virtually in all seven South Asian countries, could limit the rapid transformation of energy sources for many years to come. This in turn, will directly affect the domestic sector predominately in rural areas, where no feasible alternative to traditional sources exist, and also the small scale industrial, commercial activities taking place in and around rural and peri-urban areas, making them heavily dependent on traditional sources. Therefore the demand of traditional energy is sure to increase with the growth in population and expansion of similar activities in the future.

Further, the present thrust on renewable sources of energy (i.e. biomass energy, solar, hydro and wind power, biogas, etc) will favour further use of woodfuels in the future too. That is why the integration of woodfuel production in the extension programmes of the forestry, agriculture and other sectors related to rural development has become crucial. In this regard, expanded application of agroforestry practices during programme implementation in private/community owned lands and application of appropriate land management practices according to the carrying capacity of land, have become essential to preserve the soil and maintain its productivity. Therefore, plantation of trees as shelterbelts and windbreaks, or in homesteads, home gardens, or as conservation plantations, or as community/farm forests, or as village woodlots in degraded lands, and strict enforcement of adequate management practices in existing natural forests (and previously established plantations) to check further degradation and enhance production of multiple products by allowing direct and effective participation of the stake holders and beneficiaries, have become tasks of foremost importance. Such a strategy will be necessary, both for production enhancement from forests (including enhanced woodfuel production) as well as to promote sustainable land use practices in areas outside the control of government departments.

Wood Energy Supply:

At the national level, no developing country has a reliable data base which gives a clear picture of the supply/demand position of traditional energy, although a few site specific surveys to identify this gap have been more frequently conducted in recent years, particularly to meet the specific objectives of donors/agencies. Available data on woodfuel production is invariably biased towards forestry. It most often tends to present a scenario perceived by foresters only, which takes for granted that the forest is virtually the only source of energy to the people in most developing countries. Woodfuel collection is thus seem as the prime cause of deforestation. Moreover, foresters often tend to identify the acts of woodfuel gatherers/transporters as the most severe threats to forests, in terms of its protection from fire and other offences. They point to the energy sector for its failure, or for not being able to take into full consideration in its sectoral development plans, the household level energy requirement in rural areas, not to mention the requirement of other informal energy using sectors and its effect on the environment in the country. Most foresters seem to view that, as people's economic status improves with the opening of alternative employment opportunities outside the subsistence agricultural sector, they will be self motivated to switch, automatically, to other "modern" commercial energy alternatives.

The energy sector on the other hand does not present a prospective plan which states the timeframe and intended transformation policy and plans. Without feasible alternatives to traditional energy sources, rural inhabitants of South Asia, who share a common list of issues such as limited infrastructure, widely dispersed population living in numerous settlement nuclei or hamlets, poor economic status of a majority of the rural population, many of whom are still

being marginalized, etc do not economically qualify for large investment projects for social welfare or in the name of rural development to overcome traditional energy shortages. Most likely, the current priority for rural electrification and other nonconventional energy development- most often guided by a short-term vested political interest- will be the only feasible programmes in most rural areas, which will have no significant contribution to household level energy shortages. Although a few may switch over, most industrial and commercial activities in these areas will still be relying heavily on woodfuels (and other biomass) for energy for many years to come.

In reality, the findings of numerous localized studies (e.g. Cebu City, Philippines; HEES: Pakistan; Agroforestry and woodfuel in Java, Indonesia, Household Fuel and Home gardens, Bangladesh, and studies in Sri Lanka) suggest that forests are not the only source, for that matter not even a major source for woodfuel production for a great majority of the people in different parts of the world. Wood from nonforest lands, mostly from privately owned and managed lands (i.e., home gardens, homesteads trees, agro/farm forests, and non-forest plantations of rubber, oilpalm, coconut, etc) has become a major contributor to woodfuel production in recent years, primarily due to increasing demand and improved technology. Trees from home gardens and homesteads play a significant role in woodfuel production in Sri Lanka, Bangladesh, and to a varying degree in other countries too. Tree plantations in Pakistan, both in forest and non-forest lands, are the major source of woodfuel in Pakistan. In India, trees grown under social forestry programmes, including private planting schemes, have become an important source of privately grown wood, both as industrial wood as well as woodfuel for the market. Trees raised under community forestry programmes, including private planting programmes in Nepal are becoming an important source of wood supply in the hills of Nepal.

Although many countries have developed their own criteria to convert the number of seedlings raised in nurseries or distributed/planted in the field into area, no consistent estimate can be made at the global level for such types of tree planting programmes, reports FAO (1993). Even in block plantations, the results have been mixed, most often it has been observed that plantation yield is overestimated at the time of the project feasibility study but in reality plantation yield is much lower (less than 50%). Monitoring and evaluation of plantation programmes have been so far very limited.It is reported that four-fifths of the current plantations have never been surveyed. Survival rates calculated from 56 plantation inventories of 18 tropical countries indicate an average rate of 70 percent at global level (FAO,1993).

1.5. Status of Natural Forest Management

As stated earlier, the terminology "deforestation" adopted by FAO only refers to the changes in land use with depletion of tree crown cover to less than 10 percent. Changes in forest class (from closed to open forest) is defined as "forest degradation", which affects the site and lowers the production capacity of the remaining forests. Forest degradation is also becoming more and more prominent in many countries of the sub-region.

FAO (1993) cites the Forest Resources Assessment of 1980, jointly undertaken by FAO and UNEP, to report the status of forest management from the point of view of sustainable wood production. Only 41.3 million ha, or 4.3% of the total reported forest area, was found under management. Out of this a substantial area fell in tropical Asia (39.1 million ha) and the contribution of one single country, India, alone is 32.5 million ha. The remaining 6.6 million ha of

managed tropical forests is shared by all other countries in Asia including the other six RWEDP member countries in South Asia. Globally, the remaining 8.8 million ha managed forest is distributed in 18 other countries. Since 1980 a number of intensive studies on forest management have been carried out by FAO. According to the International Tropical Timber Organization (ITTO) the total area of tropical moist forests, which is demonstratively under sustained yield management in the member countries (excluding India) did not exceed over one million ha in 1988, which, according to FAO (1993), has now been reduced to about only one fifth on environmental grounds.

FAO (1993) also acknowledges with satisfaction, the legislative amendments initiated by India (e.g., the Forest Conservation Act of 1980 and its amendment in 1988) for its positive contribution in slowing down the pace of deforestation in India. Similarly, the logging bans initiated in several parts of the country combined with a vigorous drive to raise agro-forestry plantations is expected to reduce pressure on natural forests there. The need for direct investment to rehabilitate and intensively manage the natural forests was still felt. Many other countries in the region have also initiated similar activities in the forestry sector to check deforestation and to initiate the management of natural forests. The other disappointing message it presents is the inadequacy of natural regeneration in areas covered by forest working plans, primarily due to inadequate protection against fires and grazing.

The term "forest management", then, was not as complex as it tends to be currently. Production of wood by applying regulatory harvesting practices under an appropriate silvicultural regime, and implementation of a strict protective measure used to be the main thrust of sustained yield forest management. It was primarily geared towards the improvement of growing stock and sustained production of desired forest from forests, mostly commercial wood.

Although, the net area of established plantations in Tropical Asia and the Pacific show the largest share in the global total (73% of the world total in 1990), the share of South Asia was only 19.758 million ha, out of which, India alone takes some 18.9 million ha and the remaining 0.9 million ha is disproportionately distributed among the other six countries. Table 5.

Table 5: Production of Roundwood and Woodfuel in RWEDP Member Countries, South Asia

Country	Forest Area (million ha)	Woodland (million ha)	Plantation (million. ha)	Total Round wood Production in 1992 (million m^3)	Total Woodfuel Production** in 1992 (million m^3)	Share of Woodfuel in Total Production (Percentage)
Bangladesh	0.769	1.121	0.335	31.907	31.014	97
Bhutan	2.809	NA[5]	0.005	1.610	1.332	83
India	51.729	16.771	18.900	282.359	257.789	91
Maldives	0.001	0.00	NA	NA	NA	NA
Nepal	5.023	0.327	0.080	19.591	18.971	97
Pakistan	1.855	3.195	0.240	26.567	24.379	92
Sri Lanka	1.746	0.354	0.198	9.229	8.566	93
Total	63.932	(21.768)*	19.759	399.523	342.051	86

Source: Forest Area from FAO (1994); Total Round Wood and Woodfuel Production from FAO's Yearbook, Forest Products 1981-1992 (FAO, 1992).

Note: * Actual figure may be more than presented as Bhutan data do not include other woodland.
** Includes both fuelwood and charcoal.

[5] Discrepancy in figure, without other woodland and plantations FAO (1993) presents 2.809 million ha.

1.6. Status of Participatory Forestry Development

FAO (1993) reported a considerable achievement in non-industrial tree plantations during the 1980's, including the expansion of the area under agroforestry systems. Out of a total 19.756 million ha plantations at 1990 in the tropical countries of South Asia, 18.9 million ha (or about 96%) was confined to one large country India, the other six countries shared the remaining 0.859 million ha. (Table 5).

A major portion of these plantations was established after the energy crisis of the early 1970s under different reforestation/afforestation schemes, including rural development agroforestry schemes. Further, many participatory forestry development programmes with different names, were established in the South Asia region, also during the 1970's and 80's. Extension programmes of different sectors started integrating tree planting into private lands as an additional strategy to boost firewood production for subsistence. In hilly and mountainous terrains, watershed management and conservation planting started receiving priority, at least in the national policy and periodic development plan documents. The important role local people play, in both resources depletion as well as management, was recognized by allowing direct participation of local communities and other user groups in natural resource management and environmental conservation, including conservation of forest and wildlife.

Establishment of scattered plots of trees in fields previously devoted to agriculture (e.g., the eucalyptus and poplar drives in India, and the accelerated private planting of Sissoo, Acacia, Ipil Ipil trees in small patches in private non-forest lands in other countries, etc); distribution of free tree seedlings to promote private tree planting around homesteads; improved access to and supply of better quality planting stocks of desirable species; establishment of tree growers' cooperatives to raise farmers' bargaining power for better wood prices, etc have been the commonly promoted activities under different types of participatory forestry development programmes. With the initiation of these new development programmes, wood grown by the private sector under the participatory development strategies are becoming increasingly important sources of woodfuel. Similarly, trees from non-forest plantations (i.e., fruit orchards, and tea, rubber, coconut, coffee plantations) raised by the private sector and/or industries, though unintended, produce wood and other biomass as a byproduct. Its share is substantially increasing in the national energy balance of many South Asian countries. In this regard, the FAO/RAPA Expert Consultation on Forest Resources Monitoring systems, held in Bangkok between 27 February and 3 March 1995, categorically stated that:

"FAO and other organizations should develop effective methodologies to monitor and assess the forest resources and services coming from non-forest land, as these products play an important role to fulfil the local requirements for timber, fuelwood, fodder, environmental amenities, recreation, etc., and to meet the global requirements." (Durst, 1995)

The increasing thrust on agroforestry in recent years, to improve the equity aspect of benefit-sharing, as well as to promote sustainable land use in upland areas, tends to integrate agricultural crops or pasture (or a combination of both) with trees, either with local people's participation or through individual farmers, in regular rows (in blocks), or as scattered trees along the farm boundaries or on terraces (single linear row of trees). The association between components (other crops) may be permanent (home gardens) or temporary (shifting cultivation, intercropping in newly established tree plantations during the early years of establishment).

Participatory forestry practices including agroforestry have been classified into different types in the region, as per its structure and intended goals and functions in a specific area. Different strategies of agroforestry pursued in the sub-region to maintain, if not improve, the productivity of agricultural land; to enhance food and feed production from a limited area of land; to expand vegetation cover for greenery and environmental preservation, all include tree planting as an important component in them, no matter which sector is the main promoter of development initiatives.

Table 6 presents the contribution of non-forest wood in national/regional energy supply.

Some successful programmes of participatory forestry/agroforestry development schemes in the seven South Asian countries are presented below.

Bangladesh:

Although forests and other wooded land comprise about 15% of the total land area, the natural forest area in Bangladesh does not exceed 6% (Table 1 and 2). All forests and wooded lands have been classified according to their ownership and/or management and use rights under different categories, i.e., state-owned forest, private-homestead forests, protected forests, vested and acquired forests (formerly private forests), **khas** land and costal forests. Of these, state-owned forest and private-homestead forests cover about 11% and 2% of the country's total land area respectively. Despite the fact that the latter category of forest only covers about one-sixth of the area of the former, its contribution to total wood production in the country is very prominent and important, 70% of timber, 90% of fuelwood and 90% of bamboo is produced in the private-homesteads (Quddus et al., 1992).

Most of the forestry development programmes with the local community or participatory forestry development schemes in this densely populated country are designed to address the problems of land rehabilitation and landlessness, in addition to enhance production of basic forestry related needs of the people, which in itself is a challenging job. The popular programmes implemented in the country include: (a) the Community Forestry Project; (b) the Thana Afforestation and Nursery Development Project; (c) the Betagi-Pomora Agroforestry Settlements; (d) the Chittagong Hill Tracts Rehabilitation Programme; (e) the Betagi Community Forestry Project; (e) social forestry and agroforestry programme of the Bangladesh Rural Advancement Committee (BRAC); (f) roadside agroforestry, homestead agroforestry and nursery development, sal forest protection and action research programmes of **Proshika** Manobik Unnyan Kendra (MUK-an NGO); (g) the Village and Farm Forestry Project (VFFP) of the Swiss Development Corporation; (h) the Chittagong Homestead Agroforestry Project (CHAP) of CARE-Bangladesh - both (g) and (h) implemented through NGO's; and (i) the other participatory forestry development programmes implemented by NGO's, such as the Service Civil International (SCI), Gono Unnayan Prochesta (GUP), etc.

Bhutan:

Although biomass plays an important role in the national energy balance of Bhutan, it has not yet received adequate consideration in sectoral planning as compared to other commercial sources. Although the country is endowed with a large area of natural forest, in some parts, mostly along the southern plains, it is experiencing increasing shortages of woodfuel due to population pressure. In recent years, there has been a growing emphasis on tree planting and afforestation in the programmes of the government forestry agency. Despite the abundance of natural forests, the Royal Government of Bhutan initiated its social forestry programme as early as 1979. Two critical issues have identified (Dorji, 1993) the motivating factors for the adoption of this new strategy: localized shortages of construction wood and woodfuels; and the topography/socioeconomy of the country which imposes on the farming systems to integrate multipurpose trees in them. Bhutan's Seventh Five Year Plan (1992-97) includes social forestry as a major development strategy.

The other programme that is being implemented through people's participation in non-forest land is private forestry development. It motivates private individuals to grow multi-purpose trees on their own land and take full ownership of them.

India:

Woodfuel in rural India accounts for almost 65% of the total domestic fuel consumption (Natrajan and Sunder 1985, in Saxena 1993). In urban areas, on the other hand, energy transformation is rapidly taking place in favour of commercial sources (mostly LPG and kerosene- a drop of 40% 1978/79 and 1983/84 (Natrajan 1990, in Saxena 1993).

India initiated its massive social forestry programme in the late 1970s, immediately after the global energy crisis, primarily to overcome the problem of open access due to the rights and privileges of the local people, by creating a separate resource base around the villages to produce the wood requirement (firewood and construction wood) of the local people. Virtually every state in India joined the bandwagon of social forestry, and the Government of India did not miss any major multilateral/bilateral donor when it issued its agencies invitation to support its innovative endeavour. Even to-date, social forestry is an important programme in terms of re-vegetating waste lands (public or state, community or local village level, and/or privately owned marginal lands) for enhancing wood production as well as for the conservation of the environment, also for reducing deforestation and forest depletion in state owned natural forests. Although, more recently, increasing criticism has pointed out the failure of this programme, for not being able to meet the rural subsistence needs of the people (primarily firewood demand of the poor)- the main objective of the programme. Some critics even view the social forestry programme of India as a programme primarily pursued to release the social pressure from national forests (managed under industrial forestry strategy) by developing alternative wood resources around the villages to supply local needs, and criticise it for not succeeding in improving the supply of fuelwood to the rural poor, but instead increased the wood supplies to industries and urban users. But others feel a need to clearly define the objectives of social forestry programmes by clearly stating whether it is for income generation or for firewood and other biomass production, for domestic consumption by the participating community, or for the enhancement of the environment, or a combination of all. (Banergee 1988).

The other type of participatory forestry scheme widely practised, which is based on non-forest area tree planting is farm forestry. This is designed to expand tree cover in privately owned lands, mostly in marginal/sub-marginal agricultural lands. The average rate of plantation survival under this scheme is reported to be around 60%.

Joint Forest Management (JFM) is a new initiative undertaken recently in a majority of Indian states(i.e., West Bengal, Bihar, Himachal Pradesh, Jammu and Kashmir, Haryana, Rajasthan, Madhya Pradesh, Maharastra, Gujrat, Orissa, Andra Pradesh). It is a management strategy pursued to regenerate and develop the degraded natural forests by involving village communities and voluntary agencies in protection and management, who, in exchange for their participation, receive fuelwood, fodder and small timber. Villagers and tribals living in and near the forest area are recognized as the primary beneficiaries of JFM (for distribution of produce from such forests), and equity and environmental concerns more important than the mere earning of revenues. (Saxena 1993).

Maldives:

According to RWEDP (1989), firewood is the only indigenous source of energy which is used by about 90% of the population for cooking- a small amount is also used for fish processing and lime making outside the domestic sector. Massive reforestation and energy conservation are the two strategies incorporated into the National Development Plan (1988-90) to enhance woodfuel production and also to preserve the environment.

Management of natural forests and mangroves are important activities undertaken in the country, since the island population depend heavily on firewood from forests. More recently, some private individuals and companies have initiated planting of fruit and timber trees as commercial enterprises. A national project of countrywide coverage is reported to be under preparation to replant timber trees, but inadequate financial resources has been presented as a constraint to its early implementation.

Nepal:

The commonly practised traditional non-forest tree plantations in Nepal have originated primarily to satisfy the subsistence needs of food, fodder, fuelwood, timber, and soil protection, which Denholm (1991) calls "the intentional manipulation of land unit" out of necessity in the Hindukush Himalayan regions. This traditional agroforestry system includes the tree gardens, and the homestead, farm boundary and other wooded land trees.

The Master Plan for the Forestry Sector, 1988 of Nepal recommends new strategies for forestry development based on local community and private sector participation. The recommended programmes to implement this strategy under priority include: (a) Community Forestry Development; and (b) National and Leasehold Forestry Development, primarily for meeting the basic forest product needs of the people and the raw material needs of the forest-based industries. Numerous projects under bilateral and international assistance, with different labels covering different parts of the country, have been operational since then, to implement the recommendation of the forestry master plan. Furthermore, private planting in the form of farm forests and/or isolated trees in or around privately owned lands has been intensified under the private forestry development programme of the master plan.

Management of natural forests through forest user participation has been the new strategy applied recently for enhancing the production of wood required for subsistence by the hill farmers and also to augment forest conservation.

Pakistan:

Ouerghi (1993), citing the Pakistan Household Energy Strategy Study (HESS) 1991, highlights the important role played by non-forest trees in meeting the energy demand in the country. It categorically states that there is a distinct gap in supply/demand according to the principles of supply gap theory (consumption 32.5, sustainable productivity 23 million ton per year in 1991) which suggests further depletion of resources. But at the same time, it also suggests that, considering the dynamics of behavioral changes due to increasing scarcity, higher demand and socio-economic and cultural changes, the wave in tree planting has already begun, and if maintained could even increase by some 10 to 15% by the year 2008.

Citing HESS (1991), it further states that 125 million trees were planted by farmers in 1990-91. The share of non-fruit trees in it was almost 90%. Most of these trees are being raised under small scale farm-, agro-forestry practices on private lands, also as part of the ongoing social forestry development programme. No new state owned lands are allotted to forest department for its social forestry development programme, so it intends to achieve the target of expanding tree covered area from 5 to 10% in the country primarily by involving the private sector and its land. Some important programmes from the point of view of wood energy include: (a) the Malakand Social Forestry Project; (b) the Agha Khan Rural Support Programme; (c) the Forestry Planning and Development Project; (d) the Forestry Planning and Development Project; (e) the Sindh Forestry Development Project, (f) management of natural forest and irrigated plantations; etc.

Sri Lanka:

The Forestry Master Plan of Sri Lanka, 1986 presents a net loss in natural high forest area between 1956 and 1983 at about 40% (from 2.9 million ha reduced to 1.75 million ha). In order to reduce further loss, some forests have been classified as protected areas and the Forest Department has established tree plantations to maintain the forest cover. Since the late 1970s numerous projects have been implemented to support the extensive reforestation programme on *chena* lands and grass lands, but the drive did not continue after 1988. Non-forest wood resources (tea, rubber and coconut), home gardens and homestead trees, which accounted for 2.9 million ha (45% of land area of the country) produce 50% of industrial logs and 80% of woodfuel. In order to achieve self sufficiency in the supply of fuelwood and industrial logs, the master plan categorically suggests the implementation of programmes such as: (a) regeneration of existing plantations; (b) new industrial plantations; (c) block fuelwood plantations; (d) farmers' woodlots; and protection plantations. To develop non-forest wood resources it has been recommended that 13,700 ha be planted each year until the year 2000 (giving a total 205,900). This plan is, however, currently under review.

Table 6: Overview of Available Data on Fuelwood Sources in South Asian Countries

Country	Total Fuelwood Consumption (million ton)	Share of Forest Wood (%)	Share of Non-forest Wood (%)
Bangladesh	5.5	13	87
Bhutan	NA	NA	NA
India	94.5	26-53	47-74
Maldives[6]	0.08	NA	NA
Nepal	11.3	66	34
Pakistan[7]	29.0	10*	90*
Sri Lanka	9.1	25	75

Source: Koopmans (1993), figure does not specify any particular year; derived or estimated from secondary information sources relevant to the subject (i.e. for Bangladesh: the Bangladesh Energy Planning Project, and the figure is for 1981; for India: Natarajan, 1985 and Leach, 1987; for Nepal: Forestry Master Plan 1986; for Pakistan: Ouerghi (1993); and for Sri Lanka: Forest Master Plan 1985).

Note: * State forest in Pakistan only contributes 2 million m3 and the non-forest lands provides a major share, 20 million m3 of fuelwood.

1.7. Conclusions

Selection of an appropriate model of forestry/agroforestry extension programmes depends upon the specific objectives the programme intends to attain. From the view point of wood energy production, numerous factors could play a significant role, both positively or adversely. Besides the edaphic and environmental factors in a particular geographical area, other issues include different aspects of natural resource management such as technical, social, economic, and institutional. Therefore, to promote wood energy production under this strategy would require a thorough knowledge of the local socio-economic characteristics of the area where changes in farming and/or existing land- and resource-use practices are contemplated, including sound understanding of the local traditions and cultures regarding tree species, tree planting as well as tree species preferences for different purposes.

Almost everywhere, there seems to exist an on-going tradition, indigenous knowledge and methods or practices of land management, which often incorporate trees into the farming system in use. However, the problems of increasing population, poverty and marginalization have been more severely affecting the South Asia region, with direct impact on existing natural resources.

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[6] Data source for Maldives: Regional Energy Development Programme (RAS/86/136), Sectoral Energy Demand in Maldives, November 1989. Woodfuel consumption figure for 1988.

[7] Ouerghi cites Pakistan: HEES, 1993 for its data source.

The effects of which are an increasing intensity of forest degradation and natural resources depletion, associated with an accelerated rate of urban sprawl due to the migration of the rural poor for alternate sources of employment/income. This has also exacerbated the problem of energy demand/supply imbalance. Although there seems to be a growing tendency of inter-fuel transformation in favour of "modern" energy sources (e.g., LPG, electricity, kerosine, etc.) in most urban areas, ease of availability, reliability and affordability of alternative sources affect the decision of consumers, and may not always favour the modern energy option. Available current information indicates that a majority of the people, who are also poor, in the region will not be in a position to afford the extra cost or initial investment required for the accessories and appliances to replace the use of conventional energy sources. Moreover, rural people do not have many options to choose from, and to them the only energy option available will be biomass (i.e., woodfuels and/or residues). But, on the other hand, if they are forced to use increasing amounts of residues, it will adversely affect the natural nutrient recycling process of the soil, and is sure to affect both productivity of farms and the crop yield. What it implies in the long-run is further poverty and marginalization. The other factors which affect the energy transformation process are the type of cooking practices and food habits of the people.

With growing emphasis on economic prosperity, woodfuel in many countries is being treated as "dirty" and poor man's energy by most urban dwellers. But due to increasing demand and localized scarcity, it is also emerging as a marketable product, which not very long ago used to be a non-traded commodity primarily gathered free of cost from available sources by the users themselves. With the limited scope of energy transformation to conventional sources in most rural and sub-urban areas, both for domestic as well as industrial and commercial uses, the potential of economic production of woodfuel has become more and more feasible. The case of Pakistan with 90% woodfuels supplied from non-forest areas by private farmers is an unique example of its sustainable development potential. This, plus the renewability aspect of wood energy and the positive contributions it makes to the global environment favours the increasing use of woodfuel for numerous different purposes in the future. The additional potential of woodfuel is the prospect of generating "modern energy" by using it as the source or primary energy- (i.e., methane, dendro-thermal, etc.). This possibility further reinforces its continuing demand in the long-term and opens the prospect for further development for future use. All these positive aspects could now contribute favourably to the advancement of agroforestry practices in the sub-region and promote sustainable landuse. Therefore, RWEDP member countries in the sub-region may benefit positively by incorporating wood energy development as an additional strategy into their land based extension programmes. It can incorporate uni- or multi- purpose tree species acceptable to people for local or commercial purposes. It can introduce both indigenous or exotic species for producing desired products, depending upon the scale of operation and characteristics of an area, either under a short or long rotation, and also for better economic return or for increasing the supply for domestic use in rural and peri-urban areas. In addition to its direct contribution in benefit maximization to farmers, participatory forestry programmes in general and agroforestry programme in particular will promote a sustainable land use practices as well as help expand tree cover for the creation of better living environment. Further, it will also maintain or enhance the productivity of farms and help generate incomes to rural farming families with limited (or no) opportunity of employment outside the limited agricultural lands they own/hold, by creating a favourable atmosphere for generating employment opportunity in the wood energy sector.

The other factors which could affect the development of and contribution from forestry/ agroforestry, agriculture extension programmes with integrated wood energy production strategy may include land ownership and tenure; tree ownership and right; national policy and legislations governing tree farming, woodfuel production (harvesting and conversion) and its flow to the market (trade and marketing); etc. All these issues directly affect the success of rural extension programme based on land resources. Integration of woodfuel production strategy in extension programmes may be both a positive factor for motivating rural people in better land use practices, or a hurdle to participatory management and sustainable landuse, if subsidized alternative supply sources exist. If participating farmers are allowed to harvest, utilize and/or trade at their will the total wood they produce, there can be no problem for its production under economic, social or environmental grounds. Therefore, such schemes should be supported with cash and other incentives (provision of initial investment funds, initial maintenance cost of farming family, etc. from commercial banks or other lending institutions as loans) under easy and accessible arrangements. A move towards this direction may also call for inclusion of these issues as topics for further studies and research in the immediate future.

1.8. Energy Contents

1 Ton wood = 15 GJ (air dry, 20% moisture; and 20 GJ at 0% moisture)
1 Ton Oil Equivalent (TOE) = 42 GJ (MTOE = 1 million TOE)
1 Ton Coal = 30 GJ
1 m^3 fuelwood equals 0.33 ton coal equivalent (TCE)
1 Ton Charcoal = 28 GJ
1 barrel oil (bol) = 159 litre (litre = 1/7 ton approx)

1 metric ton charcoal equals 0.986 metric ton of coal
1 metric ton of bagasse is valued at 0.264 TCE
1 Petajoule is $10x^{15}$ joules.

Conversion Factor: J = Joule
kJ = kilo Joule = 10^3 Joule
kilo= 10^3; mega = 10^6; giga= 10^9; tetra= 10^{12}; peta= 10^{15}; exa= 10^{18}

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2. POLICY AND STRATEGY OF THE FORESTRY SECTOR IN SUPPORT OF NON-FOREST AREA WOOD PRODUCTION: AN OVERVIEW OF BANGLADESH

Ali Akbar Bhuiyan

Bangladesh is one of the mega population countries of the world, ranking ninth in order of population magnitude. But in terms of land area, it ranks one hundredth. This amply demonstrates the population density per unit area and the pressure of population on land. In fact, except for some city states such as Singapore, Hongkong or the like, Bangladesh is the most thickly populated country on the globe having more than 800 persons per square kilometer.

With a low level of literacy (about 30%) and a poor industrial base, the economy is primarily agrarian. 85% of the people live in the rural areas and grossly depend on some form of land-based production system for subsistence. Naturally, land is the most precious possession and status symbol; land is also a very scarce resource and land hunger is widespread. This state of affairs speaks of the enormous pressure of population on land. State owned forest lands, being open-yard property stretching over hundreds of kilometers, are victims of encroachment bids from the landless rural community. This way, a large proportion of the accessible forests have either been destroyed and encroached for cultivation and dwelling, or the density of tree cover has been alarmingly reduced giving many areas a savannah or scrubby jungle look. Thus, although 15% of the land area of the country is classified as forest only 6-7 % areas are estimated to be actually covered with stocked forests; the remaining forest lands are either denuded or scrubs.

Because of the resource constraints, capital intensive commercial energy development in the country is at a very low level. Of the total energy consumption, only some 25% is commercial energy, the bulk of which is imported items and importation of such energy fuel costs the country about 60% of its scarce export earnings. Nearly 75% of the country's present energy requirement is, however, met by traditional supply sources of mostly biomass origin including crop residues and animal dung. But such supplies are unsustainable and done through over exploitation of the resources base and at the cost of ecological disaster and impoverishment of farm land soils.

The country has about 2.2 million ha of land area legally classified as forest. Of these, 1.49 million ha are under the control and management of the Forest Department (FD). The balance 0.73 million ha., termed as Unclassed State Forests (USF), is under the authority of the Land Ministry where no forest management is practised or felling regulations exist. This delicate, hilly, but potential forest land is practically denuded of forest cover because of unregulated felling and shifting cultivation practised by tribal communities.

The forests of the country however suffer from skewed distribution in that 95% of the forests are concentrated in two border zones in the south-west and south-eastern regions. Most of these forests are difficult to access or are inaccessible. Consequently, whatever benefits genuinely could be expected from the meagre forests of the country are not available to the citizens. Due to this eccentric forest distribution, the supply situation of the forest based woodfuel is also uneven. While the southern zone is surplus in fuel wood, the northern zone is grossly deficit; the per capita per annum woodfuel consumption in the southern zone exceeds 60 kg but for the northern zone it is only about 12 kg. Fuelwood, even if offered free of cost to someone from the remote areas of the southern hill forests, will not be attractive because of excessive transportation costs involved in the extraction process. The same situation applies in the central and northern flat countryside where the bulk of the population lives. As a consequence, the contribution of forest based woodfuel in the overall energy balance is only marginal and imperceptible.

The following table represents the main sources of energy and depicts the energy balance of the country for the year 1990.

Table 1: Energy Balance Table 1990

In Peta Joule (10^{15} Joule)

Description	Commercial Energy						Biomass Fuels					
	Natural Gas	Crude Oil	Petroleum Product	Coal	Electricity	Total Comm.	Agric. Residues	Tree Residues	Fuel Wood	Dung	Total Biomass	TOTAL ENERGY
1) SUPPLY												
Primary Production	163.4	-	2.7	-	3.3	169.4	316.6	22.5	88.2	71.7	499.0	668.4
Import	-	53.4	48.0	12.3	-	113.7	-	-	-	-	-	113.7
Export	-	-	-6.3	-	-	-6.3	-	-	-	-	-	-6.3
Stock Exchange	-	-5.9	-6.8	0.1	-	-12.6	-	-	-	-	-	-12.6
Total Primary	163.4	47.5	37.6	12.4	3.3	264.2	316.6	22.6	88.2	71.7	499.0	763.2
Primary Percent	21.4	6.2	4.9	1.6	0.4	34.5	41.5	2.9	11.6	9.4	65.4	99.9
2) TRANSFORMATION												
Refinery	-1.0	-47.5	44.1	-	-	-4.4	-	-	-	-	-	-4.4
Thermal Power	-69.3	-	-8.8	-	24.4	-53.7	-	-	-	-	-	-53.7
Losses & Own Use	-9.9	-	-4.0	-	-8.3	-22.2	-	-	-	-	-	-22.2
Total Final Supply	83.2	-	68.9	12.4	19.4	183.9	316.6	22.5	88.2	71.7	499.0	682.9
3) CONSUMPTION												
Domestic	9.3	-	23.6	-	4.9	37.8	243.0	22.5	67.3	71.7	404.5	442.3
Industrial	14.0	-	7.0	9.5	10.0	40.5	73.6	-	19.1	-	92.7	133.2
Commercial	3.1	-	-	0.4	3.6	7.1	-	-	1.8	-	1.8	8.9
Transport	-	-	25.0	2.5	-	27.5	-	-	-	-	-	27.5
Agricultural	-	-	11.0	-	0.9	11.9	-	-	-	-	-	11.9
Others	-	-	0.3	-	-	0.3	-	-	-	-	-	0.3
Non-Energy Use	56.8	-	2.0	-	-	58.8	-	-	-	-	-	58.8
Total Final Consumption	83.2	-	68.9	12.4	19.4	183.9	316.6	22.5	88.2	71.7	499.0	682.9
Final Energy Percent	12.2	-	10.1	1.8	2.8	26.9	46.4	3.3	12.9	10.5	73.1	100.0

Conversion Factors						
Natural Gas	1 MMCF	= 0.000 PJ	Electricity	1 GWh	= 0.0036 PJ
Crude Oil	1000 Tonne	= 0.0427 PJ	Petroleum Product (Av.)	1000 Tonne	= 0.0427 PJ
Coal	1000 Tonne	= 0.027 PJ	Fuelwood	1000 Tonne	= 0.0151 PJ
Agri. & Tree Res.	1000 Tonne	= 0.0125 PJ	Dung	1000 Tonne	= 0.0116 PJ

Source: GOB 1990.

1 PJ = 70,500 tonnes = 10^5 m^3 wood

88.2 PJ = 6.21 million tonnes = 8.82 million m^3 woodfuel

Table-1 above demonstrates that the traditional energy derived from biomass is the major energy consumed in both rural and urban sectors. The biomass includes fuelwood, twigs, leaves, charcoal, crop residues, plant residues (viz, bagasse, jute stick and straw), and animal dung. Total amount of biomass supplied in the unorganised sector during 1990 was about 32.3 million tonnes (FMP 1992). The category-wise source of biomass energy and use pattern is depicted in tables 2 and 3.

Table 2: Biomass Energy Consumption in 1990 : Sector-wise and Source-wise Consumption.

(in Peta Joules)

Source of energy	Consuming sectors			Total	Percent contribution
	Domestic	Industrial	Commercial		
Agricultural residue	243.0	73.6	-	316.6	63.0
Tree residue	27.2	-	-	27.2	5.5
Fuelwood	67.3	19.1	1.8	88.2	17.5
Dung	71.7	-	-	71.7	14
Total consumption in PJ.	409.1	42.7	1.8	503.7	-
Total consumption in %	81.2	18.4	0.4	100	100

The most redeeming feature of table-2 and 3 is that woodfuel contributed to only 12.9% of the total national energy supply, while its share as energy derived from biomass sources is 17.5 %. But considering woodfuel as a whole, only about 6% supply (0.37 million m^3 out of 6.21 million m^3 consumed in 1990) came from state owned forests. The balance 94% came from village groves and rural homesteads. That means, of the total biomass fuel consumed in the country, the contribution of state owned forests through supply of woodfuel is currently less than one percent (0.73%), which is truly marginal. That is to say, if no fuelwood at all comes to the market from the state forests, it will not have a significant affect on the market supply position or on price. The situation is also similar in respect of bamboo supply, where the contribution of forests is about 10% only.

The foregoing analysis of the situation thus clearly dictates the focus of attention in wood and woodfuel production. The non-forest sector is clearly the saviour of the country in matters of wood and wood energy production and supply. The state policy should therefore foster and facilitate tree plantating in the non-forest area viz. homesteads and village groves, marginal public and private lands including strip lands, farming lands, institutional compounds etc. Formulation and follow-up of an appropriate strategy should also facilitate proper implementation of people oriented, service directed production programs.

Table 3: Estimated Fuelwood and Agricultural Residue Consumption, 1990

Type of enduse	Type of energy used					
	(in million tonne)			(in Peta Joule)		
	Fuelwood	Residue	Total	Fuelwood	Residue	Total
I. Domestic Cooking						
Rural	0.821	24.110	24.931	12.40	301.37	313.77
Urban	3.472	2.232	5.704	52.42	27.90	80.32
Subtotal	4.293	26.342	30.635	64.82	329.27	394.09
percent of Grand Total	13.32	67.70	81.020	13.32	67.70	81.02
II. Agro-based industry						
Paddy parboiling	-	2.745	2.745	-	34.31	34.31
Paddy processing	-	1.717	1.717	-	21.46	21.46
Tea processing	0.079	-	0.079	1.20	-	1.20
Sugar milling	-	0.324	0.324	-	4.05	4.05
Sugar cane gur	-	0.839	0.839	-	10.49	10.49
Palm gur	-	0.139	0.139	-	1.74	1.74
Tobacco curing	0.066	0.046	0.112	0.99	0.57	1.56
Baking	0.081	-	0.081	1.23	-	1.23
Sub Total	0.226	5.810	6.036	3.42	72.62	76.04
III. Non Agro-based industry						
Brick burning	0.754	-	0.754	11.39	-	11.39
Road tarring	0.023	-	0.023	0.35	-	0.35
Soap	0.009	-	0.009	0.14	-	0.14
Pottery	0.034	0.012	0.046	0.51	0.15	0.66
Lime	-	0.034	0.034	-	0.43	0.43
Others	0.026	0.049	0.075	0.39	0.61	1.00
Sub total	0.846	0.095	0.941	12.78	1.19	13.97
Industry Total	1.072	5.905	6.977	16.20	73.81	90.01
Percent of Grand Total	3.33	15.17	18.500	3.33	15.17	18.50
IV. Commercial	0.121	0.040	0.161	1.82	0.50	2.32
Percent of Grand Total	0.38	0.10	0.480	0.38	0.10	0.48
V. Grand Total	5.486	32.286	37.772	82.84	403.58	486.42
Percent of Grand Total				17.03	82.97	100
in million m^3	7.790			7.790		

(GOB, 1991)

Conversion Factors: Fuelwood 1000 tonne = 0.0151 PJ Residue1000 tonne = 0.0125 PJ Fuelwood 1 tonne = 1.42m^3

2.1. Policy and Strategy in Support of Non-Forest Area Wood Production

Policy

For the first time, the government of Bangladesh expressed its political commitment to the development of forest resources, preservation of bio-diversity, maintenance of ecological balance and restoration of environmental equilibrium. To this effect, a Forestry Master Plan (FMP) has been prepared and its recommendations have been recently approved by the government. A series of policy documents viz. National Environment Policy, 1993; National Forest Policy, 1994; and National Energy Policy, 1995 have also been approved to give practical shape to the political commitment. The government also exhibited its good intention to mobilize financial resources for implementation of the aforementioned policy decisions and FMP recommendations through a prospective national socio-economic plan which is now being given final shape. A donors' forum for fund commitment for implementation of projects under FMP is going to be held in November, 1995.

The salient features of the newly approved forest policy, in so far as it relates to support to non-forest area wood production, is reproduced below :

- Attempts will be made to bring 20% of the country's land area under forest and tree cover through afforestation programs of the government and private sector by the year 2015 by accelerating the pace of the program through the coordinated efforts of the government and NGOs and active participation of the people in order to achieve self reliance in forest products and maintenance of ecological balance.

- Because of the limited extent of reserved forest land in the country, effective measures will be taken for afforestation in rural areas, in the newly accreted islands in the coastal areas and in the denuded Unclassed State Forests of CHT and northern zone of the country including the Barind tract.

- Private initiatives will be encouraged to implement afforestation and tree plantation programmes in rural areas in the privately owned waste and marginal lands including banks of tanks and ponds, and homesteads. Technical and other support services will be extended for introducing agroforestry on privately owned fallow and marginal lands, and agricultural fields. In these cultivation processes, attention shall be directed to ensure that the output of grass, creepers and fodder plants for cattle feed in public and private fallow land is not hampered.

- Initiatives will be taken to implement tree plantation programmes in the courtyards and adjoining vacant places of rural institutions such as Union Parishad, school, madrasha, eidgah, mosque, temple, club, orphanage home etc. The government will earnestly encourage such initiatives in all possible ways and extend technical, logistic and other support services.

- Massive afforestation programmes will be undertaken in the waste and marginal public fallow lands by the sides of roads & highways, railways, dykes and embankments, banks of government owned tanks and ponds through government programmes as well as through participatory arrangement with private individuals and groups, and non-government organisations. Side by side, rubber cultivation will be encouraged in suitable locations of the country including Chittagong Hill Tracts, Sylhet and Modhupur Garh areas under both public and private entrepreneurship.

- Special afforestation projects will be undertaken in all Municipal areas of the country, especially the densely populated ones in order to keep the city environment pollution free. Municipal and City development authorities and other relevant authorities will design suitable projects to implement this programme. In the planned residential areas, a definite quantum of land shall be earmarked at the very planning stage for ensuring tree plantation/afforestation.

Strategy

The policy statement gives indications regarding the strategies to be followed in achieving the policy objectives. However, the broad strategy to support non-forest area wood production may be summed up as follows :

- Expand the forestry extension service programmes up to grassroots level by

    - motivation through development communication methods (i.e. publicity through media viz, radio, TV, A-V vans, newspapers, posters, public address, farm visits, school curricula etc.), and
    - Organizing massive extension training programmes to village leaders, teachers including religious teachers, private nursery men, social workers, philanthropic and youth organizations etc.

- Promote self-employment through nursery business in the rural and urban settings by extending soft term loans, technical training and extension advice.
- Foster agroforestry on farm land as well as on private marginal and waste lands through appropriate technical, logistic and financial support.
- Promote participatory forestry on marginal public lands (i.e. strip lands by the side of roads, railways and embankments), common property community lands, institution compounds etc.
- Bring about qualitative and quantitative improvement of the homestead and village groves through motivation, logistics supply and advisory services.
- A Tree Farming Fund will be created with internal and external resources to foster tree farming as a competitive economic activity.
- World Food Programme assisted tree plantation projects are being encouraged and streamlined by employing rural landless and poor community as poverty alleviation and resource building measures through a benefit sharing mechanism.
- Prime Minister's trophy for best tree planters (individual or institution) has been introduced from 1993 to encourage non-forest area wood production and environmental amelioration.

2.2. National Energy Policy, 1995

National energy policy for the country was approved by the government of Bangladesh for the first time in September 1995. The policy is a broad-based document and addresses the total energy issue; the current status and future programmes contemplated under both non-renewable and renewable energy sources. Although renewable energy includes biomass, solar, wind, mini/micro hydro, tidal, wave and geothermal energy sources, the salient features of only the biomass energy policy is reproduced below :

Conservation

- Conservation at end use level of biomass fuels is to be implemented through technological intervention, primarily by dissemination of technologies like improved stoves and biogas digesters, provided that these are otherwise found suitable on the basis of financial, socio-economic and technological considerations.
- Conservation measures for use of woodfuel in urban households, for commercial places like hotels and restaurants and as fuel for certain industrial activities are to be encouraged. In this connection similar measures for households are to be given priority.
- Motivation and incentives shall be provided in the rural areas for implementing conservation measures.

Environmental Policy

- Ban on the use of woodfuel for brick burning is to be enforced strictly.
- Use of woodfuel for melting bitumen for road carpeting is to be banned.
- Use of woodfuel in urban areas shall be discouraged and at a later stage restricted by making alternate fuels (e.g. coal, peat, LPG, etc.) available for such purposes.
- Alternate fuels are to be supplied in rural areas at an affordable price to encourage increase in recycling of agricultural residues back to the soil in order to achieve and maintain sustainable agricultural production.
- Watershed management should be an integral part of hydropower projects. Concerned government agencies should take care of soil conservation and afforestation/reforestation issues and other activities to arrest soil erosion and consequently siltation within the dam area.

Afforestation/Reforestation Policy

- Afforestation/reforestation programmes are to be primarily aimed at bringing the forest coverage of the country to an environmentally acceptable level.
- Availability of fuel wood as a source of energy is to be considered only after afforestation and forest management have attained a sustainable level and an excess amount is available after meeting demands for its alternate value added uses such as a source for timber.
- Motivation is to be strengthened to establish that afforestation is a social and moral obligation for every citizen.
- Research on identification of fast growing species of trees, having better fuel and/or timber values shall be strengthened keeping local climatic and soil conditions in view.

- Extension programmes, especially those related to community or villages forestry, shall be planned and implemented through participation of the population living in that locality.
- Phasing of afforestation/reforestation programmes shall be such that the areas like the north-western part of the country, where deforestation has already assumed an alarming proportion, are given priority.

Penetration of Commercial Fuels

- Penetration of commercial fuels, including end user level distribution and retail outlets, shall be ensured and related projects planned and implemented with the same priority as in the case of urban areas.
- Demand for commercial fuel for irrigation being extremely concentrated to a specific season, the logistics of supply of such forms of energy shall be such that supply is reliable and price is fair at all times and particularly during the irrigation season.
- Decentralized demand in rural areas may appear less lucrative to a private company as compared to the concentrated demand in the urban areas. Therefore, as and when the private sector is allowed to market commercial fuels, it should be made mandatory to ensure reliability of supply to rural areas at fair prices. Penalties should be established for the failure of the distributor in ensuring this.
- Retail outlets in the distribution network for commercial fuels shall be located so that the users can reach the nearest outlet easily and without spending much time.

Renewable Energy Technologies

- Biomass fuels have to be supplemented by commercial energy in order to help meet the demands in rural areas on a sustainable basis. But since resource constraints and other problems of logistics may actually impede attainment of such a target, renewable energy technologies are to be considered to bridge the resulting gap between demand and supply.
- Remote and isolated areas, including the off-shore islands, Beel and Haor areas, which are not likely to be brought under the networks of commercial fuels in the foreseeable future are to be considered as potential sites for implementing renewable energy technologies, in spite of their high capital cost.
- Technologies like solar photovoltaics may also be considered even in other places for specific purposes like preservation of temperature sensitive drugs and vaccines, lighting and disaster management in cyclone shelters, where supply of reliable emergency power is more important than any other technical or financial/economic considerations.
- Other technologies like those involving solar thermal conversion, may be considered for use in industries and rural hospitals.
- Assessment of wind turbine technology, compatible with the average wind speed, is to be conducted and such units shall be built at specific locations depending on its economic performance and other technological considerations.
- Technologies like mini/micro hydro, geothermal, tidal power, wave energy and others are to be assessed and considered for implementation based on their relative advantages/ disadvantages of economic, financial and technical parameters.

Tariff and Fiscal Policy

- Pricing of commercial energy may influence both demand and mix of energy consumption in rural areas. Therefore, pricing policy at the macro level shall take due cognizance of its possible impact on rural energy demand-supply matrix.
- Kerosene is used for lighting in the rural areas and lighting is indispensable for attaining socio-economic advancement including the government's goal of universal literacy. Therefore, subsidy on the kerosene price is to be considered.
- All types of taxes and duties on renewable energy technologies shall be waived to encourage their promotion.
- Finance for new and renewable energy technologies shall be provided at comparatively softer terms and conditions in order to encourage their promotion.

Legal Issues

- Legal framework shall be developed and implemented to restrain use of fuel wood for brick burning and road carpeting, with the condition that alternate replacement fuels like coal and peat shall be made available for such purposes.
- Legal framework is to be introduced for inter-connecting small and isolated electricity generating units with the national grids where applicable.

Investment Policy

- Development of rural energy, and especially the introduction of renewable energy technologies will require substantial financial support, especially as most of the rural population may not have such financial capability. As such, a separate financial institution may be organized with the mandate to provide financial support to the rural people on relatively softer term and conditions for helping implementation of energy related projects. Alternatively, existing commercial banks may be encouraged to earmark funds for such purposes.
- Adequate funds are to be allocated for implementation of different programmes and projects related to renewable energy technologies and biomass fuels. Private sector investment shall also be encouraged.
- Bank loans are to be provided for implementation of renewable energy technologies in the urban areas.

3. WOODFUELS UNDER COMMUNITY FORESTRY PROTECTION IN ORISSA, INDIA

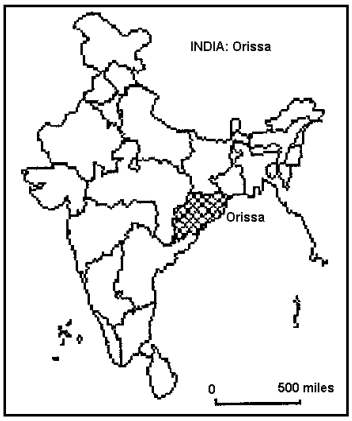
N.C.Saxena

3.1 Forest and People in Orissa

Orissa is one of the poorest states of India. Its per capita income in 1991 was only Rs 3180 (Rs 32 = 1 US $) as against the all-India average of Rs 4974. Orissa has the highest proportion of population below the poverty line, 45 % in 1991, as against the all-India average of 30 %. Eighty seven percent of the population lives in rural areas, and is dependent on agriculture and gathering from forest lands for its livelihood. Forty percent of Orissa s population is tribal, whose livelihoods and lifestyles are traditionally associated with forests.

In the early sixties the total forest cover in the Orissa State was 43 % (6.8 m ha) of the total geographical area. By 1991, according to the Forest Survey of India, the forest cover had been reduced to 34.8 % (5.6 m ha). Estimates of the degraded forest area vary from 1 to about 3 m ha. Sal (*Shorea robusta*) is one of the most important tree species in the state, with a coverage extending over about 1.7 m ha.

For administrative and management purposes, the forests in Orissa are divided into Reserve, Protected and Village forests. In 1991-92, the total forest area consisted of 47% Reserved (2.61 m ha), 28% Protected (1.57 m ha) and 25% Village forest (1.42 m ha). Reserve forests are fully under the control of the Forest Department and are managed under various silvicultural systems. All other forests are included within the village boundaries. In Protected forests, only the forest crop (trees) is managed by the Forest Department, the land is owned and controlled by the Revenue Department. Rights and privileges of the local community vary with the type of forest - restricted in Reserved forests and more liberal in Protected forests. The village forests are generally treated as open access lands with no investment from government, and are extremely degraded except where community protection schemes exist.



3.2. Fuelwood[1] Situation in Orissa

A wood balance study in 1989 showed that the source of domestic fuel of rural households was as follows:-

Table 1: Share of different fuels in rural domestic fuel consumption

source	Percent share in total consumption
wood and twigs	90.4
animal dung	2.8
leaves	3.7
charcoal	1.1
crop residues	1.5
kerosene	0.5

Reserve and Protected forests were the main source of domestic fuel, accounting for 76% of the fuelwood and 49% of the brushwood (twigs) used. Next in importance came village forests, which provided 13% of fuelwood, 32% of brushwood and 15% of dry leaves. Most of the latter - 70% - were collected from the roadside.

Eighty eight percent of rural households and 15% of urban households in the state were involved in forestry activities, mainly the collection of forest produce for their own use but also collection for sale. The wood balance study estimated that men and women collected forest produce in 149 days in a year. Forestry provided 23% of the income of rural households. About one third of the households travelled over 5 km for firewood and 2-5 km for brushwood. Only small proportions of the materials used by rural households as fuel were purchased (sales are likely to be more to meet urban demand).

Over much of Orissa, the population is finding it increasingly difficult to obtain sufficient supplies of fuel through the traditional means of gathering from the forest. However, the extent to which this has occurred varies considerably from area to area within the state. With forest sources becoming increasingly distant, people turn to using the stems of lantana, ipericum, ipomia and other shrubs on nearby common and agricultural land; and to such materials as palm fronds, the stalks of such woody stemmed agricultural crops such as dal (pulses) and pigeon pea, dry leaves and such non-wood residues as rice and maize stover. The landless, and others who do not need dung for their fields use it as fuel.

[1] Fuelwood is used here as a collective term for firewood and charcoal, but as charcoal only represents about 3 per cent of total wood, in round wood equivalent, the term may be generally taken as referring to firewood.

The position of the poor needs to be underlined. Wood is preferred over many of the substitutes they now use; burning more evenly and with less smoke than most agricultural residues. Some of these other fuels are also becoming difficult to obtain, and using them as fuel can have opportunity costs for the user. There is therefore no question that if they could obtain increased supplies of fuelwood it would often improve their situation. However, detailed studies elsewhere in India have made it clear that supplies must be available at no financial cost. With even minimum food needs usually absorbing all their disposable income, and with the option of shifting to other freely gatherable organic fuels, the poor do not purchase fuelwood.

According to the ORG study (1991) domestic cooking constitutes the highest share of firewood consumption in the household sector with an average per capital consumption of 382 kg in rural and 257 kg in urban areas. Boiling of paddy is another activity requiring 59 kg of fuelwood per capita in rural areas and 4.8 kg in urban areas. Other household activities which require fuelwood are space heating, cattle feed preparation, water heating etc. Considering all the domestic activities, the annual per capita consumption of fuelwood works out to 523 kg and 285 kg in rural and urban regions respectively. Moreover, social festivals/ceremonies, space heating in village community centres, cremation of dead bodies are activities at the community level which consume nearly 3.6 kg of fuelwood per capita per annum. The average annual per capita consumption of fuelwood for all the rural artisanal activities (like pottery, blacksmithy, brick making, laundry etc.) is around 15.9 kg. Commercial establishments, hotels, restaurants, tea shops etc. also use fuelwood at 3.7 kg per capita in rural areas and 4.7 kg in urban areas. Considering all the activities the per capita consumption of fuelwood in rural areas works out to around 547 kg and 290 kgs in urban areas[2]. This would mean a total requirement of about 15 million tonne for the entire population, with an estimated annual increase in demand of 300,000 tonnes or 450,000 million cu m.

Estimates for supply are not so reliable. The existing forests, estimated at 5.6 million ha together with homesteads and agricultural areas, would produce 15 million tonne if its productivity for fuelwood alone is 2.8 tonne per ha, which, though much above the present level of productivity, is not difficult to achieve. Thus, the impression created by the Forest Department that forests are put to severe and increasing pressure due to the insatiable demand of the people is not valid. The solutions at the macro level have to be sought primarily in increasing the supply of forest products, rather than on demand management. Thus constraints of low productivity and poor supply of forest products of the type wanted by the people and livestock, rather than biotic pressure and increased demand, should be of greater interest to a policy maker, if an alternative policy framework to save forests is to be considered.

This is not to deny the need for minimising the rate of deforestation and to speed up the afforestation efforts. At the same time, there is a need to conserve the consumption of fuelwood in the household sector through technological interventions like use of improved chulas and bio-gas plants.

[2] A lower estimate has been suggested by the National Sample Survey. According to it, per capita consumption in the rural area in Orissa was only 340 kg of fuelwood.

Although trends for Orissa are not available separately, all-India studies show two main trends. One change involves the increasing use of modern forms of energy for productive and household activities, including irrigation pumping and lighting. A second change is that in some areas rural people, instead of switching up the energy ladder to modern fuels, are switching down the energy ladder to straw, leaves and twigs. The use of inferior fuels for cooking by some rural people have implications for their quality of life. It is also possible that their general purchasing power has gone down.

Since 1985, plantations amounting to some 85,000 hectares have been established on village/ common lands and about 20,000 ha of farm forestry. Yield projections show that approximately 2 cu m per hectare can be expected from these plantations annually. This means that the project plantations can contribute 170,000 cu m per year towards fuelwood demand. Even if the total wood production from such lands were assumed to go for use as fuel, it would not meet more than a third of the estimated annual increase in fuelwood demand. But villages are unlikely to use, say, pulpwood grade material as fuel. They will probably continue to collect fuelwood from other sources, mainly Reserved and Protected forests, for their own use and for sale, and to sell as much as possible of the output from their woodlots.

This underscores the need for producing fuelwood from Reserve and Protected forests through regeneration with people's participation. The necessary policy framework for such initiatives has just been evolved in India through Joint Forest Management programmes. We first describe government sponsored Social Forestry Programme in Orissa, and then the community inspired protection efforts.

3.3. Social Forestry in Orissa

The social forestry programme of planting woodlots on village lands and distributing seedlings to farmers originated in response to the growing pressure on forests for fuel and fodder. The National Commission on Agriculture in 1976 recommended growing trees on lands accessible to village people in order to fulfill their subsistence needs, and free the forests to pursue their original objective of producing timber. The woodlot programme was based on the premise that the initial investment of afforestation would be undertaken by the government, the plantations being later handed over to the village communities for protection, management and distribution of benefits.

The Social Forestry programme in Orissa was funded by the Swedish International Development Agency (SIDA) in two phases, 1983-88 and 1988-94, with a total budget of Rs 270 million and Rs 783 million respectively. Out of the 13 districts in the state, the project covered nine in Phase 1 and all in Phase 2. In both phases, the project had four major components:-

Community Oriented

- village woodlots on government wasteland and community land
- reforestation and rehabilitation of degraded and depleted forests

Individual Oriented

- farm forestry on private land
- Forest Farming for Rural Poor (FFRP)

Survival

The main activity was establishment of woodlots under the first two components. A survey was done in 1992 to study woodlot plantations established from 1984 to 1988. Plantations already recorded by the Project as non-productive (less than 30 % survival, and which amounted to 32% of the total woodlot area) were not included in the sample. An area was categorised as failed if the basal area of trees was less than 3 sq m/ha, and partly non-productive if the basal area was between 3 and 10 sq m/ha. Yearwise results were as follows:-

Table 2: Survival statistics (area in hectares)

	Year of plantation					Total and %
	84	85	86	87	88	84-88
Planted	2196	5501	10697	12470	9955	40819 (100%)
Failed	1125	2053	4049	4624	3349	15300 (37%)
Partly non P	379	1396	2685	2258	2024	8742 (21%)
Net prod	592	2052	3963	5558	4582	16747 (41%)
	(27%)	(37%)	(37%)	(45%)	(46%)	

Based on the field verifications an average of 37% of the area planted between 1984-88 were regarded as failed and another 21% as partly non-productive. Older plantations, raised in 1984-85, had a higher percentage of non-productive areas compared to younger plantations. The reasons for failures seemed to be combinations of:

- less motivated village communities at the initiation of the plantations, resulting in unsatisfactory protection, grazing and browsing, illicit felling, and in some cases even uprooting of planted seedlings at an early stage:
- climatic conditions (like severe drought):
- unfavourable choice of species, rendering some plantations very susceptible to grazing:
- too little extension work by the forest personnel after the initial three years:
- rivalry between various political groups and neighbouring villages.

The most important reasons were nevertheless grazing and browsing. Large parts of the failed areas have, however, potential to develop as the root systems of some constantly browsed and thus suppressed planted species are still intact. Natural regeneration of *Acacia auriculiformis* appeared in many cases. However, these sites must be given adequate protection to facilitate survival and development.

It was noticed that success in village woodlots was closely associated with the success of people's participation. Wherever the village protection committees were active and developed their own approaches to protection and benefit sharing, the plantations had survived. In addition to government sponsored committees, in Orissa a large number of indigenous committees have also sprung up, described later. We first discuss the farm forestry programme and then the availability and distribution of fuelwood from government sponsored projects.

3.4. Farm Forestry in Orissa

Except in the Himalayan and regions of high fertility and steady rainfall, trees did not form an important component of the farming systems in India. Tree density on farms has declined over the years, the area under privately owned tree crops and groves falling from 2.77 % in 1951-52 to 1.15 % by 1980-81. When farm forestry was introduced in the late seventies with a view to fulfilling subsistence needs of rural households for fuel, farmers in the agriculturally surplus and commercial regions of the country saw in the programme an opportunity for substantial cash income as well as considerable savings in terms of labour and supervision inputs. This led to the eucalyptus boom in the early eighties. In subsistence regions, such as Orissa, only a few trees were grown primarily to produce goods for use within the family and in various agro-forestry combinations in which the trees complemented or supplemented other crops, rather than replaced them. Most farm-level tree cultivation was of a kind which was low-risk, requiring only marginal adjustments to existing farming practices. But the picture was radically different in the agriculturally surplus states, where an increased farm income was the driving force, as the farmers felt that by growing trees they could get a better return on their land, labour and other inputs.

Constraints in Orissa

The agrarian structure of the eastern and tribal India is characterised by heavy dependence on grain production, smaller holdings, low overall incomes, a less marketed surplus, imperfect credit markets, more dependence on the village merchant for marketing the small surplus, inter-locked credit and output markets, less monetisation, less diversity of rural incomes, greater debt bondage, a less developed infrastructure for the supply of agriculture inputs, greater insecurity of land tenure, and on the whole poor human capital as far as enterprise is concerned. These conditions can at best promote low intensity tree growing strategies for home consumption, and are not conducive to market oriented high intensity tree planting. Subsistence regions do not accept cash crops easily, and when these are introduced indiscriminately, poor farmers may be harmed rather than helped. Cases of distress sales by the poor peasants to contractors at a throw away price a few years before the crop matures are often reported.

Tree growing has been constrained in the monocropped India by other factors too. First, young trees require protection from cattle, especially in the fallow season, when the village livestock is let loose to browse agricultural residues and stubbles. During these months in a monocropped village the cattle is generally not accompanied by a herder. On the other hand, in irrigated villages a tradition is slowly emerging of herding cattle during the cropping seasons. Despite ecological necessity and the easy availability of marginal and degraded lands, protection of young seedlings is difficult in monocropped villages compared with irrigated villages.

Second, most of India's forests are located in areas of backward agriculture. Villages in this region of low productivity often have vast, though degraded, open access lands. Unlike annual crops which are grown on private lands, trees also occur on forest and other public lands. Open access to public lands may vastly reduce the cost of obtaining tree goods for a gatherer, which may work to the disadvantage of a grower. Thus, the concept of trees as a free good to be obtained from public lands inhibits investment of personal labour, land and capital in tree planting. Proximity to forest lands affects private tree growing in other ways too. The state often restricts farmers' rights to freely harvest the trees on private land in the interest of either conservation or of checking theft from forest lands. These create rigidities in the free flow of products. This may make planning of likely incomes from trees extremely difficult for a farmer. Lastly, if similar products are raised on forest lands, which are marketed through the state machinery, farmers may find it difficult to compete with the state and get a remunerative price, particularly because the traders may be less interested in buying from dispersed producers, and may prefer to deal with the centralised bureaucracy. Evaluation of the first phase of the Orissa Social Forestry Project noted that raising of eucalyptus on forest lands was one of the reasons why farmers did not feel attracted to grow commercial trees on their plots.

Suggestions for subsistence regions

The above factors have limited the spread of market oriented farm forestry to the subsistence regions. A different approach is required, which would be in harmony with the ecological characteristics of these regions. First, a great deal of research needs to be done to identify species which complement agricultural production, as farmers' primary landuse continues to be crop production. Thus the objective should change from "how can farmers be persuaded to grow trees" to "in what manner can technology help in increasing overall production from marginal lands by meeting farmers' priorities?" Ultimately the programme must improve the productivity of degraded private lands if it is to be sustained over a long period. There are some known indigenous practices which use trees to improve land productivity. Similar practices have to be introduced extensively in these regions. For instance, one should give greater importance to species like *Siddha* in Orissa which can easily provide a great deal of fuelwood to the poor families, as it can be continuously harvested for fuelwood. It also does not require any decision about distribution between the rich and the poor. Such a tree is not of much interest to the rich, as it requires labour for gathering. Thus, by default, the benefits are available for the poor primarily. If such species require more time at the nursery stage these could be raised in the central nursery, and then transported to the temporary nurseries.

It is difficult to rehabilitate degraded lands without introducing moisture conservation and water harvesting measures. Such measures are needed for all rainfed areas put to biomass production. The soil conservation technology in India has so far focussed primarily on structural works for controlling and disposing of run-off rather than capturing the maximum amount of moisture in the soil and retaining it for as long as possible to support crop growth. It is better to adopt in-situ moisture conservation practices through planting of suitable grasses and trees which may also provide sufficient protection against erosion.

Equally important are institutional constraints in watershed management programmes. Studies of similar programmes show that planning, organisation and management have been issues of major concern in all projects. In particular, the impact of watershed treatment has been impaired by poor coordination between line agencies, and there has been a marked absence of land user participation in treatment planning and implementation.

Unfortunately, watershed approach and agroforestry research for different agro-ecological regions has remained a neglected discipline. Due to a tradition of competition for land between the agriculture and forest departments of the government, both have viewed agroforestry with suspicion. The Forest Department has even gone to the extent of banning agroforestry on forest lands by law!

Problems of allottees

Under the Forest Farming for Rural Poor (FFRP) scheme, landless farmers are allotted 0.5 hectare revenue land (wasteland), and are given seedlings to plant the same. If the farmer shows satisfactory progress (survival of trees) after three years, he is to be issued a usufructuary lease- 'tree patta'. Even though the scheme has been in effect since 1985, no pattas have been issued as yet. The question of how to do it was referred to the central government, but it concluded it to be wholly within the jurisdiction of the state government to issue the pattas. Since this decision, the matter has been with the Government of Orissa. The question of delays in issuing of usufructuary rights - pattas - to the beneficiaries of the Farm Forestry for Rural Poor component is a source of apprehension for most of the farmers involved.

Because of the delays in issuing of pattas allottees feel their legal status is very precarious. They believe they have no legal right to the planted trees until the written patta is issued, with the effect that no farmer has applied for Timber Transit permits as yet. Several farmers interviewed claimed to have had trees stolen from their plantations without being able to file any complaint with the police. They do not know how to convince the police that they - landless as they are - do own trees.

Commercial regions

Some regions in Orissa, such as the coastal areas, are more suitable than others for market oriented farm forestry. Here the approach should be to link them with markets and industry. This would require a review of legal restrictions on harvesting and sale of trees.

In the case of wood from plantations under farm forestry and FFRP, the Timber Transit Rules apply. These were amended in 1991 and 1992, especially to facilitate trading of the wood produced under these components. Now a transit permit is no longer needed for the two main species grown in the project, eucalyptus and *Acacia auriculiformis*. But such restrictions continue for other species, such as bamboo and casuarina. The procedure for obtaining transit permit is as follows:

Before felling trees, ownership of the land and the trees must be certified by a 'joint verification' by the Revenue Department and the Forest Department. This entails officials from both the Revenue and the Forest Department inspecting the produce in situ.

After the joint verification, the farmer submits a list of conversions of trees and bamboos felled to the District Forest Officer (DFO). The DFO verifies (by physically marking the wood with the forest department hammer) that only what is mentioned in the list really is to be transported.

Thus, the whole procedure requires three visits to the site by Revenue and Forest Department officials and some communication between the farmer and these departments. Understandably, a farmer finds it cumbersome to approach two different departments on at least three occasions, especially since communications between a remote village and centralised departments are bound to take time.

Due to the degree of complexity of the transit permit rules, not many farmers can be expected to fully comprehend them, a factor that might render the farmers easy targets for exploitation. A survey of 12 villages in Sambalpur district in 1991 showed that only 60% of the farmers interviewed had any conception of what the transit rules signify. Of these, hardly 10% had sufficient knowledge to explain the procedures of obtaining a permit.

Lastly, government should stop subsidies on government supply of wood to industries, thereby forcing industry to buy from the farmers at a remunerative price. The entire programme of farm forestry will be frustrated if captive plantations and subsidies continue. FD could also initiate schemes for linking farmers with industries, in ways similar to the linking of poplar growing farmers with a Swedish match factory in north India. Farmers will mostly produce eucalyptus for the paper industry, of which lops and tops can be used as fuelwood.

Production for the market

Though market demand for forest products is likely to conflict with the goal of increasing supplies to subsistence users, it is essential to the success of farm forestry, and in particular of FFRP, which depends upon growers being able to sell at least part of their output. Fuelwood markets and marketing in Orissa are quite complex. A three-tiered price system exists - the heavily subsidised price applicable to rural people for their own use, the administered price paid and charged by the Orissa Forest Corporation, and the free market price. The situation is complicated further by a multiple supply system: headloaders, merchants, contractors and the Corporation.

One effect of the subsidised prices is to create a very low cost source of supply of wood available for use as fuelwood; priced at well below the cost of replacement of growing stock through investment in plantations. As long as this source is available, growers are unlikely to be able to sell their trees to middle men as fuelwood at a price that would be commensurate with the costs they have incurred.

The low value of fuelwood also means that in most situations it is likely to be a less profitable crop for farmers than the growing of trees for sale of poles, construction timber, fruit, etc. This needs to be reflected in the choice of species and management systems recommended to farm forestry and FFRP beneficiaries. It is likely that fuelwood production will be profitable only in a few special situations - for example, on the agriculturally marginal sandy soils of the coast close to markets; or when they can themselves sell directly to markets, so benefiting from the much higher prices for the new product as compared with the price for the tree.

The relatively low market value of fuelwood undoubtedly also helps explain the preference villagers have been expressing for tree species which primarily yield some other product - timber, fruit, bamboo raw material for further processing, etc. These not only have a higher market value, but also are less easily substituted by other locally available raw materials. A shortage of wood for construction or of bamboo for local artisans is thus more sharply felt, and is likely to have higher costs to the villager, than shortage of fuelwood.

The multiple species woodlots, stocked to produce such locally sought after materials, are therefore consistent with the forest products supply-demand situation prevailing at the village level. But it does mean that what is being created is a resource with a considerable market value. This raises once again the question of how well this will serve the needs of the poor for subsistence supplies.

A village level study indicates that farmers possess a very limited knowledge of prevailing market prices and of the produce in demand. Only 45% of the farmers had any idea of where to market their produce (only 7% had a good idea though), while 55% of all farmers had no idea of what price to expect. Most of the price expectations tended to be above the prevailing market price. The implication of this low level of knowledge is that markets will not be able to function efficiently since one of the basic pre-requisites of market efficiency - full, or at least sufficient, information among the actors, is not fulfilled. In practice it will mean that farmers risk exploitation by buyers. Lack of knowledge immediately places the farmer in an inferior position to a buyer who has knowledge of prevailing prices, and of the type of produce that is in demand.

A further legal impediment to commercial activity under the project is the legislation relating to the sale of trees by members of the scheduled tribes and scheduled castes. Such sale requires a special permit. Although this legislation was introduced to protect those to whom it refers against exploitation (many tribals, for example, own trees having a timber value of which they might be unaware), it is of course two-edged. Many of the project beneficiaries are subject to this legislation which needs to be reviewed.

3.5. Fuelwood Distribution from Community Woodlots

One of the main factors sustaining people's involvement in the SIDA project is their expectation of sharing its material benefits. In areas where intermediate produce from woodlots have been distributed, the following methods of distribution were observed:

- twigs and branches were made into bundles of equal size and distributed on the basis of one bundle for one kitchen.
- where economically better off sections preferred not to take material, it was sold to whoever was willing to buy at nominal price and the proceeds were remitted to the village fund. In such cases the buyers were invariably the poor.
- fallen dry leaves were allowed to be collected by interested people on a "sweep and carry basis".

- where damage to standing trees was observed to be a consequence of too many people entering a plantation for sweeping, a contract to sweep was given to one or two persons only. The contractors were permitted to sell the leaves at 0.25 Rs per 5 kg to the villagers who protected the plantation and at twice that price to members of other villages.

Each of these methods of sharing the forest produce has its merits, although one may have reservations regarding the last, which relies on contractors and requires that the poor, whose need for fuel is the more acute, have to pay a price, however small. But the merits and demerits of the sharing system are less important than the fact that the villages are developing their own innovative ways of sharing forest produce equally.

Subsistence use of fuelwood within the village is also bound to be increasingly affected by the growing market for this product, and the monetary value this places on it. In practice, the village is not isolated from the market economy, so that villagers both communally and individually could find it more advantageous to sell their fuelwood production outside the village than to use it themselves. Some villages already see their tree resource as being more valuable as a source of revenue to finance communal projects and activities than as a source of materials for use within the village. This is hardly surprising, given the lack of alternative sources of communal income.

Economic pressures are therefore likely to encourage the diversion of village forest output away from local subsistence use to higher valued market outlets. The provisions in the village forest rules designed to prevent sales outside the village may be neither enforceable nor in the interests of the village as a whole.

This assessment, if correct, clearly has very fundamental implications for some of the main objectives of the government projects, the question of how to provide for the fuel needs of the poor probably needs to be rethought. Though programmes to introduce improved stoves, gobar gas and other sources of energy may make useful contributions for those who can afford them, most of those who presently depend on gathered supplies of biomass fuels will continue to have to do so. More attention might usefully be directed to increasing resources of fast growing high yielding woody shrubs. These can often be diffused at much less cost than trees, they can be cropped more frequently to give a more even flow of fuelwood, and as they do not have alternative uses the material they produce is less likely to be diverted to market outlets.

3.6. Independent Initiatives of Villagers

As already mentioned, in addition to government sponsored committees, in Orissa a large number of indigenous committees have also sprung up. Community based forest protection is not new to Orissa. Communities claim to have taken up protection as early as the 1950s. Guesstimates of the area under protection and the number of communities involved range from 1,87,000 acres and 1,181 organisations to 1.5 million hectares and 6085 villages committees (Forest Department records). There is, however, no consensus on these figures.

Reasons for forest protection by Committees

Orissa's acute poverty provides a challenge, and can also be seen as a positive factor, as it forces almost the entire population in a village to be dependent on forest resources, and this dependence helps in the evolution of a viable village institution. The Orissa upland settlements are more homogeneous in caste, with one tribe usually dominating both in land and number. A study comparing success of collective action in the poor state of Orissa with Gujarat, a richer state, noted that in Orissa, livelihood options are almost nil, whereas in Gujarat migration or agriculture has provided an option to the communites to cope with the problem of deforestation. Hence in Gujarat despite external intervention either by the Forest Department or by NGOs to act as catalysts the programme has only been moderately successful. In Orissa, most FPCs have come up on their own initiative and have survived with almost no incentive from government. Finally, remoteness from roads and markets further helps in retaining mutual obligations, and discourages poaching by outsiders. In remote villages, fear of reprisals from village elders deters too frequent abuse of common resources.

Another reason behind people's success is the lack of full control of the Forest Department over protected forests, which facilitates people's control over such lands. In Orissa, unlike other states of India, the ambiguous status of protected forests provides a highly favourable environment for evolution of community management system. The ownership of the protected forest lies with the Revenue Department but management effectively lies with nobody. Only in the case of a few demarcated protected forests, Working Schemes have been prepared by the Forest Department. Thus large areas of protected forests have been left unmanaged. As the forest started receding further from the villages, the local communities realised that open-access usage of the resources was no longer a realistic proposition and some kind of user group regulation was required to safeguard the interests of the community. This resulted in communities undertaking protection and management of forests, starting with protected forests. Later in a few locations reserved forests (RF) were also taken up for protection by communities which did not have adequate protected forests (PF) in their vicinity or under their control.

Thus an important factor behind the success of community action has been the long term association of these villages with "their forests" and heavy dependence on these, and the loose control of the Forest Department over protected forests.

In most of the cases protection efforts have started only when communities faced acute shortage of small timber for construction of houses and for making agricultural implements. Although there had been considerable reduction in the availability of fuelwood over the years, this had hardly been an initiating factor. Small timber requirement, monetary benefits, and greater availability of NTFPs such as sal seed has often initiated the process.

When one or a few villages in a cluster takes up the protection, accessibility to a particular patch by people from other adjoining villages is restricted. This often triggers off a protection movement in the nearby villages whereby each village starts asserting its right over a patch of land. Thus they restrict each other's access.

Leadership plays an important role in the introduction of the concept of protection to a community. In some cases it was provided from outside the village (by forest department personnel) whereas in some, it was provided by influential people from within the village. Leadership was dependent on the population composition. The more homogeneous the composition the better was the leadership.

Rights of villagers over the protected patch play a critical role in the initiation of protection efforts. Where people have been assured that benefits would flow to the community, protection could be brought about. However, most of the villages in a cluster took up protection only after they had seen the rights of other villagers over the protected patch being recognised by the forest department, although informally. This reflects the importance of clarity in the rights of the villagers over the protected patch.

3.7. The Evolution of Institutional Arrangements

Several kinds of organisations have been formed at the village level to take up the management of forests, Youth Club (YC), Village Council (VC), and Village Forest Protection Committee (VFPC). VFPC are generally of two types, one that is formally formed by the Forest Department under the guidelines issued for the purpose and the second type being a sub-committee of the VC entrusted with management the forest. In some villages although a formal VFPC had been formed by the forest department, management was being undertaken by the YC. Very few people were aware of the composition of the formal committee or of the area that they were protecting.

Budhikhamari, where more than 55 villages were jointly carrying out protection and which has received several awards, was unique in this respect. The VCs of the individual villages were looking after protection and each village council was represented by a president and secretary in the central committee called the Joint Protection Party (JPP). Each organisation, irrespective of its kind, had a president and a secretary generally elected by consensus. Care was taken to involve people from all sections in the cases where the village had a heterogeneous population. Each community had a general body with one person from each household and a core group comprising 4-5 persons responsible for making decisions on a day-to-day basis. Most of the committees were found to be struggling under financial constraints. In order to meet expenses incurred by the protection activities, collection was made in cash or in kind. Expenses were also incurred in conducting rallies for raising environmental awareness, conducting meetings, payment to watchman etc. Revenue for this were chiefly from cleaning and thinning materials which was being sold to the villagers at a subsidised rate. Other sources of revenue included fines collected for the violation of rules by the people within or outside the village. However, it was found to be insufficient to meet the expenses incurred in protection. Funds collected by the VC from other sources such as from the village pond had to be diverted to forest management. This often proved to be a disincentive to the villagers, particularly the weaker sections who perceive protection as an additional economic burden. It was reported that the YC were highly effective in the protection aspect because of their tough stand against offenders and this had often been the reason why the VC had handed over the protection responsibility to the YC.

3.8. Fuelwood Pressure Shift

Fuelwood pressure shift in each cluster was very much evident. Each village in a cluster had its own method of meeting its domestic energy needs. The first source of fuelwood was within the village boundaries. Some hamlet/village had demarcated certain areas which included a part of the Village forest and pasture land for the collection purpose. In some villages, while protection was being done in one patch indiscriminate fuelwood collection was being carried out in another part of the Village forest and pasture land. While vegetation flourished in one part, degradation continued in adjacent patches. Often the village forest was seen as the property of the village, whereas the Reserved forest was that of the department. So, while protection of degraded the Village forests was taken up, the well stocked Reserved forest was left as open access. As a result, this forest is now reduced to an open scrub vegetation.

This raises the question as to what would happen with respect to fuelwood availability if the total area around a village is protected? In such cases, the fuelwood pressure shifts to two other places. First, to those distant Reserved forests with good growing stocks which are managed without community protection. Cycle-loads of fuelwood are illegally extracted every day from such Reserve forests by people of those villages with no area under its protection or if present was very small and highly degraded. Conflict often emerged between cycle-loader and the people of the village through which they generally passed. Cycle-load trading became a lucrative business as demand for fuelwood increased and supply curtailed due to protection efforts in the cluster.

The second type of pressure shift has been to those Protected forests and Reserved forests where the village committees were found to be less effective in their protection activities. Lack of effectiveness was due to internal conflicts, financial constraints and lack of leadership.

The problem of fuelwood pressure shift was relatively less in the Budhikhamari where more than 55 villages were jointly carrying out protection under an umbrella organisation of JPP. Energy requirements were met partly from the collection of dried leaves and, fallen twigs which has become a part of the daily activity of tribal women in various clusters.

A few trends need to be analysed here. Why does a community protect a patch totally degraded with a view to getting a significant benefit after two or three decades and not protect a well-stocked patch which would provide them benefits within a short span of time? It was generally felt by the villagers that it would be easier for them to assert their effort in degraded forests but not in already existing dense forests. Would this lead to a cyclic process of degraded forest developing into a well-stocked forest getting converted to a degraded one? Further, well-stocked Reserved forests or Potected forests are generally not taken up for protection because of fear of threats from within and outside the village boundaries. Threats emerge from those benefiting from a patch in terms of fuelwood and small timber when they are denied access. Thus degraded forests are brought under protection while well-stocked ones are left as open access property.

The issue of fuelwood pressure shift puts serious doubts on the effectiveness of this kind of protection. Can this pressure be contained in any way? Can the cluster approach, where all the villagers are involved in the protection, provide an answer to this kind of problem?

Although the cluster approach of protection does overcome the problem of pressure shift, certain issues in this regard need to be examined. First, what kind of leadership is required to organise such a large number of villagers under a common umbrella? If inter-village conflict exists, then bringing all of them together may result in an abortive attempt to organise a protection movement at a macro level. Second, when a number of villages join together they often perceive their mass as their strength and sometimes they abuse their power. So before organising such a cluster what control measures should the forest department have to check such abuse of power? And what should be the ideal size of the joint committee for effective administration?

3.9. Equity Issues

Looking at the equity aspects of forest protection from the broader perspective, there are large-scale processes causing inequalities between villages. Some villages have to share a large forest area with many other villages, some have much smaller areas which they have to themselves or a few other villages, and some are not adjacent to forest areas at all. Different rates of forest degradation and different degrees of awareness and concern have prompted some villages to take action and to exercise protective control over some forests much earlier than other villages.

Some smaller villages are concerned about being disadvantaged by the larger villages with whom they share access to a forest area. Members of a tribal village adjacent to Damasahi expressed criticism of people from Dhamasahi village because they had taken over land that had been planted with trees given to the village by the government. When asked what sort of problems they expected in the future they said that as the forest gets thicker more people will be attracted and there will be fighting, emphasising that they are “a very small village” and would find it difficult to oppose outsiders.

Potentially, forest protection can lead to a win - win situation, in that NTFPs can provide significant benefits to the poorest villagers; but the conditions for such benefits to accrue consistently will not exist until there is a general acceptance of rule systems which allow for access to these benefits by the poorest.

In many villages it is the “richer” households that are least dependent on the forest. Because of their relative status and authority, even NGOs who initiate community protection have pragmatically sought their active involvement in forest protection. To have such people on their committee was useful for dealing with other villages and external authorities.

Many village forest protection initiatives arise spontaneously when the forests have become very seriously degraded, to the point where even the poorest are having great difficulty getting any of their needs met from forest resources, for example, when rootstock are being dug up for firewood. At these times it is likely that everyone in the village, even the poorest themselves, see forest protection as a win-win situation, where everyone can gain, and few if any will lose.

Nevertheless, there are circumstances where the needs of the poor will be at risk. Firstly, in forest areas where poorer households already have a stake in a forest which is still giving them some return, and in forest areas, especially plantations, where the distribution of returns from future cropping are yet to be agreed upon.

One problem area in particular are those households which are wholly or partially dependent on the collection and sale of firewood for income. Such people cannot stop cutting wood in forest areas even after the introduction of forest protection in their area. Sometimes wood-cutting has been displaced to more distant “unprotected” forests. Often wood-cutting has persisted in the same village, albeit under continuing pressure to stop from the other members protecting the concerned forest. In both cases wood-cutting families are paying the costs of protection, in increased walking distances, or in harassment and fines. The basic issue is the availability of alternative livelihoods to those dependent on the forest, and that does not seem to have been addressed as a development issue by the FD.

In one village, the idea of establishing a firewood plantation to meet the needs of wood cutters was rejected on the grounds that the best firewood trees concerned cannot be grown in a plantation. It also seemed that the allocation of any special usage rights to forest areas to particular groups would inherently be a problem, because it would open up the possibility of other groups making special private claims on common land. In another village, a group of 35 to 40 potters who use wood to fire their pots are directly dependent on the forest. It would be ideal if an area of land should be left for the use of potters, but this advice was rejected by the community, in favour of a policy of total protection. According to potters in the village, they need about three quintals of wood every month to fire 300 pots. Now they are having to purchase wood from the Corporation depot, and collect brushwood from a forest 10 kms. away, and at the same time they are not obtaining sufficient wood to maintain their past production levels. In this village forest protection is not a win-win situation.

The equity issues concerned with current management of the forests pale into insignificance when compared to the impending problems of the future. The forests and plantations are maturing assets, increasing in value and visibility every day. None of the villages contacted had established any long-term management plans, especially for the allocation of benefits from plantations. It could be argued that this is in fact an unreasonable expectation at present, where sustaining what exists is the main task at hand. However, some current decisions, such as the planting of trees over a whole area, versus part-by-part, year-by-year, have implications for the ability of the villages concerned to take continuing yield from the land in the future. This in turn will affect the management of claims for benefits, with one-off distributions being more problematic.

Arrangements for guarding protected forests vary between villages; some use voluntary labour on a rotating basis, others collectively pay for a watchman. It could be argued that the volunteer-based system is more equitable, because for the poorest households cash is in greater scarcity than labour time The optimal arrangement would seem to be the situation found in some villages, where volunteer labour is used by most (called the thengapally system) but the richer households in practice paid poorer people to do their shifts.

3.10. Gender Issues

When women were asked about their preferences for different tree species for plantation, a marked difference was found between the better-off castes and the poorer Harijan (low caste) women. The better-off caste women expressed their preference for teak and Sal trees which can be used for furniture, whereas the poor Harijan women expressed their preference for fruit-bearing trees like Mango, Jackfruit, Guava, Ber, etc.

Despite the above differences, in general all groups of women appear to have understood the need for forest protection and have expressed a positive attitude towards forest protection activities. In one village, women (not low caste but not rich) said that the most important benefit next to fuelwood was the availability of privacy for defecation. They said that when the hills and the foot hills were barren they used to have to walk very far away from the village to find privacy. It was very hard especially if they had to go during midday in summer. But now the regeneration of bushes has made their lives easier.

In contrast to the better-off women, the poorer low caste women always emphasised their need for fuelwood, which they think can be met from the protected forest. This was for their own consumption and in some cases for sale. The better-off women who have purchasing power to buy fuelwood did not see the need to protect forests in order to meet their fuelwood requirements.

In the overall analysis of the problem of environmental degradation, the protecting committees feel that both men and women are affected equally and the benefits of forest regeneration are shared equally by men and women. On the basis of this understanding, the Committees have never felt the need to consult women specifically in the planning and implementation of the project activities. In none of the successful Vcs or Ycs were women represented or consulted. These were exclusively male societies.

3.11. Problems with Government

Rather than trying to locate barriers to community action in structural and sociological factors, or in inter-and intra-village problems, greater attention needs to be paid to governmental policy, which has often hampered such initiatives. Joint Forest Management (JFM) has been promoted in most states by the Forest Department. However, in Orissa there have been indigenous committees protecting forests for a long time and the establishment of these committees had nothing to do with the efforts of the Forest Department, although individual forest rangers have often been involved in giving guidance to such committees. Thus, today there exists no Joint Forest Management in Orissa. However, there is forest protection and management by village committees (VFCs) - with the Forest Department as a passive bystander/ supporter or not knowing about it at all. The initiatives taken by the state government have often resulted in confusion, as described below.

No consultation

The State Government orders of 1988, 1990 and 1993 in Orissa have officially led to formation of nearly 23,000 VFCs. Some of these VFCs are functioning very well, but a large majority have problems, or many may exist only on paper. Often, they were brought into being in a hurry without

giving attention to details, such as adequate consultation with local villagers. In some cases, the area being traditionally protected by the village was allotted to some other village for protection. In some other cases, villages a considerable distance away from a forest patch were allotted the area while the ones in proximity were neglected. Such events occurred due to formation of VFCs on paper by field staff at Range Headquarters. This is a good example of how well-intentioned policy decisions are liable to lead to unforeseen and undesirable results, if not implemented properly.

No authority under law

The resolutions do not have the strength of law. Therefore, VFCs are extra - legal bodies. The state government resolutions recommend village level committees as functional groups. However, these committees have no legal and statutory basis, and it may be difficult for them to manage resources on a long term basis. The VFCs have no power of their own to punish or challenge offenders. Their authority over the forest is very often questioned. This can be avoided if the VFC has legal powers over the patch it protects.

Recognise informal committees

One of the first needs of indigenous committees is official recognition in writing through a letter which the village people can keep. It would be useful if the names of all families involved in protection is mentioned in the letter. However, this is not provided for in the Rules. On the other hand, Orissa government has a bad track record of not honouring commitments, or at least honouring them with great delay, as in giving pattas to FFRP beneficiaries, creating village forests, etc. These committees can also be given some financial help, so that they could buy torches and a uniform of some sort for the watchman.

Ideally speaking, at some stage the informal forest protection committees need to be formalised to give them legal endorsement. The transition/transformation from informal to formal organisations should be made as smoothly as possible, with efforts to retain the strengths, viz. flexibility, representativeness, and acceptability by the community, of the informal organisations. The composition of new committees should be such that it incorporates these strengths. Necessary changes may be made in the existing Government Order for this. The process of formalisation of informal committees is very crucial and needs to be handled with utmost care.

Reserve forests treated as open access lands

In reserved forests of Orissa a forest patch does not have a well-defined and recognised user-group, admitting the rights of the entire population of that region or the entire forest area. This kind of a `right-regime', which makes reserve forests open-access lands, is not conducive to successful protection, as rights of contiguous villages protecting forests may come in conflict with those of distant villages, not protecting but still having rights to enjoy usufruct. Therefore, at least in JFM areas, use rights should be reviewed in order to put them in harmony with the *`care and share philosophy'* which is the basis of JFM. This would require redefining the village boundaries so as to include the reserve forest lands where JFM is to be promoted. Inclusion of reserve forests within the village boundary will strengthen the claim of the protecting village vis-a - vis others.

Demarcation

Demarcation and allocation of the forest area to the village communities for protection is a pre-requisite to the proper functioning of the VFCs. This aspect has not received adequate attention in the 1993 guidelines. The result is that in some cases it has not been done while in some others it has not been adequately conveyed to the villagers.

Demarcation and allocation should normally take the following into account: the prevailing rights and concessions in the forest area, i.e., who uses it for which purpose, is it informal and seasonal as for example for fuelwood, MFP collection, head loading, and grazing and so on and whether the forest area is already being protected by some village or a group of people. Neglecting these points will lead to either conflicts or irresponsible behaviour. This is one of the reasons for the oft repeated complaint against village communities that they protect their forest area at the expense of adjoining reserve forests. The counter point is that if they do not have the right to manage the reserve forest and practice exclusion, how can they be expected to protect it?

Uncertainty about sharing of produce

In the villages which have started protecting forests after the formation of VFCs or where the informal forest protection has been formalised, there is a sense of uncertainty over sharing of forest produce, both from the intermediate and final harvests. This uncertainty arises from the extra-legal character of the VFCs, mutual distrust between the FD and the villagers, lack of knowledge about the legal provision and the general casualness with which the VFCs have been formed.

The present formula of giving a share out of net income should be replaced by a share of gross income, which is easily understandable by the people. The village communities should have the freedom to decide whether this will be individually distributed or deposited in the village fund.

Rights of the VFC

The rights and responsibilities of village communities and the Forest Department have been specified in such a manner that the VFCs have been given most responsibilities and the FD most authority. VFCs' rights over the forest patch are not mentioned specifically, only certain concessions for fulfilling bona fide requirements are spelt out.

The VFC should have powers of a court so that it can arrest and impose fines upto Rs 1000 which, if not paid by the offender, should be recovered as arrears of land revenue. The VFC should have powers to compound an offence without any upper limit.

The Rules should lay down general principles for expenditure on approved items. The VFC in consultation with the DFO should be authorised to decide the financial norms. Subject to these, the VFCs should be free to spend upto 50 % of their annual income without obtaining permission from above. For the rest, they should send proposals to the Forest Officer concerned.

The VFC should have full powers to distribute and sell fallen fuel and grass to the villagers. As regards sale of standing trees, the number of such surplus annual forest produce should be determined once in a year by the open meeting of the General Body of the VFC. FD may send

its representative to such meetings and advise the VFC on technical matters. The VFC should be free to conduct auction of fallen trees in the presence of the entire village upto a value of Rs 10,000/- in a year. Outside contractors or their agents should be banned from tapping NTFPs. Short training courses can be organised to equip the local VSS with the necessary processing technique. It should be the duty of the FD to prepare a Working Plan and get it approved by the VFC. If the FD does not prepare an approved Working Plan, the VFC will be free to prepare its own plan in the interest of conservation and development of the forest.

Innovative silviculture

In keeping with the new policy, species choice and silvicultural practices will need a change in favour of ususfruct based trees and multiple outputs. Where a large number of people have claims to forest produce, low management and low value output (but high in biomass) solutions have perhaps a better chance of success. However, business seems to be as usual in the field, and commercial trees continue to be encouraged and planted on forest lands. For instance, FD's present management of sal seems to be for timber, and hence only one shoot is allowed to grow. Since sal is an excellent coppicer we suggest that degraded forests and hills close to a village should be managed to maximise biomass, with many shoots, which can be pruned occasionally to produce fuelwood, besides giving sal leaves.

Many of the forest ecosystems of India possess a high proportion of coppicing species, while water and soil conditions also permit rapid regeneration and increases in biomass. Recent studies are also beginning to indicate that regeneration is linked to increasing biodiversity. Natural regeneration through voluntary community protection costs between five to 10 % of the amount needed to establish monocultural plantations on the same land area. Studies in West Bengal and Karnataka indicate regenerating natural forests after 5 to 14 years of protection yielded growth rates between 3.4 to 8.8 metric tons of woody biomass annually, compared with 1.5 to 3 metric tons for plantations. At the same time, the costs for plantation established averaged Rs. 10,000 per hectare compared to a maximum of Rs. 600 for natural regeneration.

NTFPs flowing from naturally regenerating forests usually yield more income and employment to community members, especially women, when contrasted with monoculture plantations. Under natural regeneration many of the forest ecosystems studied also began yielding NTFPs much faster than degraded lands placed under monoculture tree plantations. Many grasses and leaves are available after three to six months of protection. Regenerating natural forests is also being associated with improved hydrological functions by slowing run-off, improving soil moisture and groundwater levels.

3.12. Need for Cautious Approach

One problem with over-promotion of JFM is that it can lead to massive donor interest and funding support, which may exceed the capacity of the forestry bureaucracy to absorb. JFM may indeed have been promoted beyond the capacity to implement it. JFM is process oriented and does not lend itself to becoming a target oriented programme. Apart from the lack of institutional capacity, the technical skills to develop different silivicultural systems (to fulfil the varied objectives of management) also are insufficient. For instance, research on economic and ecological impact of protection shows that although people's main concern is with fodder, protection beyond six years

tends to close the tree canopy and reduce grass production. Perhaps a much wider spacing is called for to maintain grass production which is one of the major incentives for community protection and management. Similarly, most silvicultural research in India so far has been done on commercial species, and techniques for large scale regeneration of multi-purpose species such as mahua and neem are still to be developed.

A development concept faces very different constraints and opportunities when it is new, unproven, and unaccepted, compared with when it is long-established and widely accepted - and the role of those who are in charge of its promotion must vary accordingly. For example, much of the effort of the `sympathisers' of the JFM to date has concentrated on promoting the principles of JFM to the government, NGOs, and local communities. Such promotion may be valuable in the early phases of a programme, but there are potential problems in sustaining it for too long. The nature of promotion results in too much emphasis on positive aspects of the programme and too little critical analysis. At the outset it is important to be able to persuade key actors of the merits of JFM, but it eventually becomes important to temper this with critical appraisal, long-term strategies, and the building of capacity to implement such policies. Care will need to be taken to ensure that JFM does not just become the next development bandwagon.

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4. A FRAMEWORK FOR UNDERSTANDING AGROFORESTRY DECISION MAKING AT THE FARM HOUSEHOLD-LEVEL

Rene Koppelman
James H. French

A framework for analysis of farm-level decision making is proposed where the farm household is used as the primary unit of analysis. Each household has a unique set of socioeconomic and biophysical conditions. The authors suggest that agricultural investment and production decisions are evaluated by farmers, landowners and agricultural entrepreneurs based on key external factors including: 1) availability and access to markets; 2) availability and access to support services; 3) availability and access to scientific and indigenous knowledge; and 4) presence of policies, rules and regulations.

It should be noted that the household is not the only level in a hierarchy of decision making. For example, if one desegregates the household into individual members, it is possible to analyze gender roles and their impact on decision making. Moving upward in the decision making hierarchy, the community, the watershed, the province and even the country may be viewed as the unit of analysis.

This paper will focus on the farm household as the primary unit of analysis. This is because the household is the level at which all farm resource allocation decisions are made. This process requires a holistic perspective, since many factors play a role. Within the farm household ***On-Farm Factors*** (Part I) play an important role in the decision making process. These decisions are called ***Farm Management Decisions*** (Part II). A large spectrum of ***Off-Farm Factors*** (Part III) can influence this decision making. This framework can be a guideline for analyzing farm household decisions and promoting agroforestry development.

4.1. Part I: On-Farm Factors

The farm household, a decision making unit, is broadly determined by the following on-farm conditions.

- Social and-economic conditions:
  - Social setting
  - Cultural setting
  - Traditional practices
  - Economic capacity
- Biophysical conditions

Social and economic conditions

These conditions have a major influence on decision making. **Box 1** summarizes social and economic factors that influence decision making.

The social setting

Household composition and allocation of responsibilities to different family members plays an important role in farm management. Division of family chores by gender influences how resource allocation decisions are made. It should be emphasized that "gender" refers to age as well as sex. For example, studies have shown in some countries that women tend to prefer the planting of trees for fuelwood, fodder and fruit while men are said to prefer the production of timber that can be sold commercially. This has much to do with women's role in fodder and fuelwood collection—a role that can take them far away from the farm and require heavy labour. Also children are often involved in fuelwood gathering. These children and the elderly often play an important role in caring for livestock, or have other functions in the vicinity of the homestead

Cultural setting

The farm household is guided by the norms and values of its members Gender roles are determined by tradition. Division of roles and responsibilities among family members occurs naturally among men, women, productive youth, and the elderly.

Traditional food habits influence the introduction of crops with a potentially high revenue given local conditions. A example of this is the introduction of potatoes in Europe. Although the rural population suffered malnutrtion and starvation, it was only two hundred years after their introduction that potatoes were produced on a massive scale.

Seemingly unproductive crops can have special functions, which make them indispensable for the household. Also, traditional cooking habits can influence fuelwood production. In northern India people sill use cow dung as fuel, although the supply of fuelwood has grown significantly. Due to the specific burning properties of these dung cakes, it is preferred over fuelwood in some areas.

Traditional practices

Traditional production and management practices play a very important role in the farm household.

Box 1: Social and Economic Conditions

Household members
- Composition (Age and gender)
- Health
- Education/skills

Values
- Religion
- Gender role divisions

Habits
- Food habits
- Cooking habits

Indigenous knowledge
- Specific crops
- Pest control
- Production calendar

Lifestyle
- Nomadic
- Sedentary
- Shifting cultivators
- Hunters/gatherers

Assets
- Land stewardship (tenure status, areas and types)
- Livestock and crop rights (ownership status, profit sharing)
- Buildings and farm implements (house, barns, machinery, tools, etc.)

Risk tolerance
- Availability of savings
- Need for food security
- Subsistence vs. market orientation

Debts and obligations
- Institutional debts and obligations
- Individual debts and obligations

Off-farm employment and income
- Dependence on off-farm income

When the farming system is sustainable this factor is no problem. It can, however, become a problem if, due to external factors, the continuation of the traditional system causes serious ecological degradation. These external factors can put pressure on natural resources due to growing population, climatical changes or transmigration. A very common case is degradation of near-by fuelwood resources. Due to over-exploitation or overgrazing, collection of fuelwood can become a difficult and time consuming activity, which usually has a negative effect on family welfare. Fuelwood collection will also detract from other productive duties, such as maintenance of the home garden.

If a farmer is required to change his farming system, it will be difficult, since, from his point of view, his traditional system has proven to be successful for generations. Farmers can be conservative in changing their cropping system, even though they fear for the sustainability of their present system. Economic factors play an important role in adopting new farming systems, since due to the decreasing revenues of his present system, risk tolerance is lowered.

Each farming system has its unique advantages, resulting in a special lifestyle of the farm family. They have adopted special skills in maintaining the system. Indigenous knowledge of this particular system can be very high. However, this indigenous knowledge can have its shortcomings when the system needs adjustment. Also a change of production system can result in a different lifestyle, which can dramatically affect the family. Shifting cultivators, and nomadic livestock farmers will have a natural resistance to becoming sedentary farmers. Also transmigrated farmers tend to pick up their old farming practices in new and different environments.

Economic conditions

A central factor affecting investment, production, and conservation decisions is the farmer's level of control over his land. A farmer with secure tenure is much more likely to think of long-term production and conservation activities than are sharecroppers or migrant laborers. The amount and types of land under stewardship of the farm household is critical. This determines their access to loans, the need for mechanization, the need to do off farm labor and the motivation to produce long-rotation products, such as trees. It also influences the extent of market oriented production.

Subsistence farmers typically have different aspirations from market-oriented or commercial farmers. These ambitions are reflected in their beliefs, attitudes, and labor investment patterns. Farmers also have varying risk tolerance based on their financial situation and food security. Subsistence farmers tend to have less tolerance for risk because they are closer to the borderline in terms of savings and liquid assets. Off-farm employment is attractive because of low risk. Also farmers with heavy debts and obligations cannot afford to risk their family welfare with untested technologies.

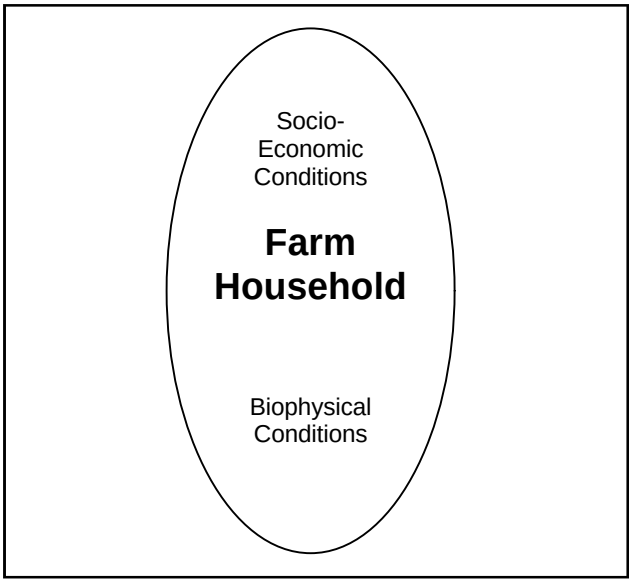
Biophysical conditions

Biophysical factors are, for the most part, beyond the direct control of the farm family. These factors, as described in **Box 2**, have a major influence on selection of crops.

Given the biophysical environment, farmers can influence the condition of their land by irrigation, fertilization, mitigation of extreme climatical conditions with shelterbelts or terracing of steep slopes. It should be emphasized that, when one limiting factor is removed, other factors become limiting factors for optimal production. Since all interventions consume money and/or labour, socioeconomic conditions can also become limiting for optimal production.

Within one farm, there can be considerable variation in the microclimate. Areas located near or around the household residence tend to get closer attention from women and receive more regular watering and fertilizing. These areas are more closely associated with family nutrition and service roles such as shade, rather than commercial objectives. The larger the distance between the homestead and the field, the less attention it will get. These areas tend to get used for low labour intensive production such as livestock grazing, cassava cultivation, timber and fuelwood production.

Based on the interaction between biophysical, social and economic factors, the farm household makes decisions. This brings us to the process of farm management.



Box 2: Biophysical Factors

Climate
- Rainfall level and distribution
- Temperature
- Solar radiation
- Frost
- Heavy or dry winds

Soil
- Depth
- Stability
- Fertility
- Texture

Landscape
- Slope
- Altitude
- Exposure of lands to solar radiation
- Exposure of lands to wind
- Presence of frost holes

Locality
- Distance of fields from homestead
- Scattered fields

Biological organisms on the farm
- Plant
- Animals
- Microorganisms
- Aquatic life

4.2 Part II: Farm Management Decisions

Investment and marketing decisions

Box 3 summarizes some of the key resource allocation decisions faced by farm families. Based on market information, the household decides which land and what labour is to be allocated to a certain commodity. The quality and price of seed can be considered, input of pesticides and fertilizer will be evaluated and, if the product is meant primarily for the market, to whom it will be sold. Even contract farming involves such management decisions.

For example, if a need or market opportunity is identified for fuelwood, the family will have to choose what specific tree to plant, how and where to procure

Box 3: Investment and Marketing Decisions

Allocation of labour
- Family labour
- Off-farm employment

Allocation of land
- By commodity
- By responsibility

Allocation of money
- For seeds (improved or own production)
- For fertilizer and pesticides

Acquisition of inputs
- Credit
- Supplies
- Hired labour

Marketing
- Products
- Market channels
- Contract farming

Conservation practices such as contour planning, vegetative erosion control, wind breaks and gully control all require additional labor and investment. Such investment must be weighed in relation to other income generating opportunities such as off-farm employment or home-based industries that ensure guaranteed sources of revenue. For example, processing of charcoal is an off-season enterprise that may take farmers' attention away from longer-term conservation activities.

All these farm household decisions are influenced by information from outside. The next section is an attempt to group these off-farm factors systematically.

seed or seedlings, who will be responsible for its establishment and maintenance, what land will be used, what investment (labour, money and materials) will be required, and how the products will be used or sold.

Production and conservation decisions

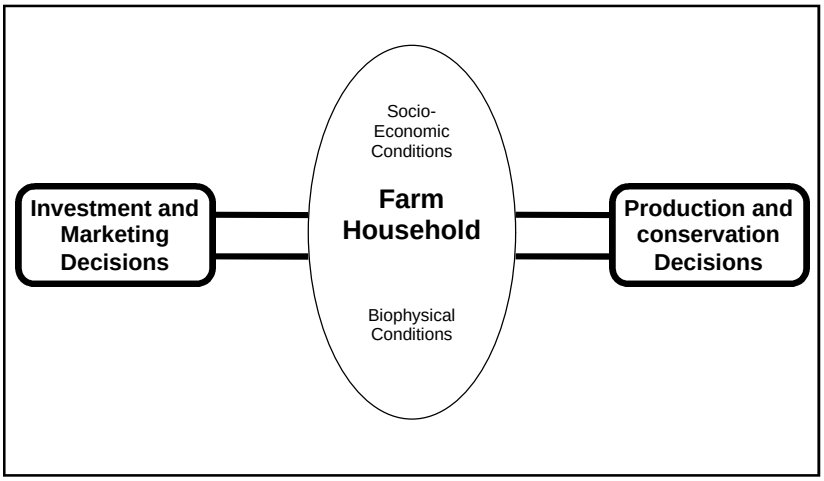
Given the above investment and market decisions, farmers must also make choices regarding management of the production process. A farmer realizing that the sustainability of his production system is endangered, will also try to identify means by which production can be sustained from year to year by minimizing damage to his resource base. **Box 4** summarizes the sorts of choices he must make.

Decisions related to management of perennial crops for fuelwood may be related to stabilization of slopes and terraces, provision of dry-season fodder for livestock, and spatial arrangement of fuelwood trees so that they do not interfere too much with food crop production.

Box 4: Production and Conservation Decisions

Production and management of agricultural enterprises
- Perennial crops
- Annual crops
- Livestock/fish
- Post-harvest processing

Conservation practices
- Crop management practices
- Erosion control practices



4.3 Part III: Off-Farm Factors

Markets and market channels

Farm families need market information for making investment and marketing decisions. Even though not all farmers do detailed cost-benefit analyses, they usually make a budget in their heads. Often they also make rough budgets on paper before making a decision. **Box 5** presents some of the market options that farmers have.

Farmers seek market information from other farmers, middlemen, and, if possible, producers associations, retailers, wholesalers, processors, and manufacturers. Unfortunately, access of a small farmer to market information is poor. A competitive market is not always present. Having said this, there is usually great opportunity to improve access to market information and, by doing so, allow farmers to tap into domestic, if not international markets.

Small farmers who are not organized into groups will find it difficult to achieve the scale of production that is demanded by more up-scale markets. Group organization under these conditions, therefore, becomes a key element.

Box 5: Market and channels

Local
- middlemen
- producers associations
- local industry

Provincial and National
- brokers and traders
- large-scale industries

International
- commodities exchanges
- multinational corporations

Policies, rules and regulations

Household decisions are also affected by policies, rules, and regulations that are enforced by the state and community. Examples are given in **Box 6.** These may be implemented either at the local or the national level. For example, teak in most countries requires a permit to be felled and transported. This is a constraint for teak producing farmers who are exploited by un-scrupulous officials. Transportation of fuelwood and charcoal is subject to stringent regulations in some places. These laws are, however, neces-sary to protect public forest resources.

Apart from formal legislation and policies, there are traditional customs and practices that govern management of agricultural lands. User rights are particularly important for farmers who live on the fringes of state forests and have a ready supply of fuelwood.

Box 6: Policies, rules and regulations

Traditional laws and common practices
- socialnorms
- customs

Written legislation
- local
- national

Support services

External support services are often needed to take advantage of market and production opportunities. Lack of roads for purchase of production material and transport of farm produce to the market is a clear constraint in some locations.

Other factors such as those highlighted in **Box 7**, however, are also important. Depending on the extension strategy and readiness of the farm household to respond to market forces, different support services will play varying roles. In some instances, farmers associations and cooperatives have played an instrumental role. In other cases direct subsidies for tree planting and manage-ment have had an impact.

Box 7: Support services

- Roads and transport
- Cooperatives
- Credit institutions
- Extension services
- Farmers associations
- Supply of seed/planting material and pesticides/fertiliser
- Middlemen, brokers and contracting industry
- Market information services

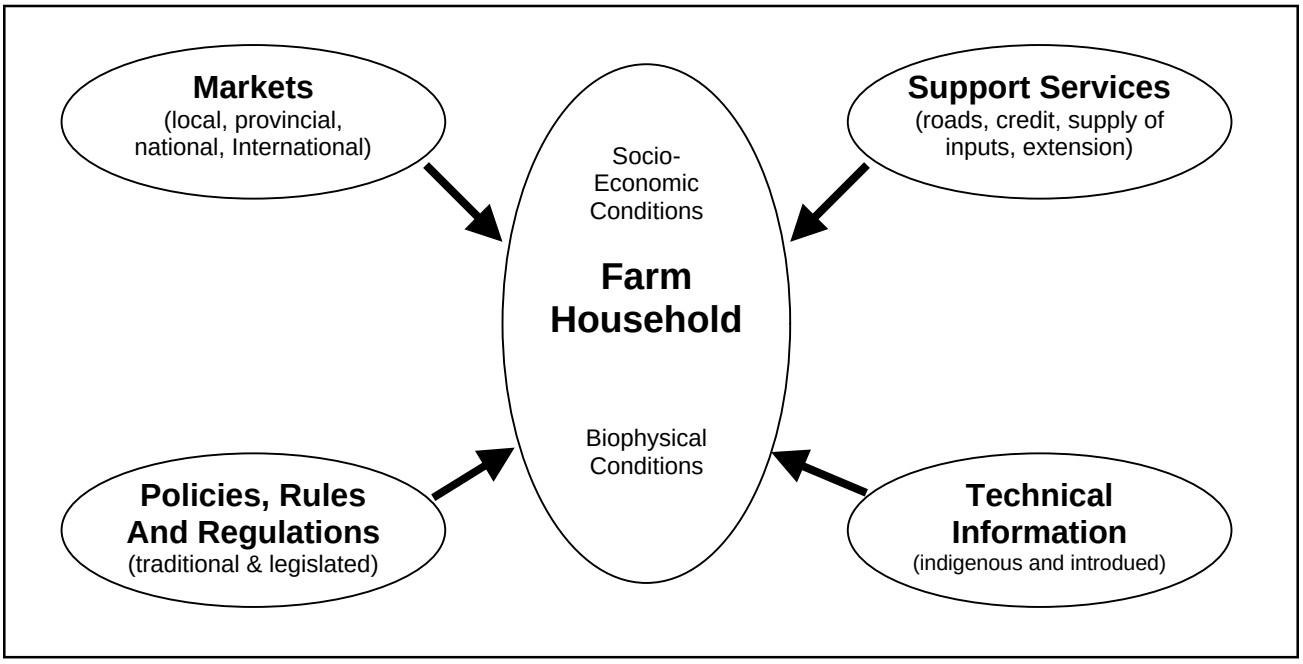
Technical information

Issues covered under this heading include information on different aspects of growing crops such as propagation techniques, plant protection, nutrient requirements and harvesting technolo-gies. Information can be provided from sources such as successful farmers, researchers, extension workers and private industry (**Box 8**).

Especially when a farm family is willing to adopt a new production commodity, technical information is essential to prevent failure.

Box 8: Technical information

- Other farmers
- Research
- Extension
- Industry
- Middlemen



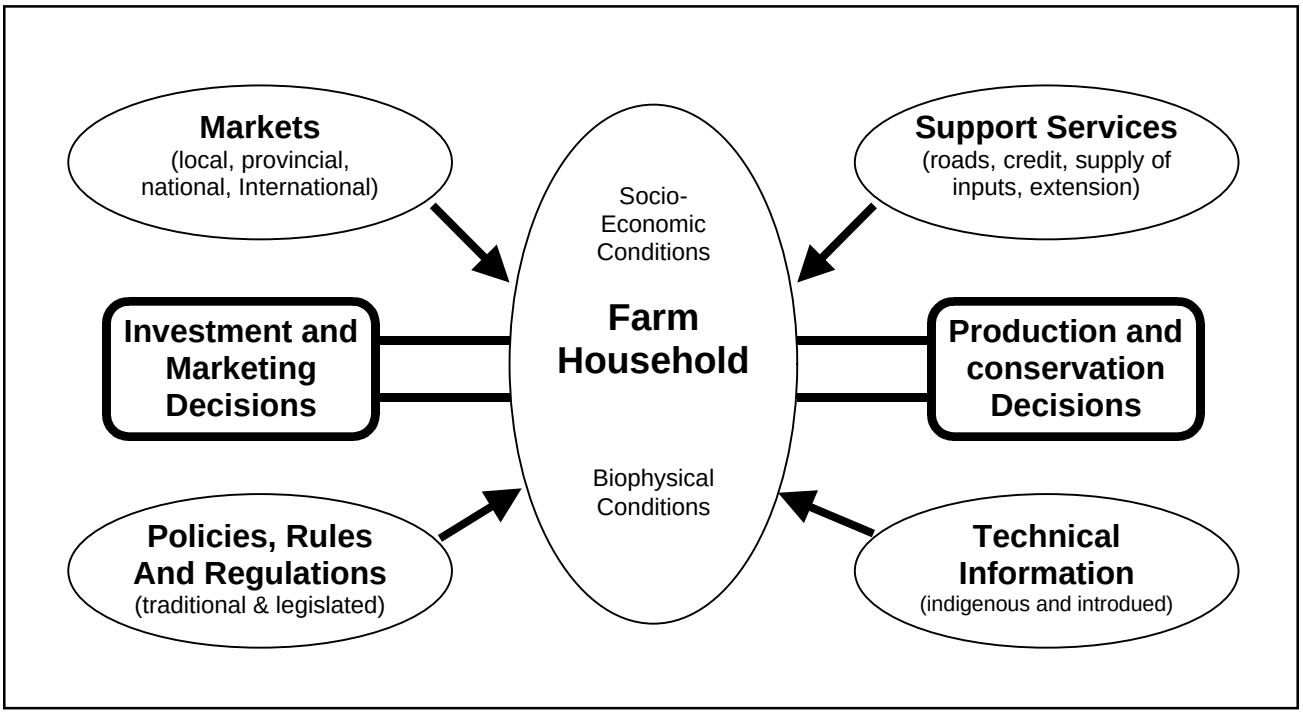
For example: When a farmer decides to produce his own tree seedlings, technical information on how to select seed and seedling is necessary, since usually farmers are used to growing crops with a short rotation. If a plant does not flourish as well as its neighbors, only a little production is lost, since the harvest takes place within a short time-span of only a few months. This way of thinking makes him very conservative in seedling selection, if he applies selection at all. Depending on seed-source an average of two thirds of the seedling many have to thrown away due to poor growing performance. If a less productive seedling is planted for production, time required to produce a harvestable product can be increased by as much as five times. All this time the tree occupies space which could be used for wood production.

Also a lot of production capacity is lost in fruit production, when a farm family uses fruit seeds for their trees instead of grafts. Much rural fruit has an average taste, and comes from average producing trees.

Also techniques developed by neighboring farmers will also be adopted if they proof to be successful. These techniques are designed by people with the same cultural setting as the surrounding farmers, so the process of diffusion will be shorter. An example: in Central Java mango seedlings die on poor soil with a pronounced dry season. An experienced farmer named Pak Maryono found a technique for increasing the survival rate. To avoid superficial root growth he suggests digging a hole 1 x 1 x 1 meter, removing the poor soil and replacing it with fertile soil and organic manure. The next year, he suggests digging 4 to 6 one-meter deep drills around the young tree and adding organic manure. Roots that are enriched with manure from the drills grow downwards and outwards seeking nutrients at deeper soil levels. In this way he could harvest his first mangos in four years. Now many farmers in this area use this rather labour intensive method for their mango trees as well.

In Summary

The interaction between all the of factors discussed above is presented in the following figure. This may be used as a framework for selection of extension strategies or to guide unstructured interviews with farmers to learn how they go about making agroforestry decisions.



5. INTEGRATION OF WOODFUEL PRODUCTION, FLOW AND UTILIZATION IN THE TRAINING CURRICULA OF THE PAKISTAN FOREST INSTITUTE

K.M. Siddiqui

Pakistan had a very small forest area at the time of its independence in 1947 due to arid climate prevailing over more than 70% of its area and its long history of forest clearance for agriculture and grazing extending over more than 5000 years. This situation has not changed to any significant extent in the last 48 years of its existence. Presently, it has probably the least forest area in Asia in terms of both percentage of land area and per capita forest area. Of the total land area of 87.98 million ha, forests cover only 4.27 million ha or 4.8 % of the total area. The proportion of production (commercial) forests is very small e.g., 26.2% of the total forest area or 1.12 million ha. The biggest forest resources of Pakistan are the coniferous forests in the north, north-east and north-west on an area of 1.93 million ha., and about half of these are production forests. Other productive forests are in the plains; irrigated plantations, 0.2 million ha. and riverine forests, 0.3 million ha. The non-productive forests in the hills and plains are the scrub forests (1.3 million ha.) and coastal forests (0.35 million ha.) respectively. For an estimated population of 130 millions, the per capita forest area is only 0.03 ha.

Current total fuelwood consumption is estimated at 26.91 million m^3 in Pakistan on the basis of data collected for the Forestry Sector Master Plan of 1992. This represents a per capita consumption of a little more than 0.2 m^3, which is probably the lowest in the world. According to this Plan, only 2% of the fuelwood supplies come from state forests and the balance 98% from trees grown on farmlands. Similarly, total timber consumption is estimated at 3.38 million m^3 at per capita consumption of 0.026 m^3. However, in spite of low wood consumption, the existing forests and plantations are under tremendous pressure from cutting of trees for fuelwood and timber, especially in the northern hilly regions, where woodfuel is used for both cooking and heating. This has caused depletion of wood resources, degradation of watersheds and deterioration of the ecosystem. Even leaves, needles, cowdung and agricultural waste are collected and burned as fuel due to which soil is deprived of nutrients. In the absence of suitable alternate energy sources, future woodfuel needs will continue to be determined largely by population growth for many years to come. By the year 2000, the population of Pakistan is expected to be more than 149 millions for which firewood requirements would be more than 30 m^3.)

One of the obvious results of this scarcity and the rising demand for fuelwood is the increasing economic burden on the poor sections of the population. The firewood prices have often risen faster than kerosene prices which is the principal alternate energy source for the poor. In the past, most fuelwood was consumed locally near the site of its production. But as wood prices in urban areas have gone up, the growers naturally find an advantage in transporting their fuelwood to sell in the nearby cities and towns. The rural poor, on the other hand, have to travel farther from their places of abode to collect firewood and other organic matter to use as fuel. Scarcity of fuelwood has also deprived farmlands of dung fertilizer and crop waste, which are commonly used as fuel in the rural areas in the plains.

In spite of the fact that fuelwood is used in large quantity by a large number of people in towns and villages, past efforts to develop fuelwood resources were meagre, scattered and patchy. The development activities were generally confined to the forests growing on state land for timber

production in spite of the fact that a very large proportion (estimated at 98%) of fuelwood and timber (more than 40%) supplies come from farmlands. This was recognized since the sixties, but nothing was done to increase fuelwood production in the country. However, the situation has been improving since the mid 1980s. A number of programmes for the promotion of social/farm forestry are operative throughout the country with people's participation and additional programmes are being planned. Promotion of tree growth on the farmlands has successfully been carried out in some localities through developmental projects of the federal and provincial governments. Enough manpower has also been trained at professional and subprofessional levels by the Pakistan Forest Institute (PFI), Peshawar, to plan and execute current and future forestry development programmes with emphasis on promotion of social/farm forestry. In this connection, the development of training curricula has evolved over a long period in the PFI since 1947. A number of changes were brought about in these curricula in past 48 years to meet the changing requirements of the forestry profession in the country. For this purpose, the strategy adopted by the Institute was to build upon existing courses, revising some courses and adding new courses.

5.1. Forestry Training Curricula Development

The PFI stated as a forestry training institution in November, 1947 to complete the training of forestry students who had to leave the Forest Research Institute and Colleges, Dehra Dun, India at the time of partition. Senior forest officers in Pakistan of that time were largely graduates of the Dehra Dun Forest College, which was established by the British Government on the pattern of a defence services' academy in 1906. Therefore, forestry training was started in the PFI on the same pattern. Its primary aim then was to train forest officers for the provincial forest departments. Later on, the research facilities in different disciplines were developed over a period of many years, and again on the pattern of Dehra Dun Forest Research Institute. This also helped in strengthening training facilities in the Institute because researchers, besides conducting research, also carried out teaching in their specialities.

The PFI, while remaining institutionally a federal government department, assumed from the very beginning some of the roles of a college within a university in the field of higher education in forestry. Its training programmes and curricula were initially patterned on those taught in Dehra Dun Forest College for training of Assistant Conservator of Forests/Divisional Forest Officers and Range Forest Officers for provincial/state forest departments. It awarded a diploma in forestry called Associate of Pakistan Forest College (APFC) to Assistant Conservator of Forests/ Divisional Forest Officers and a certificate in forestry to Range Forest Officers at the end of their two years of field-oriented forestry training. The syllabii of these two courses are given in the appendix. In all, 18 subjects were taught to diploma course and 12 subjects to certificate course students, besides field tours, etc. The curricula included a considerable number of practicums emphasizing field exercises. This arrangement lasted till 1956.

All along the provincial forest department expected that a graduate of the PFI will be prepared to assume a professional forestry post and to perform as a manager of state forests in that post with considerable independence upon graduation. However, it was soon realized that the PFI graduates did not hold a formal university degree and therefore could not gain admission in foreign universities for higher education in forestry. Therefore it was affiliated with the newly established University of Peshawar in 1956, which agreed to award a bachelorate degree in forestry to diploma students and a diploma in forestry to certificate students of the PFI after slight modifications in the curricula of these courses. The lists of subjects taught in the revised courses are also given in the appendix.

The academic level of the two forestry courses of the PFI was further raised in the sixties and seventies. The B.Sc. in Forestry degree was upgraded to B.Sc. (Hons.) in Forestry in 1961 and to M.Sc. in Forestry in 1974. Specialization in Forest Products and Forest Engineering (1981), Watershed Management (1985) and Farm and Energy Forestry (1987) in the M.Sc. Forestry degree were introduced through major revision and expansion of the scope of the curricula at different times. Similarly, the diploma course was upgraded to a B.Sc. in Forestry in 1967; its curriculum further revised and expanded in 1972. This situation continues till the present. The lists of subjects included in the two courses at different times are given in appendix.

As mentioned above, as far as curriculum is concerned, the strategy adopted by the Institute all along was to build upon the existing scheme of subjects taught in various courses, revising some and adding new subjects. The revisions in the curricula were generally made by teaching and research staff of the Institute after formal/informal discussions, which were approved by the University of Peshawar without any modifications. A number of foreign-aided development projects of forestry research and training were implemented in the Institute over the years and expatriate experts associated with these projects assisted the PFI staff in the revisions of curricula. In this regards, a major review was carried out by a three-member Curriculum Development Team of experts in 1986 under USAID assisted Forestry Planning and Development Project to include Farm and Energy Specialization at the M.Sc in Forestry level.

Academically, the PFI has remained quite independent of University of Peshawar in its courses of study and conduct of its education programmes since its affiliation in 1956. In the intervening period, it has not only reviewed, revised and upgraded its courses on its own initiative and got them approved by the University, but also proposed examiners from amongst the Institute's staff and forest officers of the provincial forestry departments to the University. In very few instances, it has asked for the services of teachers of the University and other training institutions for teaching some subjects to its students, for which it did not have its own teachers. However, it is obvious from the details of different curricula for the M.Sc. in Forestry degree, developed at different times and as given in the appendix, that the number of subjects taught to the students is very large, and it has increased with time. New subjects were added to it at the time of each revision. This is totally unlike the practice and the Master's degree programme offered by local and foreign universities in different fields. In their case, the number of subjects taught to the students in the classroom is generally small or none at all, because they are expected to conduct original research for their dissertation to fulfil the requirements of the degree. Another peculiarity of the PFI system is that and the current academic programme in the PFI is such that students holding a B.Sc. in Forestry are not automatically admitted to the Master's degree programme. And the Bachelor's degree in forestry is not a prerequisite for admission in M.Sc. Forestry degree programme.

The reasons for the above state of affairs are many. In the first instance, the system inherited from the Indian Forest College was continued with some modifications. The system was geared more towards training on the pattern of a defence services academy rather than educating as is done in a college of medicine, engineering, agriculture, etc. of a university. Secondly, the students or nominees of provincial/regional forest departments have a highly varied academic background, and every one had to be given a modicum of training in all disciplines of biological, technical and social sciences, knowledge of which would be needed by them for efficient and economical management of forests on state lands. The third reason is the entry system in the service of provincial/regional forest departments. There are two entry points, at Assistant Conservator of Forests/Divisional Forest Officer and Range Forest Officer. Unless, this is reduced to one, the qualification of a B.Sc. in Forestry cannot be made a prerequisite for admission to the M.Sc. in Forestry course.

5.2. Integration of Woodfuel Production, Flow and Utilization in the Training Curricula

In the beginning, the subject of woodfuel was not included in the PFI curricula, because fuelwood was considered to be a small bye product of the state-controlled forests by the field officers and its teaching to the students was therefore, not considered essential. This was contrary to the real situation. Fuelwood was and still is a major forest produce, constituting about 90% of total local wood production. However, for many years, it was not considered a commodity of commercial importance because most of the woodfuel supplies came from farmlands was locally consumed and was not traded through established channels as was the case with other commodities. Even the Energy Year Book of the Government of Pakistan did not include fuelwood consumption data. Further, in spite of the fact that the Forest Policy of 1962 clearly stated the need for developing farmlands' wood resources and in spite of the energy crisis of the seventies, no practical steps were taken till the early eighties to increase its production. Except for a fuelwood demand and supply study conducted in the early fifties, no records of its total actual country-wide production, demand and supply were maintained by any government department, including provincial forestry departments. For a long time, no literature was available on this subject. Even, the Manual of Indian Forest Utilization by H. Trotter, published in 1940 and used as a textbook in the PFI described only briefly the topic of fuelwood. Until 1987, fuelwood was one of those topics which were taught to the students only during their study tour of the irrigated plantations. This was in line with the situation in the rest of world, where the importance of wood as a source of energy, especially that grown on the farmlands, was realized only after the energy crisis of 1973.

In order for farm forestry to succeed to meet the country's needs for forest products the farmers must believe that growing trees on some fraction of their land is profitable given the alternatives that are available to them for the use of their land. Indeed many farmers are already profitably engaged in growing trees. However, far more farmers will have to engage in farm forestry if the supply of wood products is to be increased. They will need to be provided with advice and guidance, and in some cases, training in the subject matter of professional forestry. In Pakistan most farms are small and farmers are not in a position to employ the services of professional foresters. If professional forestry services are to be provided to farmers to help them establish farm forests and to efficiently and profitably operate them to achieve greater output of forest products, then those services will probably have to be provided either by the government or by the wood using industries. This is the pattern that has proved to be successful in the U.S. and in a number of European countries. Since the wood using industries of Pakistan are, for the most part, quite small and since consumers of forest products in Pakistan are individuals, the option of having the buyer provide the services is probably not viable. Government provision of the services seems to be the only reasonable course of action. This, however, represents a whole new dimension of professional forestry practice in Pakistan and requires that the professionals engaged in this practice have additional knowledge and skills beyond that included in traditional forestry education. Therefore, PFI on its part, realising the increasing pressure of tree cutting on state-forests and the importance of promoting the growing of fuelwood on the farmlands, introduced the disciplines of sociology and extension in its curricula in the seventies to enable the students to develop communication and motivation skills for interaction with farmers and execution of farm/social forestry programmes effectively and efficiently while in the service of the provincial/regional forest departments.

As mentioned earlier, a major change in the curriculum of the M.Sc. in Forestry was brought about in 1987 in the form of a Farm and Energy specialization on the basis of a report submitted by a three member Curriculum Development Team of the USAID supported 'Forestry Planning and Development Project'. This was done in response to a felt need to assist farmers to increase

wood productivity on their farmlands, particularly fuelwood for energy. This Team, in collaboration with the PFI faculty, carried out a detailed curriculum analysis, suggested the Farm and Energy Forestry Management curriculum, recommended texts, and reference materials. The basic aim of this curriculum was to: 1) provide the technical forestry instruction and information base appropriate for farm forestry; 2) develop the communication and motivational skills necessary for outreach; 3) provide basic training appropriate to a young officer in the provincial forest department; 4) produce a curriculum compatible with existing PFI programmes and complementary to other areas of specialization. The pattern of change in the curriculum was the same as that brought about at the time of the introduction of a specialization in Forest Products and Forest Engineering in 1981 and Watershed Management in 1985, i.e. substitution of existing subjects with new subjects. This is shown in the list of subjects given in the appendix. In this situation, the student has a choice either to follow a general course of study in forestry or choose one of the three specializations for an M.Sc. degree.

The following three new subjects were introduced at the time of commencement of the Farm and Energy Forestry specialization in the M.Sc. in Forestry in 1987 in the PFI :

- Farm and Energy Forestry Management
- Agroforestry Systems
- Energy as a Forest Product.

The above three subjects replaced the three existing subjects of Photogrammetry and Photo-interpretation, Fish and Wildlife Management and Forest Recreation and Parks Management, which were offered to the students opting for a general Master's degree in the Forestry programme, and were not considered essential for teaching to the students doing the M.Sc. in Forestry with a specialization in Farm and Energy Forestry. In the latter case, there is clearly a pronounced emphasis on developing and improving the knowledge and skills of the students for development of tree growing on farm lands for the production of wood energy. It was probably the first time that a training curricula of this type was introduced into a forestry institute in a developing country on the basis of a felt need. Further, by replacing only three subjects out of a total of 33 subjects, the basic character of the training curriculum was kept intact, and the students-specializing in these subjects were also qualified to work as a manager of state forests. This arrangement was essential because there are limited employment opportunities in the forestry profession in Pakistan due to the fact that it has small forest area, and has no large private forests or a developed industrial forest base. It was also important that trained staff in the forestry department could enjoy adequate mobility during their service career switching from state forest management to farm and energy forestry management and vice versa.

Of the above-named three subjects, Farm and Energy Forestry Management and Energy as a Forest Product deal with wood as an energy source. The details of these subjects are given in the appendix. Both deal with this topic in great detail. However, whereas Farm and Energy Forestry Management deals with wood production on farm lands, Energy as a Forest Product deals with the utilization and marketing of wood for fuel. Therefore, these are complementary subjects. Together with sociology and extension and research in topics relating to farm forestry for the dissertation, all aspects of farm and energy forestry development and management are covered. At present, more students enrol in this specialization than in other specialization or in the general forestry programme. It may also be mentioned here that female students have also been encouraged to enrol in this programme since its inception. Their response to it has been positive. A large number of male and female students have graduated in farm and energy forestry management and are working in the rural development programmes of the federal and provincial governments as well as those sponsored and executed by non-governmental organizations and development corporations.

5.3. Conclusion

The training curricula in the PFI have been continuously reviewed, revised and upgraded during the past 48 years to meet the felt needs of the forestry profession in the country. However, the integration of woodfuel production, flow and utilization in the training curricula took considerable time and was accomplished as late as 1987. This omission appears to be significant in the light of the fact that almost all supplies of woodfuel come from trees grown on farm lands. The development needs of this wood resource were anyway felt and started receiving attention all over the world, including Pakistan, in the late seventies and early eighties. The Farm and Energy Forestry Management specialization introduced in the PFI M.Sc. curriculum in 1987 is fairly comprehensive and enables the students to acquire knowledge and skills of production, supply, marketing and utilization of woodfuel on the farmlands, as well as to develop their motivational and communication skills with the farmers. However, it seems appropriate to review the curriculum again and reduce the number of subjects taught to the M.Sc. Forestry student as it is too large and unwieldy in its present form.

Annexure I

Development of Courses in Forestry for Professionals

Diploma in Forestry (1947-56)

1. General Silviculture
2. Special Silviculture & Silvicultural Systems
3. Forest Mgt. & Working Plan
4. Forest Mensuration
5. Forest Economics & Valuation
6. Forest Protection
7. Silvicultural Research
8. Forest Utilization
9. Forest Botany i/c Pathology
10. Forest Zoology & Entomology
11. Forest Engineering
12. Surveying & Drawing
13. Soil Science

B.Sc. in Forestry (1956-62)

1. Forest Law & Policy
2. Soil Conservation, Land & Range Mgt.
3. Field Engineering
4. Forest Mensuration
5. Soil Science
6. Forest Botany-A (Path. & Myco.)
7. Geology
8. Surveying & Drawing
9. Silviculture-A
10. Silviculture-B
11. Forest Mgt. i/c Finance & Valuation
12. Forest Botany-B
13. Forest Utilization-A

B.Sc.Hons. in Forestry (1961-73)

1. Field Engineering
2. Geology and Soil Science
3. Mycology & F.Pathology
4. Forest Botany (General & Systematic)
5. Watershed Management & Soil Conservation
6. Forest Mensuration & Aerial Photogrammetry
7. Range Management
8. Surveying and Drawing
9. Forest Utilization-A
10. Gen. Silviculture & Silv. of Species
11. Forest Ecology & Silvicultural Systems
12. Forest Management & Forest
13. Forest Utilization-B

1. Geology & Soil Science
2. Forest Biology/F.Maths.
3. Forest Statistics
4. Forest Biometrics
5. Principles of Economics
6. General Silviculture
7. Forest Ecology
8. Forest Protection-A (Myco. & Pathology)
9. Forest Protection-B (Forest Zoo. & Ent.)
10. Forest Surveying
11. Forest Engineering-A (Buildings)
12. Photogrammetry &
13. Exploitation of Forest Products

M.Sc. Forestry (1974 & onwards)

(Approved by the Academic Council & Syndicate, Univ. of Peshawar on 3rd & 4th June 1974 & 23rd July 1974 respectively)

23. Timber Technology & Forest Industries
24. Field Engineering
25. Recreation & Park Mgt.
26. Soil-Plant-Water Relationship
27. Research & Research Methods Protection-A)
28. Sociology, Public Admn. and Extension
29. Seminar in Silviculture
30. Forest Surveying and Roads Excercises
31. Forest management Plan Preparation
32. Conduct and Extracurricular Activities
33. General Viva Voce (alt. to Range Mgt.)
34. Thesis
35. Study Tour-I (Forest Orientation)

Specialization

I) Forest Products & Forest Engineering (1981)

39. Applied Mechanics (alternate to Forest Protection-B)
40. Work Study & Labour Sc. (alt. to Plant Taxonomy)
41. Wood Working & Sawmillioning (alt.to F.
42. Machinery in Forestry (alt. to Fish & Wildlife Mgt.)
43. Tree Harvesting & Transp. (alt. to Watershed Mgt.)
44. Wood Structure & Ident. (alt. to Forest Genetics)
45. Wood Testing & Processing (alt. to SPW Relationship)
46. Composite Wood Products (alt. to Rec. & Parks Mgt.)
47. Forest Engineering-C

II) Watershed Management (1985)

48. Design of Soil Conservation Works (alt. to Forest Protect.-A)

14. Soil Conservation & Land Management
15. Forest Law & Policy
16. Geology
17. First Aid, Public Health & Hygiene
18. Class Performance & Conducts
19. Study tour-I (Forest Orientation)
20. Study Tour-II (Forest Types of
21. Study Tour-III (Mgt. of Hill Forests and Watershed Areas)
22. Study Tour-IV (Management of Irrigated Plantations, Riverine Forests, Coastal Forests, Wildlife, Parks and Rangelands)

14. Forest Utilization-B
15. Forest Zool. & Ent.
16. Forest Protection
17. Forest Engineering
18. Working Plan
19. Viva Voce
20. Class Performance &
21. Study Tour-I (Forest Orientation)
22. Study Tour-II (Forest Types of Pakistan)
23. Study Tour-III (Management of Hill Forests and Watershed Areas)
24. Study Tour-IV (Management of Irrigated Plantations, Riverine Forests, Coastal Forests, Wildlife, Parks and Rangelands)

14. Forest Engineering
15. Forest Policy, Law &
16. Forest Zoology & Entomology
17. Genetics & Tree Breeding
18. Working Plan
19. Viva Voce
20. Term Paper
21. Class Performance and Conducts
22. Conducts Marks
23. Study Tour-I (Forest Orientation)
24. Study Tour-II (Forest Types of Pakistan)
25. Study Tour-III (Management of Hill Forests and Watershed Areas)
26. Study Tour-IV (Management of Irrigated Plantations, Riverine Forests, Coastal Forests, Wildlife, Parks and Rangelands)

14. Plant Taxonomy
15. Fish & Wildlife Mgt.
16. Forest Management
17. Resource Economics
18. Range Management
19. Watershed Management
20. Forest Engineering-B (Roads)
21. Forest Genetics
22. Forest Law & Policy

36. Study Tour-II (Forest Types of Pakistan)
37. Study Tour-III (Mgt. of Hill Forests and Watershed Areas)
38. Study Tour-IV (Mgt. of Irrigated Plantations, Riverine Forests, Coastal Forests, Wildlife, Parks and Rangelands)

49. Forest & Range Hydrology (alt. to F. Protection-B)
50. Forest Meteriology (alt. to Forest Genetics)
51. Watershed Planning & Analysis (alt. to SPW Relationship)

III) <u>Farm & Energy Forestry Mgt. (1987)</u>

52. Farm and Energy Forestry (alt. to Photogrammetry & Photo-interpretation)
53. Agroforestry Systems (alt. to Fish & Wildlife Mgt.)
54. Energy as a Forest Product (alt. to Forest Rec. & Parks Mgt.)

Development of Course necessary for sub-professionals

Certificate-in-Forestry (1947-57)	Diploma-in-Forestry (1956-66)	Diploma-in-Forestry (1967-71)	B.Sc. in Forestry (1972 & onwards)	Approved by the Academic Council & Syndicate, Univ. of Peshawar on 7.5.72 & 3.6.72 respectively
1. General Silviculture	1. Forest Law	1. Field Engineering	1. General Silviculture-I	20. Forest Statistics & Research Methods
2. Elementary Management & Silvicultural Systems with Silv. of species	2. Soil Conservation, Land & Range Mgt.	2. Watershed Management & Soil Conservation	2. Forest Biology	21. Forest Engineering
3. Forest Mensuration and Collection of Data for Working Plan	3. Forest Entomology	3. Elementary Geology & Soil Science	3. Forest Protection (Myco. & Pathology)	22. Forest Management
4. Forest Protection	4. Physical Sciences-A (Soil Science)	4. Mycology & Forest Pathology	4. Geology & Soil Science	23. Forest Economics
5. Forest Utilization	5. Forest Mensuration	5. Forest Botany (General & Systematic)	5. Forest Ecology-I	24. Forest Law and Policy
6. Forest Botany including Pathology	6. Field Engineering	6. Forest Mensuration & Aerial Photogrammetry	6. Forest Mensuration-I	25. Forest Utilization-II
7. Forest Zoology & Entomology	7. Surveying & Drawing	7. Range Management	7. Forest Utilization-I	26. Field Engineering
8. Forest Engineering	8. Physical Science-B (Elem. Geology & Physiography)	8. Surveying & Drawing	8. Watershed Mgt.-I	27. Pak Studies and Islamiyat/Ethics
9. Surveying and Drawing	9. Silviculture-A (General)	9. Forest Utilization-A	9. Forest Mathematics	28. Sociology, Public Admn. & Extension
10. Physical Science, Elementary Geology, Soil Science and Soil Conservation	10. Silviculture-B (Systems with elementary Mgt. & Silv. of Species)	10. General Silviculture & Silv. of Species	10. General Silviculture-II	29. Park Management & Recreation
11. Forest Law	11. Forest Utilization-A	11. Forest Ecology & Silvicultural Systems	11. Forest Protection (Zool. & Entomology)	30. Fish and Wildlife Management
12. Forest Accounts & Procedures	12. Forest Utilization-B	12. Forest Management	12. Forest Mensuration-II	31. Forest Accounts and Procedure
13. First Aid, Public Health and Hygiene	13. Forest Protection	13. Forest Utilization-B	13. Plant Taxonomy	32. Term Paper
14. Study Tour-I (Forest Types of Pakistan)	14. Forest Engineering	14. Forest Engineering	14. Forest Ecology-II	33. Specimens Botanical & Zoological
15. Study Tour-II (Mgt. of Hill Forests)	15. Forest Botany-A	15. Forest Law, Accounts and Procedure	15. Watershed Mgt.-II	34. Forest Management Scheme
16. Forest Mgt. of Irrigated Plantation, Riverine Forests, Coastal & Rangeland	16. Forest Botany-B (Mico & Pathology)	16. Forest Zoology & Ecology	16. Forest Surveying	35. Viva Voce
17. Class Performance & Conducts	17. Working Scheme	17. Working Scheme	17. Forest Genetics	36. Classroom Performance Conduct & Extracurricular Activities
	18. Viva Voce	18. Viva Voce	18. General Silviculture-III	37. Study Tour-I (Forest Types of Pakistan)
	19. Study Tour-I (Forest Types of Pakistan)	19. Term Paper	19. Range Management	38. Study Tour-II (Management of Hill Forests)
	20. Study Tour-II (Mgt. of Hill Forests)	20. Study Tour-I (Forest Types of Pakistan)		
	21. Study Tour-III (Mgt. of Irrigated Plantation, Riverine Forests, Coastal & Rangelands)	21. Study Tour-II (Mgt. of Hill Forests)		
	22. Class Performance & Conducts	22. Study Tour-III (Mgt. of Irrigated Plantation, Riverine Forests, Coastal & Rangelands)		
		23. Class Performance & Conducts		

Annexure-II

Farm and Energy Forest Management

Introduction

- Definition of farm and energy forestry
  - Social Forestry defined.
  - Definitions of other types of forestry.
    - Participatory forestry
    - Village/community forestry
    - Industrial forestry
    - Energy forestry
    - Farm forestry.
  - Contrast between social forestry and energy forestry.
- Importance of Farm and Energy Forestry in Pakistan.
  - The importance of wood as an energy source
  - The importance of private farms as a source of wood
  - Supplementary products
  - Fuelwood as a means of development
- Farm and energy forestry management
  - Forest management
  - Farm management
  - Farm and energy forestry management
- Farm and energy forestry management system
  - The nature of farm forestry decisions
  - Farm forestry markets

Farm and Energy Forestry Management : An Overview

- The project as the basis of planning
  - Definition of a project
  - The individual farm as the basic unit of analysis
- The stages of a project
  - Project identification
  - Project preparation and analysis
  - Project appraisal
  - Project implementation
  - Project monitoring and evaluation

Project Preparation and Analysis

- Analytical components
  - The farm as an integrated system
  - The farm and the world in which it exists
- Technical Aspects
  - Definition
  - Variables
  - Technical material
  - Agronomic techniques and their adoption
- Institutional-organizational-management aspect
  - Variables (e.g., cooperatives and associations)
  - Management aspects of Forestry Policy and Law, Public Administration and Rural Sociology.
- Social aspects
  - Variables include : income distribution, job creation, regional development, disruptive social effects, improving rural living, rates of acceptance of programmes, farmers customs and culture, and social patterns, and practices of farmers.
  - Social aspects in view of Resource Economics and Rural Sociology Principles.
- Commercial aspects : include arrangements for marketing the output produced and the arrangements for the supply of inputs needed.
- Financial aspects : include the actual costs and benefits accruing to the individual farmer.
- Economic aspects: include the financial aspects and the "off-farm" impacts accruing to others.

Commercial Aspects of Project Analysis

- Market and demand forecasts
- Marketing systems
  - Inputs - supply of adequate factors of production
  - Outputs-sufficient demand per outputs of production.
  - Financing.
- Pricing policies
  - Government
  - Market

Financial Aspects of Project Analysis

- Definition of costs and benefits.
- Identifying project costs and benefits.
  - Costs
  - Benefits
  - "With" and "Without" comparisons
- Pricing project costs and benefits
  - Market price as a measure of value.
  - Finding market prices
  - Predicting future values.
- Farm investment analysis
  - Objectives of financial analysis
  - Elements of farm investment analysis
- Comparison of project costs and benefits
  - Objectives of financial analysis
  - Decision criteria.
- The Project plan
  - Importance of a well prepared plan
  - Format of the plan report
- Plan implementation
- Utilization exercises with MULBUD - a computer package for the analysis of multi-period and multi-enterprise budgets.

The Dual Role of the Farm and Energy Forestry Specialist

- Service to the forestry department
  - Promote national/provincial departmental objectives
  - Technical expert in forest management of government owned forest lands.
- Service to farmers.
  - Serve farmer's objectives
  - Technical advisor/outreach capacity

- A conflict of interest?

    - Farmers objectives may be inconsistent with forestry department objectives - since (being a government agency) the forestry department's perspective, is more global than that of an individual farmer, the sum of the parts (pursuing individual farmer's objectives) may not equal the whole (pursuing the forestry department objectives).

    - Forest management techniques may be inconsistent with Farm and Energy Forestry Management techniques.

Economic Aspects of Project Analysis

- Similarities to financial analysis

- Differences from financial analysis

    - Identifying costs and benefits
    - Valuing costs and benefits

- Aggregating projects.

Case Studies in Project Failures

- Problems of project design and implementation

    - Inappropriate technology
    - Infrastructure and support systems.
    - Failure to appreciate the social environment
    - Administrative problems
    - Policy environment

- Problems of poor project analysis.

Energy as a Forest Product

The Role of Wood in National, Regional, and Local Energy Budgets

- Assessment of wood based energy use.

    - Domestic use
    - Industrial use

- Inventory methods for determining wood fuel supplies

- Comparison between point and non-point energy sources

    - Point sources
    - Non-point sources
    - Comparison of the logistics of distribution

- Alternative sources of energy
- Alternative uses of Wood.

Developing an Energy Budget

- Units of measurement and conversion
- Tree materials balance
- Forest materials balance

Wood as a Fuel

- Forms and Wood based fuel
    - Solid wood
    - Charcoal
    - Wood gas
    - Liquified wood
- Heat of combustion of wood fuels
    - Definition
    - The process of combustion
    - Factors influencing the difference between HHV and LHV
    - Wood fuels and components
    - Competitive fossil fuels
    - Other biomass fuels

Wood Fuel Utilization

- Favourable factors influencing the use of wood as a fuel
    - Burns without major toxic emissions
    - Widely distributed geographically
    - Can be used as a fuel in solid, liquid, or gaseous form
    - A feasible way of using solar energy as an energy source on a large scale.
    - Maintains product flexibility from forest systems
    - Provides a convenient way of storing energy for future use.
    - Forest fuels are renewable.
- Unfavourable factors influencing the use of wood as a fuel
    - Wood has a low heat value to weight ratio as compared with fossil fuels.
    - Wood has a substantial moisture content as it comes from the forest
    - Geographical dispersion makes collection expensive
    - Wood emits moderate quantities of particulates and water vapour under usual combustion conditions.
- Domestic use of wood as a fuel
    - Efficient stove design.
    - Cultural preferences for fuel form, e.g. solid wood vs charcoal.

- Industrial use

    - Heating and drying
    - Steel manufacture
    - Lime kilns
    - Electrical generation
    - Co-generation

- Sources of wood fuel

    - Industrial residues
    - Logging residues
    - Forest residues
    - Exploitation of natural forests
    - Production on managed forests

Production of Derivate Wood Fuels

- Charcoal

    - Conversion of wood into charcoal
    - Charcoal properties
    - Charcoal production processes

- Wood Gasification

    - Gasification involves producing a low or medium BTU gas by pyrolysis plus water-gas shift reactions
    - Gasification reactors
    - Wood gasification reactions

- Wood liquification

    - Liquification is the conversion of wood to liquid fuel
    - Forms of wood based liquid fuel

- Comparison of the fuel values of wood, methane, and methanol.

The Cost of Wood Fuel

- Assignment of residue costs
- Wood production costs
- Harvesting costs
- Transportation costs
- Processing costs

Marketing Wood Fuel

- Non-market industrial use
- Non-market domestic use
- Urban fuel markets
- Rural fuel markets
- Fuel prices and pricing policy
- Fuel and forest welfare.

Agroforestry Systems

Introduction

- Explain the purpose and scope of course.

- Discuss course organization, emphasis and subject matter in relation to silviculture, farm forestry, range management, and extension courses.

- State instructional objectives of the course : Upon completion of this course students will be able to

    - Understand agroforestry as a practical but evolving discipline with wide application.
    - Identify, describe and classify agroforestry systems used in Pakistan and abroad.
    - Explain key agroforestry system components and interaction
    - Use the systems approach as a tool in the analysis of agroforestry practices.
    - Design or improve agroforestry systems using the diagnosis and design methodology.

Overview of Agroforestry

- Define agroforestry and explain its importance to both user groups and management agencies.

- Review historical background of agroforestry.

- Clarify the purpose/role of agroforestry in relation to industrial forestry and agriculture.

- Explain agroforestry as a strategy in economic development relate to social forestry, farm forestry, etc.

- Discuss the state of knowledge regarding agroforestry, identify useful journals and sources of agronomic data and services.

Define Agroforestry in Systems Context

- Introduce general systems theory and illustrate its wide application through examples in engineering, agriculture (use farming systems as example), and military logistics.

- Introduce forestry as a system defining components and interrelationships including, land, capital, biota, and organizational infrastructure.

- Introduce agricultural systems discussing components, interrelationships, boundaries, inputs, and resources within the systems.

- Define agroforestry systems and contrast with traditional agriculture, range management, and forestry.

- Agroforestry systems classification by :

    - Major components
    - Temporal and spatial character
    - Function or application.

Ecology of Agroforestry Systems

- Describe interactions between plant and soil components of the system.

    - Site quality, special arrangement and rotation period.
    - Competition between plant components.
    - Complementary relationships between plant-soil components.
    - Adverse relationships.

- Discuss interaction as a result of the addition of domestic animals to the plant-soil system.

    - Complementary relationships.
    - Adverse relationships.
    - Influence of forest components on field crop yield.

Describe and Analyze Illustrative Types of Agroforestry Systems

- Discuss currently used Pakistani Agroforestry systems highlighting establishment, cultural, and harvest techniques.

    - Rotation systems (Hurrie) Acacia nilotica with wheat or other cash crop on 6 year rotation (Sind).
    - Permanent tree and field crop systems.
    - Tree-pasture systems: Broad-leaved and conifer species with grass and other forage species with domestic animals (variations on a system common throughout Pakistan).
    - "Minor" forest product systems are natural forest areas producing timbers, fuelwood and fodder in addition to a variety of other products, such as medicinal plants.
    - Sericulture systems.
    - Apiculture systems.
    - Lac system.

- Illustrate and analyze the key attributes of representative Latin American, African, and Asian agroforestry systems.

    - Rotation systems.
    - Intercropping.
    - Permanent tree and field crop.

- Tree and aquatic.
- Tree and forage.
- Miscellaneous forest products, such as medicinal plants.

Agroforestry Systems : Improving the Old, Designing the New

- Explain land capability classifications and their application to design of agroforestry.

- Describe the Farming Systems Research (FSR) methodology explaining :

  - The farm as a system combining animal, field tree and pastoral crops.
  - Use as an analytical tool and for outreach programme.
  - Procedural steps :

    - Characterization and analysis of system.
    - Planning and design of improvements.
    - Generation/evaluation of technologies.
    - Information accumulation and analysis of improved farm system.
    - Re-evaluation of technology and dissemination via extension.

- Introduce the Diagnosis and Design (D&D) Method and explain.

  - Objectives of method and design criteria.
  - Use as iterative design and implementation process.
  - Procedural steps :

    - Description.
    - Diagnosis.
    - Technology design.
    - Implementation planning.

  - Relationship to farming systems approach.

- Illustrate the D&D method by presentation of a case study directed at improving an existing Pakistani Agroforestry System.

6. PRODUCTION OF WOODFUEL IN NON-FOREST LANDS AND ITS FLOW TO USERS IN PAKISTAN

Mohammad Iqbal

6.1. Forestry Situation

Pakistan has traditionally and historically remained a forest poor country. Wood production on forest lands managed by the government forestry services has been disappointing. Although government forest lands and plantations have expanded, their recorded output has stagnated or declined and now meets only a very small fraction of the country's timber and fuelwood needs (Leach 1993).

Recorded timber production from the public forestry sector averaged only 300,000 cubic meters, a rise of just of just one-quarter over the sixties - well behind the growth of population and wood consumption. Recorded firewood production fell by over 50% over the same period (Amjad et al 1990a).

Pakistan is following the trends of other countries within the Asian region (Clark 1990). Most importantly, wood supply is shifting from declining natural forests on state controlled forest lands to plantations growing on private lands. In 1990 the estimated wood production from state controlled forest lands was approximately 1.5 million cubic meters (Jan 1993). Of the total quantity consumed, less than 0.2 million cubic meters was imported into Pakistan (Clark 1990). The difference between the public land production and import figures and annual consumption (Table 1), shows the potential to raise trees as a cash crop on farmlands in Pakistan (Charles and Naughten 1994).

Basic consumption data is inadequate. The Foresty Sector Master Plan (FSMP) shows that in 1992 annual national consumption of roundwood was 29.5 million m^3 and that 90 % of the consumption was for heating and industrial fuel, but the data do not reveal how much of the energy consumtion comes from a) fuelwood gathered by villagers, b) planned fuel production, or c) scrub forests (ADB 1994).

6.2. National Energy Balance and Role of Firewood

Sector-wise details of energy consumption in Pakistan are given in Table 2. These idicate that out of a total energy consumption of 38.342 million TOE in 1991, 48.1% was met by modern fuels and 51.9% by biofuels. The household sector has the largest demand for energy (54%). Another important characteristic of this sector is that the bulk of its energy requirements (86%) are met by biofuels, i.e., firewood, crop residues, dung and charcoal.

In addition to the household sector, commercial and industrial sectors also meet part of their energy requirements from biofuels. Thus, during 1991, 58.3% of the total energy requirements of the nation were met by biofuels.

6.3. Land-Use

Farmlands of Pakistan amount to some 21.0 milion hectares of cultivated land plus 9.4 million ha of cultivable waste (MINFAC 1992), both together constituting 38.2% of the total area of the country, against which the forest area is less than 4 %. About 80% of the cultivated area is irrigated, the proportion ranging from close to 100% in Punjab to 35% in Baloshistan. Punjab is the largest agricultural region, posessing nearly 60% of the cultivated area and 75% of the irrigated area (Table 3).

Table 1 . Estimated annual consumption of wood in Pakistan (1990).

Type of industry	Consumption		
	Cubic meters (1000)	Tonnes (1000)	percentage
Residential fuelwood	24,300	13,000	85.60
Tobacco	157	110	0.72
Brick kilns	99	69	0.45
Sub-total	**24,556**	**13,179**	**86.78**
Construction timber	1,040	728	4.79
Mining	200	140	0.92
Saw milling	200	140	0.92
Veneer and plywood	23	16	0.11
Furniture	850	595	3.92
Railway	19	13	0.09
Vehicle body and boats	10	7	0.05
Match	410	164	1.08
Sports equipment	200	80	0.53
Chipboard	225	90	0.59
Hardboard	50	35	0.23
Pulp	0	0	0.00
Sub-total	**3,227**	**2,008**	**13.22**
Total	**27,783**	**15,187**	**100.00**

Source: Jan 1993.

Table 2. Pakistan energy consumption by sector, 1991 (Thousand TOE).

Sector	Modern fuels	Biofuels					Total	%
		Firewood	Dung	Crop residues	Charcoal	Total		
Household	2,889	11,031	3,747	2,921	123	17,822	20,711	54.03
Comercial	1,018	713	0	0	0	713	1,731	4.51
Industrial	8,197	5	0	1,353	0	1,358	9,555	24.92
Agriculture	2,092	0	0	0	0	0	2,092	5.46
Transport	3,769	0	0	0	0	0	3,769	9.83
Other	484	0	0	0	0	0	484	1.26
Total	**18,449**	**11,749**	**3,747**	**4,274**	**123**	**19,893**	**38,342**	**100.00**

Source: HESS estimates.

Table 3. Land-use statistics of Pakistan (1988-89)

Category	Area (million hectares)				
	Punjab	Sindh	NWFP[1]	Baluchistan	Total
Cultivated	12.01	5.56	1.87	1.58	21.02
Culturable waste	1.75	1.82	1.05	4.77	9.39
Forest	0.45	0.58	1.31	1.09	3.43
Other	6.42	6.13	5.94	27.28	45.77
Total	**20.63**	**14.09**	**10.17**	**34.72**	**79.61**

Source: MINFAC (1992)
[1] North -West Frontier Province

6.4. Wood Production Systems on Farm Lands

Tree growth on farm lands

Although most of these lands are used intensively for agricultural crops there is nevertheless a large potential for growing trees alongside these on field boundaries and roadsides etc. as well as on marginal lands, without serious competition from field crops. This is where most small farmers in Pakistan are planting trees today, typically in fairly small numbers, for their own subsistence use and to earn a little extra income. There is also a good potential for alley cropping and other kinds of mixed tree and field crop systems, and for tree based methods of conservation farming to improve soil nutrients and to reduce soil erosion on hill slopes.

Tree number and volumes

Surveys of woody biomass conducted by the Household Energy Strategy Study (HESS) in 1991 indicated that for the whole country, there are some 1,435 million standing trees with a total wood weight (air dry) of 203 million tons, or an average of 2.38 tons per ha (Table 4). Very close to half the trees and standing weight were on farm lands, where the average stocking density was 4.87 tons per hectare or just over twice the country average. Average number of trees per ha was found to be 16.8 with twice this density on the farm lands. Total growth of wood per year was estimated to be 22.2 million tons or 10.9% of the standing stock (Leach 1993).

Table 4. Tree numbers, stocks, stocking densities and annual growths by agro-ecological zones of Pakistan.

Zones	Area[1] (000 ha)	Trees (million)	Density[2]	Stock[3]	Tons per ha	Annual growth[4]
1. Irrigated high north	9,184.8	411.0	44.80	58.50	6.37	7.05
2. Irrigated high south	1,987.0	26.4	13.30	8.81	4.43	0.76
3. Irrigated low north	3,186.4	197.3	61.90	24.80	7.79	3.84
4. Irrigated low south	4,460.9	37.0	8.30	8.51	1.91	2.65
5. Barani	2,787.8	56.2	20.20	4.46	1.60	0.42
6. Forested	12,996.6	562.1	43.30	81.70	6.28	5.23
7. Semi-arid	25,383.2	134.8	5.30	10.90	0.43	0.91
8. Desert	25,234.2	9.8	0.39	5.45	0.22	1.30
Total farmland (1-5)	21,606.9	727.9	33.70	105.10	4.87	14.72
Total	**85,220.9**	**1,434.8**	**16.80**	**203.10**	**2.38**	**22.16**

Source: Leach 1993.
[1]Excluding 2501.8 thousand ha of permanent snow cover
[2]Trees per hactare
[3]Million tons
[4]Tons/year

Forested vs. non-forested lands

It is interesting to note that farm lands - particularly irrigated farm lands in NWFP and Punjab (North in Table 4) - have more claim to be called 'forests' than do the forested/highland areas of the country. According to the HESS estimates, the former contain 50.7% of all trees and 51.8% of the stock weight, compared to 43.3% and 42.2%, respectively, in the forested plus highland zones. The northern irrigated farm lands also contain more trees per hectare (44.8 and 61.9 for high and low productive zones compared to 43.3 for forests and highlands) and more tree mass per hectare (6.4 and 7.8 tons/ha compared to 6.3). Most significantly, annual wood growth is much higher on the farm lands: 14.7 compared to 5.2 million tons. Nor is this entirely due to their greater area. The per hectare wood growth on farm lands averages 0.68 tons per year (0.77 tons and 1.21 tons in high and low productivity northern irrigated zones) compared to only 0.40 tons per hectare in the forested and highlands zone.

Characteristics of farm trees

Tree Species

Although many tree species are grown in Pakistan, a relatively small number dominate the mix. According to the HESS biomass supply survey, just over a third of all trees in Pakistan are of only three species: shisham (*Dalbergia sissoo*) at 16.6%, *Ailenthus* species at 9.5% and Babul (*Acacia nilotica*) at 9.4%. A further three species or groups - Citrus trees at 7.0%, *Acacia modesta* at 9.4% and *Populus* species at 6.0% - bring the share of the leading species up to just over 55% of all trees (Leach 193).

On farm lands alone, the species mix is even more dominated by a few species than in the country as a whole: the leading six species account for nearly three quarters (73%) of all trees, broken down as follows: babul 21.8%, shisham 18.3%, citrus 12.9%, poplar 10.4% and guava 5.2%.

Fast growing trees, particularly *Eucalyptus camaldulensis*, poplar and simal (*Salmalia malabarica*), are gaining popularity because they grow faster than native species, but command much the same price. For example 65% of seedlings distributed in recent Punjab social forestry projects were eucalyptus, followed by babul at 15%, poplar (10%) and semul (5%) [Khan 1991].

Size/Age Class Distribution

One of the major findings of the HESS surveys was that majority of the trees growing on farm lands were of younger age classes; 23% had stem diameters 5 cm or less, 70% had diameters of 10 cm and under and 89% had diameters no greater than 15 cm. Combined with a very high rate of planting compared to felling (11.6 : 1) this size distribution suggests that numbers and standing voume of farmland trees should increases ubstantialy in future years - provided that present rates of planting versus felling are maintained (Leach 1993).

Rotation

The majority of the farmers harvest trees when they are quite young. For example, in Punjab eucalypts are typically harvested on 4-5 years rotations, semul at 6-7 years and shisham at 8-10 years. Traditional high density babul (*Acacia nilotica*) plantations in Sindh known as '*huries*' are typically harvested after 5-6 years (Sheikh 1986). Several facors contribute to this practice. It may be due to simple economics of discounting the investments. Early harvesting of field boundary trees reduces crop losses to shading and water competition. The high demand for firewood and poles adds to the pressure to harvest on short rotations.

Factors promoting wood fuel on farm lands

Reasons for Planting Trees

The HESS survey found that the principal reasons for planting trees seem to be for timber (44.9%), fuel (29.8%), fruit (10.6%) and shade plus other environmental improvements (14.7%). Strikingly fewer than 7% of households planted trees only for fuel. This low level of interest adds further confirmation to the view that fuelwood is generally regarded as a residual product of tree management. Nevertheless, trees planted for any purpose including fruits ultimately end up in yielding some firewood. About 50% to 60% of the wood produced from the felled and/or lopped trees is used or sold as fuel, the remainder being for construction poles or saw timber. Therefore,

the programms that focus on energy plantations - rather than multipurpose tree growing - are unlikely to succeed.

Tree Planting and Farm Size

A strong relationship between tree planting and farm size has been observed by the HESS biomass supply survey. The largest farms of over 10 hectares were found to have the lowest incidence of non-planting. The smallest farms (less than 1 hectare) accounted for 2% of all plantings; the medium sized farms for 30% of the plantings; the largest farms of over 10 ha, accounted for 68% of the new trees.

6.5. Economics of Wood Fuel Production

Trees on most farms are either scattered or arranged in rows, typically along field boundaries. Most farmers who are planting trees are planting in rather small numbers. The HESS survey indicates that 73% of the farmers who planted non-fruit trees in 1991, planted fewer than 20 each (average 5.5) and a further 14% planted 21-50 trees (average 37). On this small scale, trees are only a minor part of the farm enterprise. Labour, capital and land inputs are therefore small. Trees do not compete with agricultural crops at these density levels, particularly when they are harvested at short rotations. The commercial benefits from this form of tree growing should therefore be regarded as a supplement, not as an alternative, to the income from commercial agriculture.

The relative size of this extra income would vary with the cropping pattern, tree densities and discount rates applied. When no account is made for land rent, Leach (1993) has estimated that 100 border trees per ha gave a discounted annual revenue of 5% to 6% of the net returns from cotton-wheat double cropping, the most profitable crop combination. For rice-wheat and sugar cane the returns from the trees were much greater at 10-11% and 16-17% of the discounted revenues from the crops. The returns increase to 10% for cotton-wheat and 60% for rice-wheat, when land rents are also included and a 15% discount rate is applied.

The benefits of border trees become even greater when the wood consumed by the farm household is priced in terms of firewood which otherwise would have to be purchased: namely around Rs 27 per maund (40 kg) in Sindh, Rs 33/maund in Punjab and Rs 36/maund in NWFP instead of the figure of Rs 18/maund assumed in the above calculations. On this basis even a few border trees can provide very attractive savings on family budgets (Leach 1993). Moreover, the trees reduce risks of crop failures, by diversifying farm income. Trees sales can be postponed for a year or more if prices are low or income from other sources is sufficient. Thus, for small farmers particularly, owning even a few trees can be an important risk-reduction strategy and a "living bank" which provides a means of raising cash when it is needed.

Studies by Sheikh (1986) compare the economics of the century-old practice of raising compact block plantations of babul (*Acacia nilotica*) in Sindh, vernacularly known as "*huries*" with agricultural crops. Average net annual revenue of Rs 2,073 per ha was estimated for agricultural crops (wheat, maize, sugarcane, cotton and rice). For babul on a typical 5 years rotation, with a growth of 10 m^3/ha/year and a wood sale price of just under 500/m^3 (equivalent to roughly Rs 24 per 40 kg maund), the undiscounted net return was Rs 2,960/ha, i.e., 40% greater than average field crops. However, applying a 9% annual discount rate, the return from tree growing fell to around Rs 1,475/ha/year - well below that from agricultural crops.

Sheikh, therefore, concluded that *hurries* could not compete with agricultural crops in terms of net returns per unit of land but were a much more favourable investment per unit of capital employed. Farm trees also produce much larger earnings per unit of labour. High returns to capital and labour, a frequent characteristic of farm forestry, are decisive advantages for poor small farmers.

An analysis done by Iqbal (1989) indicates that intercropping babul with agricultural; crops in '*rod-kohi*' (flood inundated) tract of D.I.Khan would give a benefit:cost ratio of 6.42 compared to only 1.49 for crops alone.

In high hills slow growing coniferous timber trees like chir pine (*Pinus roxburghii*) and kail or blue pine (*Pinus wallichiana*) are not suitable for private forestry when lands are rented and returns are discounted, even though high-value timber gives enormous revenues when the trees are finally harvested after 70 years: Rs 5.28 million for kail and Rs 2.36 million for chir. Discounting over seven decades of tree growth, however, severly reduces the average returns. Even with a low discount rate of 8.5%, annual net returns are negative to the tune of Rs 407/ha for kail and Rs 377 for chir. However, fast growing species like poplar, robinia and daravi (*Ailanthus excelsa*) on ten years rotation give excellent returns which greatly exceeds those from field crops.

All these assessments support the visible evidence that farmers are growing trees because they find them to be a profitable addition to their incomes or - in many cases - give better returns than agricultural crops. Results of surveys conducted by the HESS further support this evidence. The surveys indicate that 51% of tree growing farmers said that they planted trees for 'commercial reasons' and a further 33% for the 'proper utilisation of waste land', presumably in order to get a good result from it. Just over four-fifths of the farmers also said that tree growing is more profitable than field crops (Leach 1993).

6.6. Provincial Forestry Departments' Programmes to Promote Farm Forestry

Provincial Forest Deparments have been promoting farm forestry by subsidies of various kinds. During the 1980s the Punjab Forestry Department, for example, had a 40% subsidy on seedlings and a large subsidy of Rs 3,000 per hectare for the first five years after the establishment of block plantations on farmlands. Since this sum was considerably larger than the net returns to be made from some major agricultural crops, not surprisingly many farmers "came running" to the department with their claims.

This was followed by a new scheme (from 1992 to 1995) under which a subsidy of Rs 5 per seedling surviving up to 2 years on agricltural land on farms of less than 10 ha, with a total commitment of Rs 100 million or enough for 10 million trees per year. This large subsidy, which could amount to Rs 10-15,000 per hectare for a densely-spaced plantation, was also quite attractive for the farmers. As a matter of fact subsidies of this size are not required, and, indeed, can prove counterproductive in the long run.

According to the HESS findings, Punjabi farmers planted as much as 10 million trees in 1991. Of course most of them plant trees even without the subsidies. Nor is it clear whether the subsidies will be taken up by the small farmers who would not otherwise plant trees or by larger farmers who would have planted anyway, without the subsidy. Policy-makers might consider the replacement of subsidies by other methods of reducing the start-up costs and the effects of delayed returns from tree growing. In particular, improved credit facilities and financial incentives should be actively considered to replace subsidies (Leach 1993).

Throughout Pakistan's four provinces nearly 140,000 farmers have planted almost 119 million trees under the Forestry Planning and Development (FPD) Project started in 1985 (Hatch and Naughten 1994). About 33 million saplings, mainly eucalypts, were supplied by the Project to its farmers during 1990-91 alone. Farmers' nurseries, free supply of seedlings to farmers who intended to plant trees on their farms, and farmers' training were the main components of the programme. Results of this project are now being carried forward, in a bigger way, by launching a World Bank funded Foresty Development Project in Punjab; Asian Development Bank funded Social Foresty Project in Sindh and Asian Development Bank funded Foresty Sector Project in NWFP, in accordance with the recommendations of the Foresty Sector Master Plan.

6.7. Wood Distribution Systems

Extensive firewood market surveys have recently been conducted by the HESS Project, which provide better insight and understanding of the wood fuel market mechanism, price build-up and catchment areas. (Aftab Associates 1992a, 1992b, 1992c, 1992d; Dougherty 1993). These surveys confirm earlier remarks by Clark (1990) that there is a comprehensive wood fuel distribution system in operation in Pakistan that is based on free enterprise and is generally serving the country well. It operates almost entirely within the private sector. The system efficiently and economically allocates wood resources to the different market segments. Although the participants may not be elated about the price or quality, any one with wood to sell can find a buyer, and any one needing wood can find it (Hatch and Naughten 1994).

A number of salient features and characteristics of the firewood trade have been highlighted by the HESS surveys. Various components of the system, namely, wood production, distribution, transport and final sales are well integrated and provide a valuable commercial service to the nation. The wood markets are competitive, they are responsive, and they provide a reasonable annual income for the traders. They should be allowed to continue to operate under the economic constraints and exigencies of overall market forces without the pressure of government intervention.

Perhaps the single most important feature of wood markets in Pakistan is their dependence upon trees from farm producers. Wood catchment areas coincide with wood producing farm areas throughout the NWFP, Punjab, and Sindh provinces. Thus, even though Pakistan's forests are only a small fraction of its total surface area, traders have tapped the vast tree resources of thousands of private farmers across the country. The NWFP and Punjab have emerged as key contributors to this supply chain.

Nevertheless, there is only marginal involvement of tree producers in the inner network of the firewood trade. They see themselves primarily as suppliers of standing trees (mostly shisham and kikar) and leave tree cutting and transport to the (typically) roadside trader. This reluctance to market their own trees puts them at a disadvantage to traders and seriously limits their profits. A program of information dissemination on how farmers can better grow and market their firewood products, therefore, needs to be implemented in the main wood producing areas.

Even though wood is a primary commodity with a low value added content, it provides substantial profit margins in a retail-dominated market. At the national level, wood markets generated roughly Rs 13,375 million during the year 1991-92, or roughly Rs 115 per capita. About 36,650 retail businesses operated throughout the country, employing nearly 85,400 people, and earning an average of about Rs 53,000 per year in sales to the households and commercial sectors. These businesses are generally small-scale, may sell other type of material, and remain open throughout the year. Winter is the busy season, accounting for roughly double the sales of summer. In this

environment, the optimum role of government should be to improve the overall civil works infrastructures and remove other obstacles to the free movement of wood.

Results of these surveys also indicate that firewood weaves its way to the final consumer in a variety of ways. This is an important indicator of the resilience and efficiency of local markets. The distribution chain, although kept as short as possible, is characterised by numerous levels of exchange prior to its purchase by the final consumer. Unlike other commercial products, it does not possess an easily traceable, standard distribution route. These flows of wood as well as resulting revenues are unevenly distributed with regard to trader location and type.

Balochistan is the one province which stands in contrast to national trends. Wood producers typically sell their trees on a standing tree basis, except where farmers opt to prune the trees themselves. Most of the wood sold in a given province originates in the same province, except for Balochistan which imports most of its supplies from neighbouring Sindh and Punjab. Price mark-ups tend to average around 30% throughout the country except in Baluchistan where the average mark-up is 50%. And lastly, large transport distances for the traders in this province stand in stark contrast to the shorter routes in the NWFP, Punjab and Sindh. All these patterns are attributed to the agroecological distinction of this largely semi-arid to desert region and call attention to an important consideration: should wood shortages arise in the future, it is this province that will feel the effects of scarcity earliest and hardest.

The transport of wood in Pakistan typically involves high tonnages over large distances by means of 6-wheel Bedford trucks. Not surprisingly, transport costs are the largest component of the wood price accunting for 67% of en route and yard arrival costs. Costs are lowest for roadside traders in Punjab and NWFP who operate closer to farm supplies. About 90 perent of the wood which is transported is medium to large diameter round logs. Any government efforts to intervene in the pricing of diesel fuel is certain to affect the transport component of the purchase price. A separate study is suggested to assess the impact of rising diesel prices in Baluchistan and Sind.

Transit taxes applied to these hauling trips show considerable variation per province. Overall, transit taxes take the same share as costs involved in unloading and other yard arrival tasks and about half the total en route costs in case of Punjabi traders. Indeed transit taxes are poorly understood by transporters and thus subject to widespread abuse, adversly affecting the final consumer. A review of country wide zila (district), octori and forest departments' taxation structures should be undertaken with a view towards transparancy, simplification and standardization.

Although the present free market system is working well, there is need to to make information on current prices and market trends, as well as economic returns analyses and technical information on new species and management methods, available to private tree growers and wood purchasers.

6.8. Socio-Economic Impact of Wood Energy

Current level of tree planting

The results of the HESS survey indicate that in total the firewood users planted about 125 million trees (112 million non-fruit and 13 million fruit trees) in 1991 (Leech 1993). This number has been found to be insufficient to ensure sustainability, even if all of them survive (Hosier 1993). It is necessary for the number of trees to approach 200 million per year and for a large fraction of them to survive for the wood fuel system to achieve sustainability for the immediate future.

Apart from the survey estimates, it is difficult to know the actual numbers of trees being planted annually in the country in the absence of comprehensive records. The USAID sponsored Forestry Planing and Development Project distributed about 33 million trees to its farmers in its project areas during fiscal year 1990-91 (USAID 1993). Forestry Departments produced 174 million seedlings during 1990 (including 33 million seedlings produced under USAID Forestry Support Program), of which 30 to 40% ended up being planted by the farmers. HESS survey also indicated that about 30% of the farmers planting tree seedlings obtained them from government nurseries and another 10% obtained them from private nurseries. But the largest share (59%) claimed to grow their own seedlings from cuttings and seeds. If this percentage is added to the number of seedlings obtained from official sources, then it is possible that a figure of 100-120 million tree seedlings being planted per year is not an unrealistic assessment of the level of tree planting by private farmers (Hosier 1993).

The actual number of trees surviving, however, is more important than the number of trees planted. No good estimates of the survival rate of the tree seedlings once they are planted on farm lands exist. Estimates based on the personal judgement of informed observers indicate 85-90% survival rates on irrigated farm lands, particularly when farmers had to pay for the seedlings. Another estimate indicates that on average, about 60% of the trees planted from seedlings survive. However, estimates for the survival rates of trees planted outside of farm lands are much lower. The 75% estimate, though often used, is quite optimistic.

The number of trees planted varies not only by year but also by agroecological region. According to HESS survey results, the number of trees planted per capita varies from a low of 0.03 in the Southern High Productivity Irrigated Areas and 0.2 in Barani (rainfed) Areas to 1.3 in the Northern High Productivity Irrigated Areas and 1.5 in the Semi-Arid Areas. Tree planting has a long history in various regions of Pakistan. The tradition of *hurries* or block plantations in Sind Province has encouraged farmers to grow *Acacia* trees on wastelands and irrigated farm lands (Leach 1993). The Punjab Forest Department began actively promoting tree-planting on private farm land in the 1950's (Hocking et al 1991).

This evidence goes to demonstrate that farm forestry is an established practice in Pakistan. But efforts are needed to make tree planting sustainable. This can be achieved by ensuring security of tenure to the farmers which would ensure them that the products of the trees they plant are theirs to harvest and sell. The uncertainity of tree tenure is an important disincentive to tree planting by farmers (Leach 1993).

Reducing Volatility

Although the size of the wood shortfall in Pakistan makes the possiblity of a tree-product "bust" like the one encountered in Northwest India, a remote possibility, such an occurrence may, nevertheless, have to be precluded through policy initiatives aimed at establishing a stable policy

environment which encourages planting, management and harvesting of trees on private agricultural land. This goal can best be achieved through allowing the market to operate unhindered rather than through attempting to manage a complex system of price supports and subsidies. Under such market conditions there is a much more limited chance of "overshoot" of the required tree planting rates. This may be one of the true causes of the pole "glut" in northwest India, as the Indian social forestry network is rife with subsidies and price controls.

In order to reduce the chances of a volatile wood market, existing the dissemination of information on prices of various forest products needs to be ensured. Realistic gains expected from planting trees are to be provided to the farmers by the extensionists. As the bulk of the trees (about 75%) end up producing fuelwood, timber and firewood, demands that are quite complementary, the stimulation of the commercial demand for timber is an important action that can be taken to overcome the shortage in fuelwood supply (Hosier 1993).

Forestry benefits and tree farming

Trees growing on farmlands do not provide the same level of public amenities as do closed forests. They behave and should be treated as perennial cash crops. Therefore, their harvesting and management should not be subjected to special government regulations and interference, but rather left to the discretion of private land managers. Environmental benefits from forestry can be gained through forest management, protection and preservation. From this perspective, the Forestry Department should redouble its efforts to manage the few remaining natural forests in the country.

Conservation

Since fuelwood consumption accounts for such a large quantity of trees, it is important to think of conservation as one of the logical policy interventions. Reducing fuelwood cosumption through improving the efficiency of its use is one straightforward way to bring consumption back into line with supply. Dissemination of improved and energy efficient stoves is to be encouraged where appropriate and possible. However, gains from such efforts are liable to be modest.

6.9. Substitution by Modern Fuels

The natural solution to fuelwood shortage is for households to move away from wood to other fuels, particularly modern fuels. Results of the HESS survey, however, indicate that movements up the energy ladder are caused by increases in income rather than increases in scarcity. The interfuel substitution is, therefore, a natural process which will follow its own course. The government should focus its attention on making modern fuels available in a cost effective manner. No subsidies should be given to achieve this, but rather fuel supplies can be increased through reliance upon market forces and public investments justified by benefit-cost analysis.

Fuelwood prices in Pakistan have increased only slightly over the past 20 years. As such they have not demonstrated any depletion effects. However, in order to compare prices of traditional and modern fuels, it is necessary to evaluate their prices per effective energy unit. Average cost estimates of various household fuels are summarised in Table 5. These data do not include any amortised appliances costs, so the transaction cost involved in switching from one fuel to another has not been taken into consideration. This transaction cost may prove to be prohibitive in many cases. These data demonstrate three important points. First, the cost of crop residues and dung at the end-use level are roughly equal. However, the cost of the both is significantly lower than that of fuelwood, reflecting its lower quality as a fuel.

Second, the effective cost of using firewood is almost identical to the cost of using kerosene, ignoring the transaction cost involved in a stove purchase. In both urban and rural areas, the financial cost of using firewood is just about equal to that of using kerosene. This should mean that many households are beginning to utilise kerosene for supplementing traditional fuels. If these relative prices continue, the households which have begun using kerosene as a supplement will begin using it as a primary fuel. HESS surveys indicate that kerosene is already heavily used for cooking in urban areas. In Barani areas, 45% of the households claimed to cook with kerosene. Kerosene will undoubtedly begin to play a more important role as a bridging fuel between traditional fuels and more convenient modern fuels such as LPG and natural gas.

Third, the effective cost of using firewood and kerosene for cooking is considerably higher than the cost for either LPG, natural gas, and electricity. Electricity is not generally considered as a desirable cooking fuel in Pakistan, and this is as it should be, given the load constraints. But both LPG and natural gas are cheaper than traditional fuels for those households using them. In both cases question of access loom large. Households have to be located near the gas pipelines to utilise natural gas. Although LPG bottles and stoves represent considerable investments for poorer households, it still remains cheaper than the traditional alternatives, even if the price of LPG is doubled. This demonstrates the increasing importance of modern fuels to the household sector, necessitating access to these modern fuels at a larger scale, but without any price controls, allowing free market to operate, so that households are permitted to use whichever fuel they find economically attractive.

Table 5. Effective cost of household fuels

Fuel	Energy content (MJ/unit)	Physical unit	Appliance efficiency	Financial cost (1991 Rs/unit)	Financial cost/ effective MJ (1991 Rs/MJ)
Crop residues	15	Kg	12.0	0.70	0.39
Dung	12	Kg	12.0	0.58	0.40
Fuelwood-urban	16	Kg	12.0	1.01	0.53
Fuelwood-rural	16	Kg	12.0	0.98	0.51
Kerosene	35	Lt	35.0	6.62	0.54
Natural gas	1030	Mcf	60.0	31.30	0.05
LPG	45.54	Kg	60.0	5.70	0.21
Electricity	3.6	Kwh	65.0	0.69	0.29

Source: Hosier 1993

6.10. Future Direction

- Emphasis should be on growing trees rather than planting trees.
- Facilitate linkages between industrial associations, or individual companies, and tree farmers to explain the industry's raw material needs and quality constraints, and to improve industrial understanding of the farmer's production constraints.
- Industries should be encouraged to support tree farming by providing nursery stock to farmers, by cooperating with the forestry staff and by offering technical forestry extension services.

- Strenthening wood-user producer linkages through:

  - Access to credit for forestry activities both for farmers and industry.
  - Stronger forest department extension and technical outreach activities.
  - More extensive research to support private sector forestry as well as extension programmes.
  - The formation of a federation of industrial commodity associations at the national level (similar to the National Forest Council of the U.S.) for the purpose of promoting forestry. Such a federation could give high level recognition to the private forestry sector as a national leader in self-help programmes and provide a long-lasting institutional framework for the sponsoring of tree-farming.

- A program of information dissemination should be implemented in the main wood producing areas on how farmers can better grow and market their firewood products. There is a need to make information on current prices, market trends, as well as economic returns analyses and technical information on new species and management methods available to private tree growers and wood purchasers.

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7. THE ROLE OF NON-FOREST LAND IN WOODFUEL PRODUCTION IN SRI LANKA

Anoja Wickramasinghe

7.1. Introduction

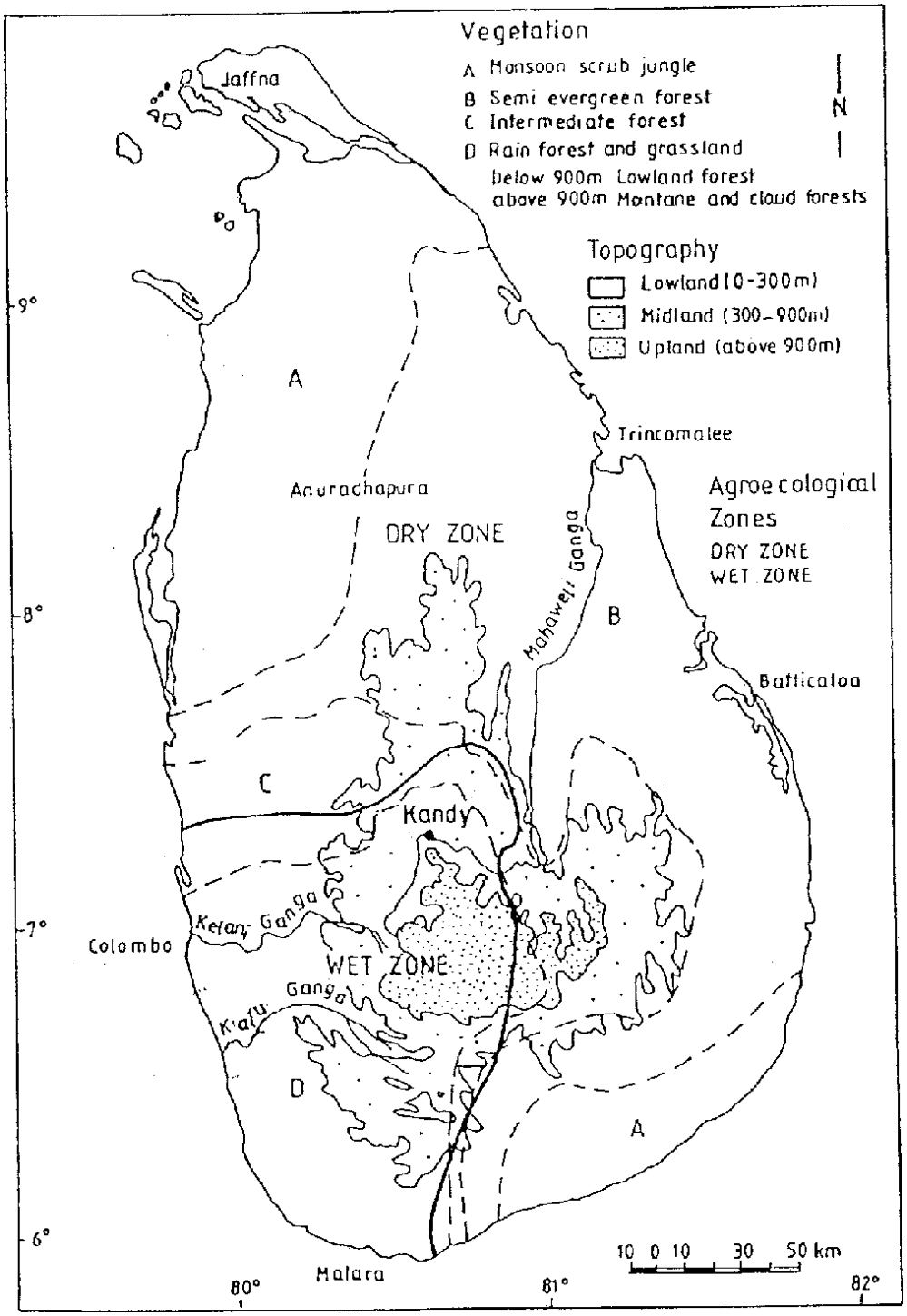
Irrespective of variation in types and sources of supply, woodfuel has become a basic need. It is primarily used for ensuring human survival and to a lesser extent for production work. Since time immemorial it has been obtained freely from natural vegetation systems. The sources have been freely shared by users without obligations as no costs other than time and energy have been incurred. With the growth of population and the acquisition of forest lands for other uses a drastic change has taken place. People's dependence on natural forests has been changed to non-forest sources. This was due to a number of factors. These include the fast depletion of natural supply sources, the expansion of agriculture and other land-based activities, strict legislation introduced with the objective of inhibiting free use of natural forests, protecting such systems, the claim of natural forests as state owned lands to which people had free access on customary grounds and also the increasing demand for domestic consumption as well as wood energy based industries.

Sri Lanka is located between 5^0 54' - 9^0 52' N and 79^0 39' - 81^0 53' E and covers nearly 6.5 million hectares. The most outstanding features are its diversity in terms of its bio-physical and socio-economic environment and also its land utilization. Nearly three quarters of the land consists of gently undulating lowlands in which the elevation varies between 0-300m. The south central portion of the country known as the central highlands have a remarkable topographic variation. It gives rise to a variation in vegetation in addition to its impact on climate. The altitude of the central highlands goes up to about 2524m. It is subdivided into midlands (300-900m) and uplands (900-2500m). The distribution of rainfall is affected by its tropical and island location, topography and the pattern of monsoons.

A remarkable variation exists between the south west portion where the variation in rainfall is between 1900-5000 mm yr^{-1} and the rest of the island which receives less than 1900 mm yr^{-1}. These features are not only of hydro-climatic significance but also of direct significance to the spatial variations in vegetation communities, land use and farming. The broad vegetation types of the country: (A) Monsoon scrub jungle; (B) Semi-evergreen forest; (C) Intermediate forests; and (D) Rainforest and grassland (Mueller-Dombois, 1968) are associated with these spatial rainfall patterns (Figure 1).

The area under forests has been reduced to isolated islands. From the beginning of the century forest cover has been reducing at an alarming rate. Since 1881 it has dwindled from about 80% to 24% of the total land area in 1992. The 1985 national forest inventory of Sri Lanka estimated that the forest cover should be about 42%, made up of 28% dense high forest including both natural and man-made with a canopy cover of 75% to 100, and the balance 14% to include open forest with a canopy cover from 45-75%, scrub forest cum grassland with a canopy cover with 0-45% (FAO, 1985). Nanayakkara (1986) has described that: 'taking all tree cover into account, forest, non-forest, agricultural plantations e.g. tea, rubber, coconut, home gardens etc, around 65% of the country is under tree cover. This is a good situation for the integrated wood energy development and the national wood energy utilization considering the fact that Sri Lanka is a densely populated country where 94% of the people use fuelwood for domestic purposes, and

many industries use fuelwood for energy in their factories'. The crucial problem in Sri Lanka is not the extent of land area under trees/woody perennials, but those related to the imbalance between the supply and consumption, and disparities in the distribution of 'hot-spots' in production and 'sinks' in consumption. The scarcity has been felt by some end-users more crucially than the others due to pressure and competition on the supply sources as well as to their resourcelessness.



Figure(1): Vegetation, topography and agro-ecological zones of Sri Lanka.

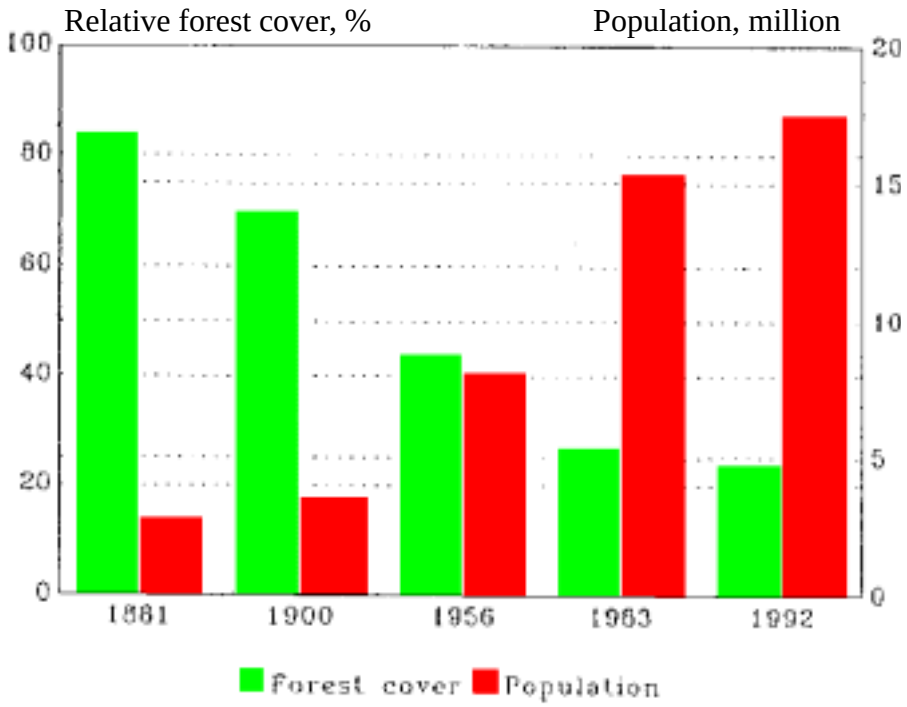


Figure 2. The increasing population and declining forest cover between 1881-1992.

The whole scenario of fuelwood production and consumption is complex. The link between the growth of population and the national consumption has been postulated on the per capita consumption and biomass fuel production. A similar connection has been constructed between deforestation and population growth (See Figure 2). Increasing population, particularly in the agrarian economic context of the country means acquisition of more land to produce crops and increased pressure under land-based survival. The country's population has risen from 889584 in 1822 to 2.4 million in 1871. It has increased by 518.5 % between 1871 and 1981. It is important to note that since 1953 the total fertility rate has declined from 5.3 to 2.8 in 1987. The growth has come down to 1.2 % in 1993. The share of urban population has not shown a dramatic change. The average density of population was 230 persons per km^2 in 1982 and this has risen to 273 in 1993. This in fact is important in the consumption of fuelwood. In mid 1990s about 17 million people lived in the area of 65100 km^2, with a per capita GDP of US$ 418. Projected population in the year 2001 will be 21,943,000 average (Department of Census and Statistics, 1984). According to the FSMP (1995) population growth will be a dominant factor in governing the forestry sector due to its effect on the demand on forest products. In the past, while crop monocultures were being established for massive production, the lands under 'chena' cultivation, originally featured with a fallowing period, have been absorbed into permanent agriculture. The dichotomy associated with deforestation and population growth is the reduction in the supply source (the forest resources) and the increasing expansion of non-forest land use systems and the demand for fuelwood and other products. The two interrelated factors affecting the fuelwood scenario of the country include, the heavy dependence of people on agriculture, in which nearly 48% of the people are engaged, and the concentration of about 76% of the population in the rural areas. The question is to what extent the rural concentrated population is able to cater for the country's woodfuel needs out of the lands that they use for agriculture?

7.2. The National Energy Scenario

The national scenario discloses the sectoral specific features in the type of energy supply and consumption. Energy consumption has consistently increased in Sri Lanka. For instance, the per capita consumption during 1971-1981 has increased from 300 kgoe to about 338 kgoe in 1990 (UNDP, 1992). The total energy consumed comprises biomass, oil and electricity, which the consumption of coal insignificant. The share of energy consumption in 1992 comprises 66% bio-energy, 22% petroleum and 12% electricity (FSMP,1995). It was 69.4% bio-energy, 20.2% petroleum, 10.2% electricity and 0.2% coal in 1986. Of the total of 590,653 (toe), in 1984, 71.2% has been supplied from fuelwood; 18.95% oil; 8.5% hydro electricity; 0.69% oil fired electricity and 0.66% coal (Ceylon Electricity Board Energy Unit, 1984). The trend over these years has been a reduction in the bio-energy from 71% in 1984 to 66% in 1982. The petroleum consumption has increased from 19% to 22% while electricity has increased from 8.5 to 12%.

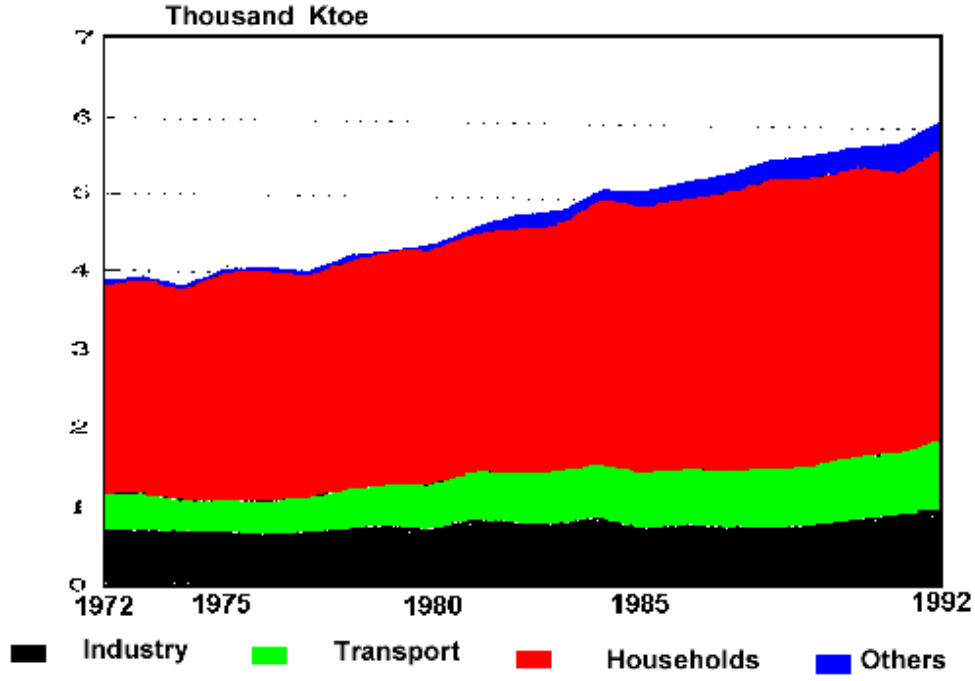


Figure 3. Changes in the sectoral energy consumption between 1972-1992.

The total energy consumption has increased annually on an average of 2.3% in the period between 1982 -1992. The picture on sectoral energy consumption (Figure 3) exhibits a growth in all the sectors, with an outstanding increase in the household sector. The household sector is the biggest consumer, absorbing nearly 61% of the total energy in 1992. In 1986 it has consumed 65.1%, while industry, transport and others have absorbed 16.9, 13.6 and 4.4% respectively.

The national scenario shows that the total energy consumption has risen by about 47% between 1972-1992. This was associated with an increase of about 36.9% in the industrial sector, 84.2% in transport, 39% in the household sector and about 400% in all other small consumers. In spite of these variations, in the consumption pattern, the household sector is the biggest consumer, industry comes second and the third is transport (see Table 1). The internal trends are marked by two features: First, the increased demand for energy since 1978/79 with the liberalization of the economy; and second, the switching over of the industrial sector from petroleum to fuelwood, whenever possible, with the increase in petroleum price. For example, per capita commercial energy consumption has reduced from 90.9 kgoe in 1972 to 73.2 kgoe in 1976. The use of non-commercial energy to substitute commercial energy has implied an increase in woodfuel demand from the industrial sector.

Table 1 Distribution of total energy consumption by sector 1972-1990 (Percent).

Year	Industry	Transport	Household	Other	Total	Total (ktoe)
1972	18.7	11.9	68.2	1.3	100	3,907.8
1973	18.6	11.7	68.7	1.1	100	3,936.2
1974	18.8	10.3	70.0	0.9	100	3,829.4
1975	18.0	10.0	71.1	1.0	100	4,039.9
1976	17.1	10.1	71.6	1.2	100	4,072.8
1977	18.1	10.8	70.0	1.2	100	4,021.4
1978	18.5	11.7	68.4	1.4	100	4,240.0
1979	19.2	12.0	68.5	0.3	100	4,313.3
1980	17.8	13.1	67.7	1.4	100	4,399.5
1981	20.0	13.4	65.2	1.4	100	4,621.1
1982	18.6	13.5	64.5	3.4	100	4,782.4
1983	18.2	13.6	64.5	3.7	100	4,844.1
1984	18.9	13.4	65.1	2.6	100	5,142.8
1985	16.3	13.9	65.8	4.0	100	5,126.5
1986	17.0	13.6	65.1	4.4	100	5,256.6
1987	16.5	13.3	65.7	4.5	100	5,375.2
1988	15.7	13.4	66.5	4.4	100	5,555.3
1989	16.2	13.4	65.4	5.0	100	5,630.9
1990	17.4	14.0	64.2	4.4	100	5,745.4

source: Sectoral energy demand in Sri Lanka, UNDP, 1992

The Forestry Sector Master Plan (1995) insists that 'the real price of fuelwood has increased only slowly during the last ten years, and has mentioned that fuelwood scarcity is not a serious matter at national level. The price increases are noted as a matter affected by increased transport costs, reduced availability and the lack of alternatives for the poor sectors. Calculations have been made to construct a general picture referring to the price of urban fuelwood. Accordingly, Liquid Petroleum Gas (LPG) has been reported as the cheapest for domestic cooking, irrespective of costs of basic equipment (Table 2). Between 1981 and 1991 its consumption has increased tenfold (FSMP, 1995).

Table 2. Cost of generating heat from different sources of fuel in 1994.

Fuel	Purchase price Rs / Kg	Efficiency = (heat utilized/heat available)x100 %	Price paid for actual heat utilized Rs/GJ
Fuelwood (retail)	2.00	15 (household)	0.84
Fuelwood (bulk)	1.20	66 (industrial)	0.11
Furnace oil	6.90	75	0.22
LPG	22.00	60	0.73
Kerosene	20	45	1.02
Electric (hot plate)	5.25/kwh	75	1.94
Elect. (rice cooker)	5.25/kwh	90	1.62

source: FSMP, Sri Lanka, 1995

The national energy scenario highlights a few major features. These include:

- There has been no remarkable reduction in the share of woodfuel in the energy supply and consumption of the country. Despite the extremely high attention paid by the national sectors to promote the supply of hydro-electricity, particularly under the river valley development programmes, it has not made significant changes in the energy scenario;

- Continuous and consistent pre-occupation of woodfuel in the domestic sector, suggests that it has not only been basically dominated by the sector but the availability itself has also ensured a secure living for a majority of the people in Sri Lanka;

- Even if transitions occur within the energy scenario, it is unlikely that woodfuel consumption will decline. The growing population, deepening poverty that inhibits the capacity of people to purchase substitutes, and also the absorption of woodfuel into growing rural industries point to the fact that woodfuel will remain the primary energy source in the future;

- The cultural context is an important, but ignored, dimension of the energy scenario of the country. Woodfuel is not a matter of generating 'energy' per se, but encompasses a number of interrelated domains such as resource management, survival maintenance, psychological and physical well-being, traditional practices etc;

- The predominance of 'renewable resources' in the energy scenario and its dependence on non-forest sources suggests the potential for a dopting local solutions.

7.3. Sources of Woodfuel

Woodfuel practically encompasses woody and non-woody biomass like barks, twigs, roots, crop residues, shells etc that are derived from vegetation and converted into energy. The end users' consumption of these depends on:

- the availability of fuelwood in its real form as 'wood';
- the purpose of energy generation, i.e. whether its for industry, cooking, food processing etc;
- the type of supply sources and access to them;
- pressure on sources, and;
- the demand for specific wood types in addition to location and the household-specific forms of socio-economic governance.

The wood types used in generating energy in Sri Lanka are supplied from many species and a number of sources. Nanayakkara (1986) has reported that all 18 sources that have been recognized as sources in South Asia are relevant to Sri Lanka too. These include: natural forests, man-made forests, agricultural plantations, scattered natural woodlots, domestic woodlots, village gardens, urban gardens, hedgerows and live fences, roadside and avenue trees, canal side trees, railway line plantings, shade trees in pasture lands and estates, scattered trees, wood waste from industries (saw millions, plywood, mulch, paper), logging waste, small sized thinning, bagasse and agricultural residues. According to the country scenario forests and non-forest lands are the two primary supply sources. When tenurial aspects are taken into consideration it seems better to separate all state sources from privately owned ones and put into one category. This is mainly because there are many types of reservational areas used in procuring woodfuel but remain neither as forests nor as private property. However, it is difficult to construct a generalized clear

picture. This is due to the outstanding spatial variation of the country, the differences in approaches and methods adopted in national surveys as well as the different perspectives of the researchers. For instance, the data presented by Wijesinghe (1984) by zones and the fuelwood production by species given by Howes (1990) under land use systems and 3 categories: ‘exportable’ ‘other fuelwood’ and ‘other fuel’ inhibit the possibility of either bringing these data together or comparing the actual sources.

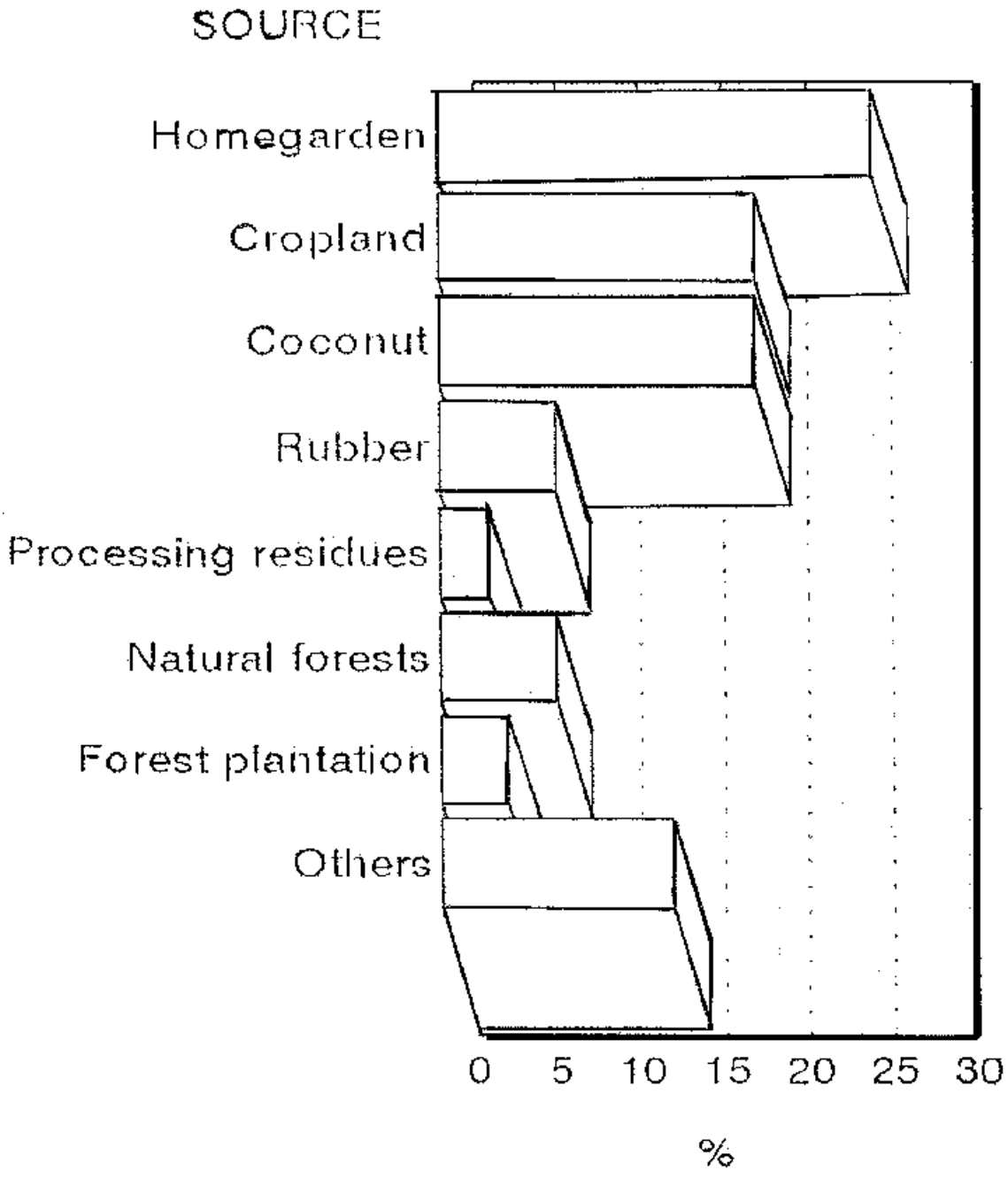


Figure 4. Estimated sources of bio-energy supply.

The source of bio-energy supply have been identified by reference to 8 categories (See Table 3). The comparison of the share derived from these sources has led to the conclusion that non-forest sources play a dominant role. The share derived from home gardens, coconut, rubber and croplands alone comes to about 71% of the total supply (Figure 4). This suggests that supply sources are highly area specific and closely linked with the area under each category of land use.

Table 3. Estimated sources of bio-energy supply.

Source	Percentage share
Home garden	26
Cropland	19
Coconut	19
Rubber	07
Processing residues	03
natural forest	07
Forest plantation	04
others	14

source: FSMP, 1995

The basic arguments out forward by Howes (1990), in distinguishing three categories; 'exportable', 'other fuelwood' and 'other fuel' is that it helps separate the types available for local consumption from that of exportable which can be made available to any consumer. Similarly, the 'other fuel' which comprises crop waste refers to all low density fuels. These include primarily the non-woody residues such as coconut husks, corn stalks etc. These are consumed at or closer to the point of production. In this context, from the perspective of wood quality and source of fuel this categorization displays what types enter the market channels and what are consumed locally. The data given in Table 4, reveals that out of the total production during 1985-1990, 57.8% consisted of exportable wood. The main supply sources were forests, rubber and coconut which are transportable over relatively long distances. These include the forest wood of the dry zone areas and the wood of coconut and rubber plantations of the wet zone. An important feature is that these are commercially transacted and primarily supplied for industrial consumption.

The second category, the other fuelwood, primarily consists of small wood derived in relatively small quantities. The percentage share is 12.9%. Supply sources include home gardens, sparsely used croplands, cinnamon, shade trees in teaestates, urban lands etc. Although these fuels provide good quality woodfuel, they are not commercialized. The second category includes most of the supply sources of 'other fuel' which accounts for nearly 28%.

Table 4. Annual potential fuel production by source 1985-90.

Category	Fuel source	'000 tonnes	Percent
Exportable fuelwood	Rubber	2,012.1	12.2
	Coconut	204.4	1.2
	Forest	7,340.0	44.4
	Sub-total	9,650.5	57.8
Other fuelwood	Home garden	898.2	5.4
	Sparsely used crop land	820.1	5.0
	Cinnamon	154.0	0.9
	Tea shade trees	151.0	0.9
	Other	105.0	0.6
	Sub-total	2,128.3	12.9
Other fuel	Home garden	1,270.4	7.7
	Coconut	2,106.6	12.7
	Palmyrah	330.6	2.0
	Teaestates	920.3	5.6
	Other	131.1	0.8
	Sub-total	4,759.1	28.8
	TOTAL	16,537.9	100.0

source : Howes, 1990

7.4. The Spatial Characteristics

The commercial fuelwood supply is dominated by forest wood. The 5 zones used by Howes (See Figure 5) by combining agro-ecological zones with predominant land-uses, show that the supply sources of these 3 types are distributed unequally. The major features disclosed by the data presented in Table 5 are:

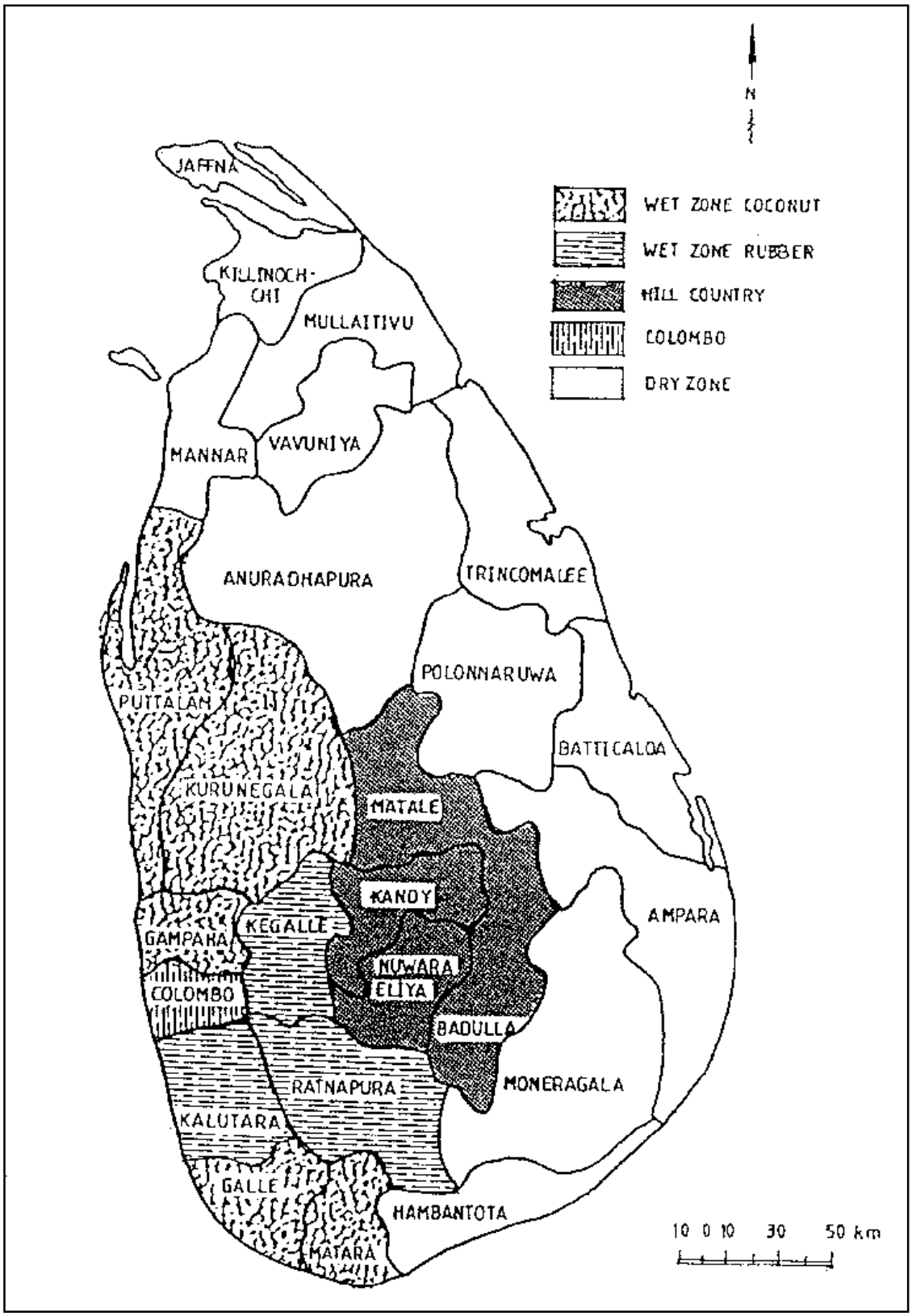
- The exportable or commercial woodfuel supply is dominated by the natural forest, rubber-wood produces nearly 27% of the share derived from natural forest, and coconut is the third source, but a relatively low amount is obtained;
- The bulk of commercial woodfuel comes from the dry zone, so it is governed by the spatial distribution of the forest cover. The wet zone, the predominant rubber and coconut growing areas, are the next most important zones the contribute to this category;
- The sources of 'other fuelwood' supply are diverse, and the contribution depends on the tree cover in various land-use systems. In terms of the share of contribution the sources rank as home gardens, sparsely used crop lands, cinnamon, shade trees and others;
- This situation suggests that the distribution pattern as well as the area under home gardens, sparsely used croplands etc are important determinants. As a result supply sources get expanded and are distributed among the agro-ecological zones. Yet, coconut being the producer of many types of fuelwood, and a widespread species in home gardens and crop lands, both earned outstanding importance;
- The supply pattern of other fuel, the crop waste burned or used as a substitute to "woody parts" are associated with the distribution of crop lands and tree crop based systems that produce crop waste. Due to the wide use of coconut husks the areas/systems where coconut predominates are the biggest suppliers; so the spatial pattern follows the distribution of home gardens, crop lands etc;

Table 5: Annual potential fuel production 1985-1990 (tonnes x 10 air dry).

Zone	Exportable Fuelwood			Other Fuelwood					Other Fuel				
	Rubber	Coco-nut	Forest	Home garden	Crop land	Cinna-mon	Shade tree	Other	Home garden	Coco-nut	Palm y-rah	Tea estates	Other
Colombo	219.6	3.7	--	19.0	10	10.2	2	5.6	40.8	39.1	--	0.9	23.2
Wet zone Coconut	325.2	158.7	463.2	319	206.8	110.6	25.2	18.5	598.9	1,670.2	--	153.6	26.2
Wet zone Rubber	1,355.5	16.7	--	138.1	91.0	22.3	27.0	14.9	296.0	132.0	--	164.4	38.8
Hill-country	79.5	5.7	--	175.7	233.7	--	98.2	15.7	83.4	59.6	--	597.9	25.7
Dry zone	32.5	19.5	6,971.6	246.6	267.6	10.9	0.6	50.3	251.4	206.1	330.7	3.6	17.6
TOTAL	2,012.3	204.3	7,434.2	898.4	809.1	154.0	151.0	105.0	1,270.5	2,107	330.7	920.4	131.3

Source: Mick Howes, 1990.

Figure 5. The Geographical zones relevant to woodfuel scenario by districts.



The overall picture discloses that 71% of the country's energy requirements and over 94% of domestic energy are obtained from non-forest sources. Well-distributed sources such as home gardens, crop lands, shade tree etc come primarily from the non-forest lands, so forests are primarily the commercial sources. The examination of the user groups of the commercial and non-commercial woodfuel require further analysis.

7.5. Consumption of Non-Forest Woodfuel

The domestic and industrial sectors are the primary consumers of woodfuel. It is the main form of energy used in the household sector. The household sectoral energy is composed of 87.5% fuelwood; 6.6% electricity; 4.8% kerosene and 1.1% liquid petroleum gas (LPG). Electricity and kerosene are the major types consumed for lighting while fuelwood is primarily used as cooking energy. The household sector, which absorbs two thirds of the total, is not only the largest consumer of all energy but is also the consumer of about 87% of the total wood energy. In 1993 fuelwood was the source of cooking energy for 92.4% of the population of Sri Lanka (98.4% of rural population, 79.8% of urban and 99.1% of the estate population have used woodfuel for cooking (Karunatilake, 1993). The Forestry Master Plan (1986) has identified 7 categories of supply sources to the domestic/household sector. These include rubber-wood (28%), coconut (24%), tea pruning (4%), home gardens (11%), natural forest (23%), forest plantations (2%) and other (8%). Nearly 75% of the requirements, accounting for about 5.6 million tonnes, were obtained from non-forest sources in 1986.

The nationwide Consumer Finance Survey conducted in 1990 estimated that in 1986-87 the share of bio-energy by types was: rubber wood 17%, other fuelwood 52%, coconut residues 22%, tea 8%, cinnamon 1% and saw-dust 1%. In fact quite close estimations have been derived from a field survey conducted by Wijesinghe (1984). Accordingly rubber-wood provided 18%, crop residues (mainly coconut branches and husk) 29%, and other fuelwood (from home gardens, natural forests, plantations, off-cuts and saw-dust) 53%. In preparing the FSMP (1995), on the basis of the information given by 4 sources: Wijesinghe (1984), the Consumer Finance and Socio-economic Survey (1986/87), The Central Bank of Sri Lanka (1990), Howes (1990), it was estimated that 67% of fuelwood and 33% of crop residues are the two important types of bio-energy. Nearly 84% of woodfuel used by households has been obtained freely by users, the balance of 16% has been purchased (Dheerasinghe, 1993). The results of these studies show variations in estimations. The estimations of per capita consumption of fuelwood are an example (See Table 6). Variations among three sectors - rural , urban and estate exist. These variations are partly due to location factors and the stoves-types. Per capita consumption reveals a trend. For instance, the average for 1986 was nearly 1.56 kg; in 1983 1.44; and in 1993 1.32 kg per person per day. As these data have not been derived from a longitudinal investigation, detailes analysis cannot be done. The spatial disparities, seasonal variations together with methodological limitations inhibit the construction of a picture incorporating all micro-level conditions.

The Sri Lanka Energy Balance (1992) has shown that of the total energy consumption of 1120 ktoe in the industrial sector, 49% was derived from fuelwood, 10% agro-residues, 25% hydro-electricity and 16% oil. Among all industrial and commercial sectors that consume woodfuel the tea industry is the largest consumer (See Table 7). Out of the total annual consumption of 1,053 thousand tonnes, 23% is consumed by service sectors, hotels, eating houses and bakeries while 77% is absorbed by industries. The tea industry consumes 43%. In industrial and household sectors both plantation crops are the primary suppliers. Rubber and coconut supply 51% of the woodfuel consumed in the commercial sector while only 25% is derived from forests for the household consumption (See Table 8). This suggests that woodfuel production from non-forest sources dominate the country's energy scenario which basically depends on woodfuel.

Table. 6. Summary of the sample survey on fuelwood consumption in households.

	PER CAPITA CONSUMPTION - kg / person / day				
				Present Study 1993**	
District / Type	**Presents Study ****	**Naresa Study * 1983**	**FMP Study 1986**	**Traditional Stoves**	**Improved Stoves**
Kalutara (U)	1.09	1.04	1.41	1.10	0.73
Galle (R)	1.14	1.38	1.41	1.19	0.86
Matara (R)	1.37	1.38	1.41	1.39	0.98
Ratnapura (R)	1.36	1.40	1.41	1.34	1.66
Polonnaruwa (R)	0.98	1.46	1.44	1.48	0.80
Puttalam (R)	1.08	1.38	1.44	1.06	1.39
Badulla (R)	1.56	1.65	1.72	--	1.56
Badulla (E)	1.66	1.87	1.72	2.10	1.53
Kandy (R)	1.07	1.65	1.72	1.11	0.63
Nuwara Eliya (R)	1.43	1.65	1.72	--	1.43
Nuwara Eliya (U)	1.18	1.02	1.72	1.33	1.13
Nuwara Eliya (E)	2.11	1.87	1.72	--	2.11
Anuradhapura (R)	1.07	0.95	1.44	1.07	--
AVERAGE	1.32	1.44	1.56	1.37	1.23

source: Forestry Master Plan, Sri Lanka, 1986.
* = Wijesinghe (1983); ** = Forestry Master Plan Study, Sri Lanka, 1993.
U = Urban; R = Rural; E = Estate.

Table 7. Consumption of fuelwood by the industrial sector (1992).

Industry	Annual Fuelwood consumption 1000 tonnes	Percentage share (%)
Tea	455	43
Hotels & Eating Houses	164	16
Brick & Tile	150	14
Coconut	51	5
Bakery	99	9
Rubber	72	7
Tobacco	13	1
Others	49	5
TOTAL	1,053	100

source: Forestry Sector Master Plan, Sri Lanka, 1995.

Table 8. Comparison of supply sources of fuelwood to commercial and industrial and household sector.

Industrial and Commercial		Household	
Source	Percentage	Source	Percentage
Rubber-wood	44	Rubber-wood	28
Natural forest	40	Coconut	24
Coconut	07	natural forest	23
Forest plantation	02	Home garden	11
Other	07	Tea pruning	04
		Forest plantation	02
		Other	08
TOTAL	100	TOTAL	100

source: Forestry Master Plan, 1986.

7.6. Balance in Woodfuel Production and Consumption

On a national basis, the bio-energy production of the country exceeds the demand (FSMP, 1995). However, a future serious fuelwood crisis has also been predicted. The depletion of sources of supply, increasing pressure on remaining sources, problems of getting access to sources indicate the serious difficulties in meeting needs in some areas. The real situation of the country cannot be generalized by masking the serious problems faced in some areas by some sectors, primarily the poor, the lower socio-economics strata. So the question of balance between production and consumption, is in fact a prerequisite to introduce strategies to smoothen imbalances.

Howes (1990) has shown that extreme shortages exist in Colombo, Kandy, Gampaha, Nuwara-eliya and Badulla districts. Fuelwood deficit has been predicted to take place in Matale, Matara, Galle, Jaffna and Hambantota. Kalutara and Kegalle have been recorded as surplus areas. The domestic sector being the biggest consumer of woodfuel tends to absorb more in the densely populated areas. Thus, extraction of woodfuel for the market that this entails tends to lead to the depletion of supply sources.

Woodfuel flow at the macro-level, from one area to another, indicates the spatial imbalance in production and consumption. For example, the areas that produce forest wood are not the biggest consuming zones, while areas where the biggest consumption has been noted are areas with shortages/deficits. In addition to the area figures on production and consumption Howes (1990) used price and proportion of households that purchase fuelwood as indications of imbalances (See Table 9). Accordingly, the urban consumers heavily depend on purchased biomass. The percentage varies between 52-90%, the highest percentage is in Kandy. The percentage of households that purchase biomass fuel in rural areas varies between 14-28, the lowest is in the wet zone (rubber areas) while the highest is in the up-country areas. The indication here is that not only the areas with high population density experience shortages, but that deepening problems also exist in highly urbanized areas. Households with no homestead and croplands seem to be the ones that heavily depend on imported stocks. The excess production is in the dry zone areas and rubber areas. The deficits are in the up-country areas and areas with an urban population. This cannot simply be matched by ignoring the fact that the transportation cost is exclusively high due to high fuel prices. This suggests that the generalized picture reflecting the surplus production of woodfuel is of marginal relevance to the problem of deficits. The cost of transportation itself is unbearable for the ones who exclusively depend on fuelwood. Local solutions in this respect are more appropriate and economically feasible.

Table 9. Percent of households purchasing biomass fuel.

Zone	Urban	Rural
Wet zone Coconut Areas*	52.8 (37.0 / 68.5)	22.3 (13.3 / 31.2)
Wet zone Rubber Areas	76.9 (53.8 / 100.0)	14.1 (13.3 / 14.8)
Up-Country	90.0 (90.0 / 90.0)	27.9 (26.9 / 28.8)
Dry zone	85.0 (80.0 / 90.0)	11.8 (9.6 / 14.0)

source: Mick Howes, 1990.

The most important features under fuelwood scarcities are the cost of resources, human time, energy and production work. With the increasing difficulties, people tend to spend more time and energy for procuring free fuelwood. Women spend 10-15 hours per week; travel 0.5 - 3 km per trip, and carry more than 25 kg in headloads, which is harmful to their health, to meet the household needs (Wickramasinghe, 1994). What is important to examine is how surplus production and deficits occur in real terms, due to the unequal distribution of non-forest supply sources. Depletion of forests has resulted in turning towards home gardens, hedges and fences, farm lands and also common and reserve lands located within villages (Wickramasinghe, 1990a). Even in rural areas only the better off communities who own large plots of home gardens and farm lands have the least problems. So the problem is not the inadequacy of bio-energy production, but the inadequacy of production and supply sources that are within the reach of the end users and also the unequal distribution of sources at the national, regional and community levels.

7.7. Subsititutes for Woodfuel and their Affordability

Technically speaking, there are a number of substitutes for woodfuel, that can be adopted by users, whether the household sector or the industrial and commercial sectors. Before examining the question of why substitutes have not become popular it is important to see what is available and who could afford to use them. The possible substitutes for woodfuel are:

- Kerosene;
- Electricity;
- LPG;
- Furnace oil.

The extent to which the end users of woodfuel have absorbed these substitutes vary among sectors. Only 20.2% of urban households, 1.6% of rural and 0.9% of tea estates have adopted these substitutes. In the industrial and commercial sectors too, only 12.5% use modern types of energy. When compared with woodfuel, all these modern forms are cleaner, more efficient and more convenient to use. In a broad sense there are a number of features influencing poor adoptability. These include:

- The traditional context and convincing experience of people. Woodfuel is the type of energy to which people have a deep attachment into their daily life - so adoption of substitutes, in most cases, has been a matter determined by the non-availability of this traditional type of energy, difficulties in procuring, it excessive costs and problems of space needed for woodfuel cooking;

- Woodfuel, unlike all other substitutes, has been procured as "free energy" by the bulk of consumers. The users' ability to procure them without cash payments has been for the advantage for the users, particularly the poor;

- From a biophysical point of view the traditional procuring practices, the harvesting of dead branch-wood, collection of fallen wood, utilization of raw stuff derived from pruning have had no adverse impact on the environment, nor on the sources of supply and regeneration. Woodfuel is mainly a by-product of trees so it is a part of multiple management practices related to trees, agroforestry, land and forest management;

- The generation long experience in using woodfuel has created strong preferences for woodfuel, particularly for those who prefer the taste of food cooked in clay pots on firewood hearths. These differences in 'taste', 'smell', texture of the meals cooked on firewood versus others cannot be fully understood by outsiders. Users have not gone by the calorific qualities of different wood, energy efficiency or cost benefit analysis, but have used different combinations of wood to get the right output;

- The multiple nature of woodfuel heat when compared with the others. The energy derived from wood has primarily been used for cooking, but the secondary uses of the heat released from hearths are trapped above hearths for drying food stored in smoke trays, to protect food stocks from pest attacks, and also for heating purposes in the hilly areas;

- In rural areas in particular, fuelwood hearths sustain the habit of having a "kettle of water" boiled on hearths to mash 'plain tea" at frequent intervals. This has reduced the number of times that women have to kindle the hearths to boil water;

- The choice under these circumstances is between the "free energy" and "costly energy substitutes". The question that needs to be answered is who could afford substitutes, even if the wood fuel users were prepared to turn over their woodfuel to others, and what would be the socio-economic implications of such a turn over;

- The next feature that needs careful interpretation is: in areas where woodfuel supply is commercial and costly, and nothing is freely available, how can users choose other substitutes for their comparative advantages?

The price trends of fuelwood and other energy forms that have been estimated show that prices of all substitutes for fuelwood, such as kerosene, liquid petroleum gas (LPG) and hydro-electricity have been higher than that of fuelwood throughout the period between 1982-1992 (Figure 6). The analysis based on data obtained from urban areas suggests that the real price of fuelwood has increased only slowly during the last 10 years. Despite the trends in price increase, fuelwood is still a relatively cheap energy form even for the users depending on the commercial market. The relative energy costs for all forms of energy, exclusive of cost of installments and basic materials, suggests that LPG is the cheapest energy form (See Table 2). But simple market prices only enable a partial analysis, as they do not take into consideration the fact that substitutes are not widely available. The LPG, for example, is mostly available in urban centres only, and is only supplied by a few agents. The unreliability of supply, or more pertinently the entry costs and the basic material costs are not in favour of wide spread use. For instance, the entry costs for LPG might represent at least one month's income for 70% of households and five months income for the poorest 12% (Central Bank, 1985).

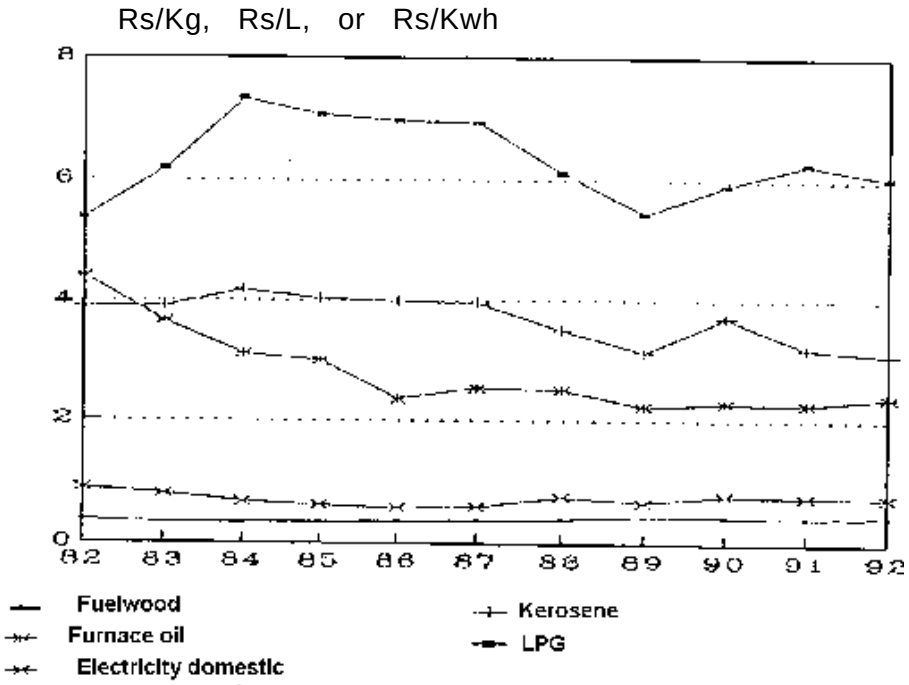


Figure 6. Trends in various fuel prices in Sri Lanka.

In fact bio-energy is the only type of energy available for rural dwellers. In fact it is the only affordable energy type available for a majority of the population as a whole. More specifically it has been observed that the percentage of rural consumers purchasing fuelwood is low (See Table 9). The range in the rural areas is between 11.8 - 22.3%. The rural situation points to the fact that rural consumers do not make a comparative analysis of prices, neither the assess the cost of time and energy, nor the cleanliness and convenience of use. The possibility of procuring for it free appears to be all that concerns them. The poor whose struggle is to meet the basic needs of their families, primarily food, do not have a clue about the actual cost of fuelwood. Women walk several kilometers, spend hours of what might be their leisure time and also combine procuring of fuelwood with many other tasks. For them, head-loading is less trouble than having empty pots or spending money on energy (Wickramasinghe, 1990a,1994). In fact substitutes have been adopted by those who could afford them, even with difficulty. The Urban dwellers are more or less forced to adopt substitutes because problems such as smoke, pollution, and lack of space need to be solve urgently.

Problems related to the use of a free of energy versus adoption of costly substitutes involve socio-economic and environmental factors and are also related to the availability of substitutes. Throughout history substitutes have been costly. According to Leach (1987), the cost per unit of kerosene was five times that of fuelwood in 1982. Electricity was more expensive, besides only 13% of the households had the services connected. Howes' analysis (1990) reveals that 'in 1981 few households with incomes less than 4000 rupees a month have purchased electric or kerosene cookers, and for gas the income threshold was even higher. Only 6.7% of households fall within this bracket. Medium monthly household income is in the range of 1,000 to 1,250 rupees.

Affordability of commercial energy or modern energy forms depends exclusively on the income levels of users, households and the industries - primarily wood energy based rural industries which often function in small units as a means of survival. The majority of the population live below the poverty line, and in the past have depended upon many forms of free food subsidies delivered to them to eliminate the problems of food scarcities and resulting mal nourishment. For those who live below the poverty line, and also for those who live on irregular and unreliable earnings, adoption of costly substitutes is not possible.

Often the cost of energy for cooking is not a part of the household budget. In rural areas the majority find it difficult to spend on woodfuel in addition to all other expenses; so every effort is made to procure it from all non-forest sources, and to use crop residues such as coconut leaves, fronds, husks, shells etc.

7.8. Trends in the Woodfuel Sector

There has been an increase in the consumption of crop waste, except in the communities which live close to the natural forests (Wickramasinghe, 1994). In the forest peripheral areas not only is the per capita consumption high due to the habit of kitchen hearths being lit for more than 15 hours or so per day, not including specific cooking times, but the amount of crop waste added is also insignificant. In other areas, where people cannot procure high calorific hard woody parts the use of crop residues is quite remarkable. During the last 3 decades or so, with the establishment of crop monocultures, the use of crop residues has increased.

It is important to note that less appropriate wood types of are being used in rural industrial and domestic sectors. For instance, *Gliricidia* sticks are a major type in used the domestic sector. It has become a marketable item during the last 2 decades or so. Similarly the coconut no market potential about one decade or so back, now one husk is sold at the price of Rs 0.20 in rural areas around Kandy. It is the same with regard to wood shavings: at present it cannot be collected freely, but about a decade ago saw millions encouraged people to take them in order to clear their yards. Similarly, tender segments of coconut palm have had no demand, now it fetches about Rs. 250-300 for about 1 cubic metre (roughly containing 900-950 kg). Where all sorts of solid woody parts are absorbed into rural industries, the quality of wood available for domestic uses has become poor. This implies that non-forest wood producers have to cater for local markets, primarily wood energy based industries, in addition to domestic needs.

Among household users, there has been a change in the type of cooking devices used, from 3 stone open hearth types to more closer energy saving types. The percentage of households relying exclusively on three-stone stoves varies between 4-53%. It is 53% in the dry zone, 48% in the wet zone (coconut areas including Colombo), 26% in wet zone rubber growing areas and 4% up-country (Howes, 1990). Except in the wet zone rubber areas, the three-stone stoves are widely used in rural areas of the dry zone (59%) and in the wet zone coconut areas (51%). The use of this type is negligible up-country. The change from commonly and traditionally used three stone open stoves to partially enclosed ones has other objectives too.

The results of unpublished investigations (Wickramasinghe, 1995a), explain that this trend is associated with the level of household modernization and the allocation pattern of kitchen space. With the introduction of elevated cooking surfaces, that have replaced the floor level hearths, stove space has been reduced in covered mud stoves with one feeding facis. These are more admired due to small space occupation and the neatness with regard to the spread of ash and wood barks etc. This is found to be of immense importance in the estate sector where both fuel and space have to be saved. Where cooking space/kitchen is part of the main unit of the house, the three stone stoves are rare when compared to the ones with a kitchen separated from the main house. The type of stoves used has a direct connection with the type of wood. The more 'messy wood types and residues' are difficult to insert into the stoves with one open facis. Coconut residues and woodfuels of dry zone shrubs are more comfortably inserted into the three stone stoves than the partially closed ones. This suggests that location specific features and household conditions have an impact on the trends.

Since the late 1970s and 1980s attempts have been made at national level under the National Fuelwood Conservation Programme to promote 'improved stoves' in the domestic sector. It has been implemented with the aim of saving per capita consumption of woodfuel. It was observed that 90-95% of all of the heat generated is wasted when three stone stoves are used (Howes,*et al,* 1983). The UNDP (1992) reported that nearly 300,000 efficient stoves have been distributed and the target of efficient stoves production has been estimated as 100,000 per year. The FSMP (1995), has estimated that the daily per capita consumption of bio-energy has been reduced to 1.23 kg from 1.37 kg, with the change over from traditional stoves to energy efficient ones. This is found to be a 10% difference. According to the Ceylon Electricity Board is estimation (1989) the reduction in consumption could be as high as 30%. A strong subsidy scheme has been introduced to make it adoptable to the household sector. The main argument was that deforestation on a 'catastrophic' scale would occur if rapid and large scale adoption did not take place and that the balance of payments would be adversely affected if people switched to kerosene in the longer term (Howes, 1990).

The number of domestic stoves installed during 1985-1987 was about 95,949 (Amarasekara,1986). It has been recorded that the number established in 1985 was 15,232; 1986 - 254,52; and 1987 - 5,525. However, the effectiveness of wood stoves in real terms, in field conditions rather than in laboratory conditions shows that it is more complex (Foley *et al,* 1985). Where fuelwood is gathered freely or in areas where wood is available the amount of 'saving' has not been a matter of concern.

The use of LPG for domestic cooking has increased particularly in the urban areas and suburbs. It has risen to about 38,200 between 1987-1994 (FSMP, 1995). The dependence of urban users on rubber and coconut woodfuel has not declined (See Table 10). The reduction of both rubber and coconut as a result of their wide use as timber is well marked in the rural and state sectors. There has been a marked increase in the use of uprooted and pruned parts of tea slants particularly in the estate sector. In the manufacturing sector, there has been an increase in the consumption of firewood and biomass bagasse. Between 1982-1990 the bagasse use increased from 41.1 ktoe to 143.3 ktoe. Firewood and biomass consumption has increased from 383.8 ktoe to 437.0 ktoe. This accounts for more than a three fold increase in bagasse, and about a 14% increase regarding firewood and biomass. The use of paddy husk is another change in the tobacco industry, particularly in energy efficient barns. In the coconut industry the wood use has been marginally reduced with the introduction of fuel oil fired boilers under the modernization programme. In village based small production units, attempts have been made to substitute wood with locally available saw dust, coconut husk and wood-shavings to reduce the cost of fuelwood (Wickramasinghe 1990b). However the price of local wood obtained from non-forest, particularly from home gardens has increased by 2.5 times within a 8 year period in Kundasale.

Table.10:Trends in the percentage consumption of firewood in the household sector.

Sector	Rubber		Coconut		Tea		Cinnamon		Other		Total	
	1981-1982	1986-1987	1981-1982	1986-1987	1981-1982	1986-1987	1981-1982	1986-1987	1981-1982	1986-1987	1981-1982	1986-1987
Urban	43	43	11	15	00	00	00	2	39	39	93	100
Rural	13	14	29	26	2	1	2	1	54	57	100	100
Estate	18	8	2	1	40	60	0	0	40	31	100	100
Country	18	17	25	21	5	8	1	1	51	52	100	100

7.9. Characteristics of Woodfuel Flows

The flow of woodfuel from production sources to end-users varies between two primary sectors, the household and the industrial sector. In the household sector, it flows from a number of sources to the kitchen-yards, more as a commodity for subsistence. As such it is neither commercial nor marketed with direct price labels or shadow prices. In the household sector, the flow of woodfuel through market channels primarily occurs in urban areas where 50-90% of the woodfuel is purchased. in rural areas the proportion varies between 11-22%. The situation is more complex and more location specific.

The woodfuel flow is mainly characterized by better quality wood. The sale of crop residues such as coconut husks and shells are more of a local feature. The flow occurs between excess producers, households with large land areas and the resource poor. In addition there is a rural to urban flow within narrow geographical areas.

The macro level woodfuel flow is between the larger production areas and the deficit areas. The areas with a large extent of forest in the dry zone and agricultural plantations with rubber and coconut are the exporting areas. The main receiving areas include up-country and densely populated parts of the country including Colombo, Gampaha, Galle etc. (See Table11). Another channel prevails between the small scale local producers and the local village based industries and this exists between large farm operations/home gardens and local entrepreneurs. This implies that two main channels are practically important: one is between the producers/production zones and urban users, and the other is within production areas. In both cases, harvesting is performed more by hired labour. Yet, in the househoold sector woodfuel is freely procured, so it is primarily the gathering of dead wood, fallen wood and branch pruning.

Except for urban buyers who are heavily clustered in cities such as Colombo, Gampaha, Kandy, Badulla, Jaffna etc. where wood gets formally transported in lorry loads, head loading is predominant in rural areas. The processing involves primarily the splitting of logs. Wood is transported in lorry loads from production areas to the splitting spots and wood is transported in lorry loads, from there the split wood is distributed in bullock carts to urban consumers. This implies that in the process of marketing, contractors are involved in harvesting, then the middle level buyers who purchase the stocks and transport them to the processing points, then the local merchants purchasing and processing the transported wood and then the retail sellers. These sellers are either paid employees of the processing places or those that make their purchase and deliver at households with a profit. The price of wood varies tremendously from the harvesters to the end users. As there is no market standard price, it tends to vary from one area to another and from one type to another. The national data in FSMP (1995) shows that the bulk price, i.e. the purchase price of bulk stockes, is Rs. 1.20 per kg, whereas the retail price per kg. is about Rs. 2.00.

Table 11. Identifying fuel shortages.

Category	District	Zone	Overall Balance '000 tonnes [1]	Fuelwood Balance '000 tonnes [2]
Overall Deficit	Colombo	Wet Low	-373	-399
	Kandy	Up-country	-333	-436
	Gampaha	Wet Low	-228	-210
	Nuwara-Eliya	Up-country	-176	-292
	Badulla	Up-country	-90	-172
Fuelwood Deficit	Matale	Up-country	4	-34
	Matara	Wet Low	71	-85
	Galle	Wet low	77	-52
	Jaffna	Dry	81	-172
	Hambantota	Dry	111	-9
Self-sufficient	Batticaloa	Dry	123	86
	Ratnapura	Wet Low	270	56
	Kurunegala	Wet Low	774	72
Rubber wood	Kalutara	Wet Low	178	177
Exporting	Kegalle	Wet Low	403	240
Fuelwood Exporting	Amparai	Dry	591	584
	Mullaitivu	Dry	853	808
	Polonnaruwa	Dry	808	789
	Anuradhapura	Dry	809	792
	Moneragala	Dry	1,110	1,064
Potential Exporting	Trincomalee	Dry	513	517
	Manner	Dry	570	477
	Vavuniya	Dry	578	568
	Puttalam	Dry	640	405

source: Mick Howes, 1990.

7.10. Socio-Economic Impacts

A broad analysis of the overview came out for the preparation of the Forestry Sector Master Plan - FSMP (1995) points to the fact that for a majority of rural people bio-energy is the only available energy. This situation is likely to prevail for some years to come. This means that decrease in production or any increase in the real cost of fuelwood (in terms of actual price or increased time needed to collect), will affect mostly the poorest people. This is the category who already have inadequate access to cheap bio-energy, or who can ill afford to substitute for fuelwood. The urban poor, the landless rural people, and the estate workers belong to this group. As end users are not a homogeneous groups in terms of their socio-economics characteristics and are not equal in producing or getting access to supply sources, the socio-economic impacts of woodfuel cannot be generalized. One overall feature is that all end users, irrespective of whether they themselves procurers or purchasers, get affected by the reduction in supply and increase in cost. Those who cannot afford substitutes but depend heavily on fuelwood for domestic cooking and industry are the most vulnerable groups. Woodfuel is the sole source of cooking energy for the poor and the wealthy in rural areas. It is the same for the small-scale production work such as pottery, treacle and jaggery, brick making, lime kilns etc. Socio-economic impacts can be classified under following categories:

- Gatherers and head loaders who combine the responsibility of gathering fuelwood with reproductive and productive roles as a conventional task related to survival maintenance;
- Low income sectors that depend on purchased woodfuel. They cannot afford an increase in price or costly substitutes;
- The landless poor who gather stocks freely and depend on non-household sources;
- The small-scale wood based entrepreneurs depending on locally purchased or freely procured energy to sustain their employment and income;
- The end users of the household sector who have to bare the burden of the scarcity and the poor quality bio-energy;
- Families who get affected seasonally or consistently by way of unboiled water, the elimination of processed food for buffer stocks and the exclusion of raw food stuffs that require lengthy cooking and traditional herbal medicines that are often prepared at family level to cure and prevent the spread of disease; and
- The consumers of wood energy based products who pay for the increase production costs.

The impacts on different categories vary. The direct users of woodfuel and the consumers of products pay for wood energy in many different ways. Gatherers and head loaders, who consist primarily of women, and to a lesser extent men and children, have to bear an additional burden under a situation of wood scarcit. Firstly, gathering and head loading from distant sources increase the time and energy that they have to spend, and secondly, there are a number of health implications. The head loading of excessively heavy wood bundles of more than 30 kg in weight increasess the llikelihood of repetitive strain injuries, suffered by women in particular (Wickramasinghe, 1993a). The number of hours that women spend in gathering a headload of wood per week varies, on average from 9-15 hours. The distance per trip varies between .5-3.5 km according to the location. They face more difficulties in finding time to go gathering and the tendency for them to carry excessive weights is greater (Wickramasinghe, 1994). Although there are no hard and fast rules forcing women to take the responsibility of procuring fuelwood it is conventionally considered a of woman's role related to food processing and preparation. A time budget study done in Sri Lanka (Wickramasinghe, 1993b) shows that women share 88% of the tasks related to food preparation, 69% collection of firewood and 94% in the preservation of food. The consequence is that unintentionally, within the context of social construction of gender, the responsibility of 'fuelwood' has been connected with 'food', both of which are considered as part of household maintenance. So women are engaged in the task without considering the distance, and the source variations which they have to access. Women who live in the forest peripheries are the primary collectors of forest wood too. (Wickramasinghe, 1995b). Where state forests remain a primary source and their own production systems are not sufficient, women consistently bear the heavy burden of gathering fuelwood (Wickramasinghe, 1993c).

A study on the gender analysis in forestry, focused on community forestry in Badulla districts (Wickramasinghe, 1992a) revealed that while Eucalyptus stands are kept as wood stands, women spend time and energy on long distance walks to gather the pruned branchwood of tea plants to satisfy domestic needs. There is enough evidence to prove women's domination in the non-commercial energy sector primarily depending on non-forest sources. This cannot be connected merely with the reproductive domain of women, but it has a direct impact on the productive domain of women. In Sri Lanka wood energy has been an essential commodity for the village based industries which are either managed as women's own enterprises or employ daily paid workers. Crystal sugar production for example is mostly done by women as a home industry by boiling the florescence sap of fishtail palm (*Caryota urens*). This task depends completely on the availability of woodfuel. In severe woodfuel scarcit situations men tend to sell the sap as toddy, so women have little or no control over transactions or financial matters. Woodfuel is also

necessary for the production of pottery and earthen wore, in which women are engaged. Village brick industries also depend heavily on woodfuel and women are engaged in these either as family members or as daily paid workers.

However, from a gender perspective on woodfuel production we can see that women are not merely the procurers and end users of fuelwood produced by male dominated production systems or natural forests, but are the active producers of woodfuel as managers of trees and agroforestry. Woodfuel stocks are maintained by women in sheds and they save stocks for the rainy seasons. The mud stoves are prepared by women to reduce the excessive consumption of woodfuel in three stone open hearths. Multiple use of energy is a decision made by women in order to get more benefits out of the energy released from the hearth. Locally appropriate cooking devices have been installed by women using cylinder type tins to feed saw dust and paddy husk. Women's knowledge on calorific values of specific woods, their limitations such as excessive smoke and ash, are practically used to reduce such limitations by mixing different wood types with crop residues and agricultural waste. For example, where coconut husk is heavily used, they try to minimize wood sticks. For them crop residues alone could never make a strong flame so a few wood sticks are mixed to sustain the heat. The gender perspective on wood energy specifically stresses the fact that for women fuelwood is a by product of trees and the output of multiple land management systems. So they affirm the fact that it is an output produced for the tree/land managers, and freely procured.

The poor who depend on purchased woodfuel are affected by increasing prices. Based on the data from CFS (1986/87), the share of expenditure on fuelwood out of a total household expenditure per month has been calculated (See Table 12). It shows that the very low and low income groups in the urban sector spend 21-22% of their expenditure for fuel, whereas the figure is between 19-20% for all income groups in the rural sector, and between 16-17% for very low, low and medium income groups in the rural sector. This suggests that:

- The expenditure on fuelwood of low income groups is high because their income levels are extremely low;

- Any further increase will be unbearable for those who get less than Rs. 5000/=, with critical adverse affects on the poor.

Table:12. Percentage share spent on fuel out of the total expenditure for a month by sectors and income group.

Income Group	Urban			Rural			Estate		
	All energy types	Fuel-wood	%	All energy types	Fuel-wood	%	All energy types	Fuel-wood	%
Very low < Rs. 800 (Monthly)	45.85	9.70	21	99.21	19.85	20	222.80	38.89	17
Low Rs. 801-1500	166.19	36.89	22	218.99	44.52	20	294.25	50.70	17
Medium 1501-5000	278.77	52.35	19	307.50	59.88	19	398.26	63.37	16
High > Rs. 5000	562.64	46.66	8	501.27	74.60	19	1,482.80	28.75	2

In urban and estate sectors, the high income groups spend a relatively smaller amount on fuelwood. The competition for fuel from industrial sectors tends to contribute to increasing prices, although they are important in creating employment opportunities. The consumption of tree species that have not been used traditionally for industries and the flow of coconut husk to urban markets are indications of deepening future problems. This interrelated scenario shows that only poor quality twigs and residues will be left for household use. This is again a situation where women will be subjected to smoky kitchens, frequent blowing of hearths, spending more time in search of wood, and less for cooking and food processing (Wickramasinghe, 1990a, 1994). Instead of enabling women to spend more time on production work as theoretically proposed by development interventionists, woodfuel itself could absorb more of their time. Although the opportunity cost has not been constructed systematically, woodfuel does not contribute more in cash terms. But for those who do not have a sufficient income to meet food needs the problem is not the high opportunity cost of procuring wood, but the need to procure it for free. For those who have sufficient land, and access to forests and other supply sources, the situation is not critical.

As an output produced by multiple production systems and multipurpose trees woodfuel is an additional source of income to meet contingency needs, for the better off grouts and for households which produce excess woodfuel. Land has not been allocated to produce fuelwood alone to make sufficient income. For domestic consumers it is a product ensuring subsistence. For excess producers it helps to earn an income in addition to what they get out of the production systems such as home gardens, croplands and all agroforestry systems with trees and woody perennials. Many species, irrespective of the nature of the systems in which they occur, like Rubber, Coffee (*Coffea arabica*), Coconut (*Cocos nucifera*), Gliricidia (*Gliricidia spp.*) contribute to the woodfuel production. But harvesting of timber for fuelwood is a rarity in non-forest systems. (Wickramasinghe, 1990c; 1990d and 1990e).

7.11. The Non-Wood Sources

The production systems primarily meant and managed for non-wood products are the ones that cater to woodfuel needs. These include tree crop plantings; home garden hedges and fences; small-scale crop lands with scattered trees and the narrow strips of reserve lands with trees and shrubs. On the one hand, forest clearance in the dry zone for irrigated paddy farming has reduced the availability of forest wood. It must be noted that, the body of legislation introduced in favour of conservation is a constraint to the procurement of fuelwood for the market although many users who live in the adjoining lands continuously use the forest as a primary source. The forest plantations covering about 66,500 hectares of land are primarily the wood stocks consisting of exotics, basically the species with fast growing characteristics. The use of such wood plantations to obtain fuelwood is negligible due to the extremely low preference given to their characteristics such as the smell at burning, the low production of branchwood, poor access etc. The plantations consisting of *Pinus*, *Eucalyptus*, *Acacia spp.* etc. under these circumstances are not the production systems that contribute to the peoples' woodfuel needs, while the natural forests are a rare source for the woodfuel consumers (See Figure 7). This situation indicates the need to promote the supply from non-forest sources.

Woodlots, introduced with greater investment costs are examples of the unsatisfactory results of attempts to establish wood stands for fuelwood. All four elements of social forestry: the farmers' woodlots, community woodlots, demonstration woodlots and block fuelwood plantations introduced since the early 1980s to cater for villagers' fuelwood needs remain unharvested and contribute nothing to meeting the target needs.

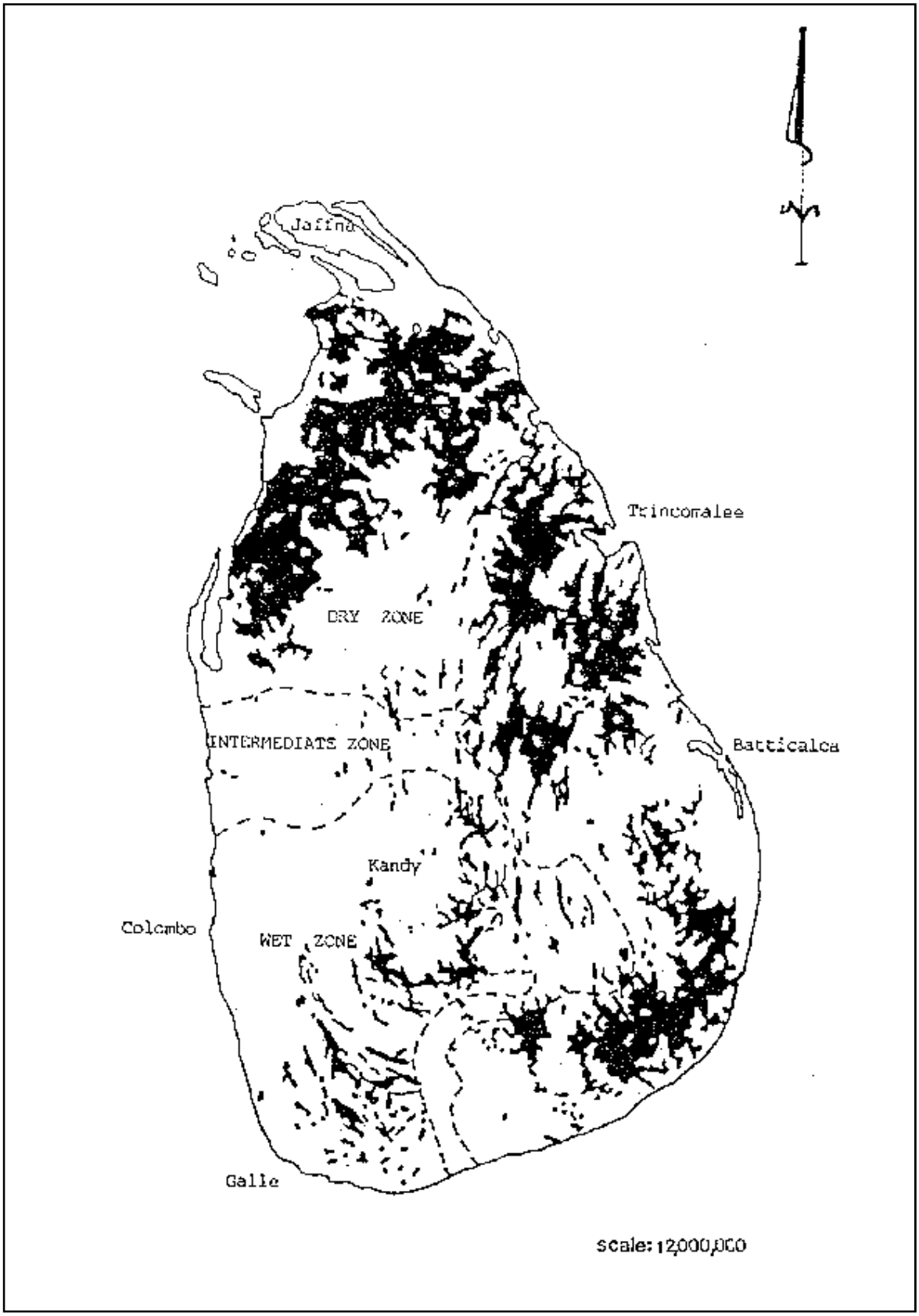


Figure7: Spatial distribution of forest cover in Sri Lanka, 1992.

This means that production systems managed for non-wood products are the ones that cater for woodfuel, although farmers do not ignore the fact that the end harvest of trees is timber. The systems that have been recognized as wood stands of high biomass production, poorly serve woodfuel neeeds. The sections on supply sources and the figures on production and supply have indicated that non-wood production systems cater primarily for the household sector, and these have been exclusively promoted and managed by people. These include agricultural systems dominated by coconut, rubber and tea and the multiple land-use systems that include many types of agroforestry, home gardens, boundary demarcations, hedges, fences and reservations to irrigation tanks, drainage and paddy tracts. All these systems consist of a wide variety of species and are of immense importance to villagers for fuelwood. Within the context of woodfuel, how resources that have been promoted for non-wood outputs have become the 'hot spots' for woodfuel production mainly for the household sector is important. Similarly how species not recognized as 'fuelwood species' have become the best producers is worth examining.

Under these circumstances, the 'multipurpose tree species' of non-forest areas play a dominant role in catering to the wood energy demand of the country. Woodfuel is one of the preferred by-products, secondary to food, derived from all woody perennials. The physiological characteristics, the species suitability for managing for fuelwood, the species composition and their multiple production functions are interrelated. The trees in the land-use systems are not extracted for fuelwood, but either the dead or seasonally harvestable parts are used for fuel. A field survey conducted in Bambarabedda (Wickramasinghe, 1990e) reveals that among many species grown in home gardens, the widely used wood perennials are Coconut (*Cococ nucifera)* and Jack *Artocarpus heterophyllus.* In farmlands out of 42 records, 18 have indicated that coconut is extrenely popular. 11 mentioned Jack as being improtant. Coconut is extremely popular, because throughout the year, and also over a period of more than 60 years during its life span, its dead and fallen fronds, branches etc are used in addition to shells and husks. The branch wood of Jack has been recorded as a popular woodfuel, due to it being available when the tree is pruned and when the branches fall off naturally. All the other woody species of home gardens produce woodfuel. These species include Avocado pears (*Persea gratissima*), Guava (*Psidium guajava*), Mango (*Mangifera indica*), Rambutan (*Nephelium lappaceum*), Tamarind (*Tamarindus indicus*) etc. Madugalla, a village located in the neighbourhood of Bambarabedda shows that coconut is considered as a prominent woodfuel producing home garden species, while all the ones with woody branches wood contribute. The branch prunings of non-food producing species such as Kududawla (*Neolitsea involucrata*), Kenda (*Macaranga peltata*), Havarinuga (*Alstonia macrophylla*), Sapu (*Michelia champaca*), *Albizziaspp.* are also used to meet household needs in particular.

Fuelwood is a by product of market oriented species such as coffee, cocoa and also gliricidia grown thickly on hedges, fences and boundary demarcations. Either the branchwood or sticks obtained at prunings/coppicing are piled up for domestic use. If the excess is harvested then producers tend to sell them in cubic metres. The empirical data points to the fact that most trees grown, maintained and protected by villagers are meant to provide multiple products. Villagers' priority for tree species is determined by their ability to produce the most essential products. These include food/fruits or nuts, fuelwood, timber, fencing materials and agricultural poles etc. All priority species produce fuelwood (Wickramasinghe, 1992b). The objectives of promoting biodiversity in home gardens are related to multiple needs, among which fuelwood has been noted (Wickramasinghe, 1995c).

Studies focused on farmers' tree use practices, and home gardens demonstrate that woodfuel for domestic uses consists of a variety of materials of various forms, sizes and calorific values. For instance, fuelwood production is a socio-economic attribute of trees (Wickramasinghe 1990c), while branch wood of almost all perennials are a main source of fuelwood (Wickramasinghe. 1990d). The situation concerning the fuelwood scenario of individual households in the rural sector shows a few major features which could be used in promoting the production systems for fuelwood. These include:

- Fuelwood is only a by-product, obtained throughout the life span of woody perennials grown in farmers' lands and also maintained in state lands;
- More prominently, branch wood is preferred, so the species suitability for pruning without reducing the production of fruits/food etc is an advantage. Another associated feature is that the ability to obtain dead wood regularly is important;
- Fuelwood is part of the multiple land management systems, so the systems primarily meant for non-wood products are the systems producing food;
- For the resource poor it is not an income venture, but it is a source of meeting contingency needs of excess producers where the excess is harvested;
- Better quality woody parts are mixed with many other forms of fuelwood;
- Fuelwood production is one aspect of multiple tree and land management, so the integration of this aspect into development is more favourable than developing specific areas for fuelwood production or substituting other purchased types of energy for fuelwood.

7.12. Issues Related to Woodfuel Production

Issues related to woodfuel production are broadly associated with the country's development policies because it is a integral part of resource management and development. The country scenario revealed that at least 75% of the woodfuel is derived from non-forest areas, from the lands under agriculture. It can be seen that within the agriculture sector, the tree crop-based systems, particularly coconut and rubber, exclusive of home gardens with mixed composition provides 26% of the bio-energy. This is equivalent to the amount derived from home gardens. Home garden products are not only of greater importance in terms of their convenience to obtain, but it indicates the self supportability of the whole system. The state efforts on diversifying plantations, particularly rubber and coconut indicate that there is an increasing tendency for them to contribute to woodfuel. The solutions that could be offered through this will be rather limited due to the fact that the high cost of transport for portaging plantation wood to consuming areas will be increased in the years to come with increasing fuel prices. The increasing transport cost is an advantage for the local producers because competition from wood coming from outside is low. On the other hand, it stimulates the private sector to produce, wood for local consumers.

From a perspective of addressing the problems through locally appropriate measures, the role of state policies related to overall land management is important. State policies on agriculture, broadly the programmes executed for promoting rice production; incentives delivered to expand crop monocultures in the country, and conversion of natural forests for forest plantations, for tree monocultures which contribute so little to woodfuel needs, and also the land fragmentation for housing development, primarily the coconut lands in the shadow urban areas are threatening. Highly compartmentalized state sectoral intervention is a constraint to assure self sufficiency in woodfuel production and also to promote tree growing among farmers. For instance, the random integration of trees into farm management has obstructed farmers' from getting state subsidies for export crops. For instance, to obtain subsidies for tea, small-scale tea growers are encouraged to clear their lands. Although subsidy schemes have been introduced to promote woody

perennials among farmers, particularly rubber, coconut and many other species such as cloves, cocoa, coffee etc, woodfuel production has been excluded from the development packages. In the absence of incentives for tree growers, the woodfuel from all supply sources including farmlands, home gardens, forests and forest plantations has been obtained as a by-product or secondary output.

With the absorption of rubber wood into the industrial sector and also as a result of deforestation in the dry zone areas, the state sector, primarily the tea sector, has allocated its marginal lands for woodfuel production. As the goal has been to become self-sufficient in producing wood for their own consumption, it has not created competition in the market. The wood obtained from forest plantations are often confined to branch wood and immature segments of the harvested timber. One of the constraints faced by the non-forest woodfuel producers is the high cost of transport. The limited market potential in the areas of production is another. Woodfuel has not been a primary source of income for the producers, so in situations where an excess harvest is obtained by pruning of trees in hedges, home gardens and farm lands, they sell them for contingency needs. In addition, due to the lack of state interventions to stimulate private tree growers by way of organizing markets, woodfuel often fetches a low price at the farm gate so the economic returns are also low. This is a result of lack of institutional arrangements.

7.13. Conclusions

In Sri Lanka any macro level analysis regarding the distribution of supply sources and broad consumption patterns tends to exclude the area or specific or sectoral features, particularly the role of non-wood production systems. The diversity of the production systems and the multiple nature of management practices are often not recognized in the national scenario. Yet, from the point of view of the majority of the country's end users, the households and village industries what is important is the real situation, of woodfuel not merely a woodfuel balance. The balance between the country's woodfuel biomass and the demand is quite satisfactory. But the real situation related to sources of supply within the users' reach, access and procuring systems and the sustainable use of fuelwood as a "free commodity" is complex. The most deserving end users of "freely procured" woodfuel are the rural and urban poor, estate dwellers and the small scale entrepreneurs. For these groups the 'modern types' of fuel which incur a high regular cost is not their concern, because paying for energy is beyond their reach.

Under these circumstances not only are non-wood production systems of immense importance, but their functions must also be assessed in a holistic manner from the point of view of the users. The economic analysis adopted in examining the direct cost of woodfuel or on opportunity costs has been insignificant to the users. If opportunity costs are used then spending labour for procuring freely is not economical. For those who have no employment opportunities, no regular income, and no sufficient land to produce crops, procuring woodfuel freely is a great relief and helps to ensure survival. It relieves them of the burden of finding cash to pay for fuel.

The promotion of woodfuel production entails improving on local initiatives, rather than directing local people with external incentives. The integration of priority species, primarily the multipurpose tree species into the local production systems is more appropriate in the sense that it could strengthen the supply systems. As a result of the unequal distribution of production sources, unequal access to forests, gender specific implication of scarcities and stress, and also unequal affordability either to purchase wood or substitute it with modern fuel types, problems are not experienced equally.

With the depletion of natural forests the dependence on non forest sources has increased. The multiple management of lands to obtain all basic needs including woodfuel has been sustained as a stratedy evolved over generations. The tradition of procuring it freely points to the fact that it has remained a by-product of non forest production systems. The competition for fuelwood from external and industrial sectors will have a negative effect on households, because under the market potentials poor quality stuff will be available for many who procure from non-household resources. Woodfuel should be integrated into all land-based development systems because transportation from outside areas is costly and also there is better potential for reformulating farming systems to promote woodfuel production. A process should begin with the existing traditional examples like home gardens, rather than allocating lands or selecting 'fuelwood species'.

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8. THE ROLE OF NON-FOREST LAND IN WOODFUEL PRODUCTION IN BANGLADESH

Dr. Md. Jahangir Hussain

8.1. Introduction

Woodfuel may be defined as tree biomass of cambial origin. According to this definition, stem, branch, twigs as well as rootstocks fall under woodfuel. As such, woodfuel excludes leaves and foliages, which occur in the branches and twigs of the tree, though this non-wood fuel constitutes an important source of fuel, particularly for the poor. Furthermore, woodfuel occurs in the form of primary/direct products; as residues in the process of production/ processing and as rejected materials during and after use. Unlike other fossil energy, woodfuel is renewable and its production contributes towards environment quality.

Until the industrial revolution forests were the major source of energy; even today more than half of the removals from forests on a worldwide basis are used for energy production. In Asia, more than 85% of wood removed from forests is used for energy (Gujral, 1988). Out of the per capita fuel consumption in rural Bangladesh in 1991, fuelwood, branches and tree waste constituted 44.5% (FMP, 1992).

The energy harvest per acre from forests can be 20 times or more than that for annual crops because it represents many years accumulated growth (Burwell 1978, cit. Nautiyal). This has important implications for management and transportation. Different rural industries e.g. brick burning, road tarring, tea leaf processing, tobacco curing, soap making, confectionery, catechu making, pottery and others use the woodfuels, as well the restaurants, hotels, tea shops, establishments and households located in the sub-urban/urban and rural areas of Bangladesh.

Sources of these renewable woodfuels are forest and non-forest land. Non-forest land i.e. other than forest land, which includes homesteads, farmlands wasteland, and marginal land along railways, canals, roads are important resource bases of renewable energy in Bangladesh. Of these sources homesteads make the greatest contribution to the overall supply of the country's woodfuel.

The potentials of non-forest land to meet the energy demand i.e., for woodfuel, have not been fully explored. The productivity of the sites are not fully utilized. There are several socio-economic and technical reasons responsible for this.

8.2. Review of Past Studies and Research Reports

Village and Farm Forestry Project of SDC

The rural energy sector was identified as a priority sector for field of cooperation and involvement the of Swiss Development Cooperation in Bangladesh.

Under that sector village and farm forestry was identified as possible focus for joint activities. After a study of village forestry and roadside plantations in Bangladesh (Hussain 1985), an action research plan was outlined (Hocking 1986). The main objective of the action research was to

determine the acceptability of intensifying the number and management of trees in homestead (Bari) and farm land (Khet) of the Northwestern region of Bangladesh.

In farm lands the the frees would be at a low density and under management to minimize the crop impact. If found acceptable, then the designated species, new potential species, technology for introduction and management in farm land (Khetland) would be tried, and comparisons with alternative land use technologies would be conducted. SDC action research identified two opportunities:

- Intensification of management of existing *bari* trees and introduction of additional trees (of desired species) into the vacant niches. It was also determined that there was potential for the introduction of fast growing exotic fuelwood species.

- The introduction of trees in farm land (*Khet* land)

While implementing the project to grow trees in homesteads (*Bari* land) - although a traditional practice in Bangladesh -, it was found that there was a great shortage of good quality seeds and seedlings for planting and a lack of improved management techniques. The major activities of the homestead component of the programme included :

- Promoting improvements in the management practices of existing homestead forestry/tree resources.

- Promoting and planting of the desired and potential high yielding and improved varieties of tree species (fruit, timber, MPTS, NFTS) to obtain a better balance of the desired products through diversification of species and by multi-story and relay-planting in the homesteads.

- Variety improvement of already grown poor quality (fruit and yield) fruit trees by special horticultural techniques (Top-working/Tree renovation & rejuvenation).

Introduction of trees into crop farming system (*Khet land*) and the development of tree management technologies for agrisilviculture (tree-crop-intercropping) production systems was another important component of the SDC programme.

The concept of growing trees in cropland (*Khet land*) is not a new practice in Bangladesh. However, little knowledge exists about suitable species, their performance and management in the Bangladesh context. A technology development stage is needed before its widespread application can be recommended (Islam, 1995).

Under this component different types of fuel & timber and also fruit species were planted. In the farm land model trial 0.20 ha of land comprising 27 trees of 3 different species were tried. The farmer selected two species and VFFP selected one species. The planting was done using 8m x 8m spacing. During the period between 1987 to 1993 altogether 168,172 trees of 40 different species were planted in the crop land of 3240 farmers. Of the trees planted 115,040 trees survived, i.e., about 60% survival rate. The area covered was around 1256 ha of farm land.

Considering the need for the desired seedlings and the extension services required by the farmers, a new approach was adopted by developing the core farmer's concept.

The core farmers are the local farmers, who would establish and run small family operated enterprises to supply seedlings and carry out extension work in support of tree planting on homesteads and farm lands. The local NGOs (10) would select, train and support the core farmers in the area of its operation. 20 core farmers at a time will be trained at the NGO's control nurseries. The activities of the 10 NGOs are consolidated in their own areas and their programmes are expanded by involving NGOs in other areas. The core farmers are really the core of the VFFP. Certain conditions need to be fulfilled to be a core farmer e.g. a farmer must show his interest in operating a nursery/technical advice business and he must possess the land for the small nursery.

The core farmers are selected from their local areas if they demonstrate sufficient knowledge pertaining to the local demand and supply of seedlings and also the capability to provide the needed extension services to the farmers. These farmers are trained at NGO nurseries where they are shown proper techniques of nursery establishment and practice along with other relevant knowledge and training. The core farmers through establishment of the tree nurseries make the desired species of standard quality available to the local people. He provides technical skills such as grafting and budding, and top working to the farmers of his locality. He monitors the survival rates of species purchased by local people for which he is paid. The CFs receive a small grant of Tk. 5000.00 in the first three years. Most of the CFs start with a small portion of land of 1 to 5 decimals producing 2000 seedlings but within 3 years they are able to increase the size of their nurseries to between 33 and 100 dcm, usually by renting land and increasing their capacity many fold. This initial support under the project to potential nursery business entrepreneurs has triggered a many fold increase in the production of seedlings and in this way rapid operational success could be achieved within the shortest possible period.

A key factor behind the success of the core farmer concept lies in the adoption of an individual rather than a group approach to the management. Although the CFs evince a remarkable degree of social embeddedness within their communities, the whole phenomenon is motivated by the individual's self-interest (Islam, 1995). The major problems or weaknesses faced by the VFFP are as follows;

- Although tree growing is a traditional practice in the homesteads, it seriously lacks quality and authentic inputs & service delivery, i.e. in the supply of good quality seeds and seedlings for planting and improved management technologies.

- The concept of growing trees in farm land is not new but little knowledge exists about suitable species, their performance and management in the Bangladesh context. A technology development stage is needed before its widespread application can be recommended.

- To ensure equal and equitable participation of women in the development activities, efficient and effective extensions strategies need to be designed thatl recognize women as main actors and not simply as side players.

- In order to achieve the objective of maintaining environmental equilibrium, the project should not be limited to activities which meet the needs of any narrowly focused target group e.g. "the landless"

- The major problems of working through small and local NGOs are their weak management and technical skills, although they learn very fast over time. Over- dependence of NGOs on external support/finance for carrying out programme (s) is a key element for future continuity and sustainability of any programme at their level.

The following important lessons were learned through implementation of the Village and Farm Forestry Programme (Islam 1995).

- Farmer and community participation is strong when one can make the people "motivated by self-interest".

- Adequate flexibility in implementing for keeping pace with the times need an appropriate extension strategy and community level service and inputs delivery system. Having an entrepreneurial touch can make a real difference in promoting a programme

CHAP of CARE Bangladesh

The Chittagong Homestead Agroforestry Project covers three coastal Thanas of Chittagong and Cox's Bazar districts, which are located in the Southeastern part of the country. This project had its origin in 1991 when a cyclone caused severe damage to the lives and properties of the people living in the coastal region of the country, but also revealed the important protective function of trees, palms and other plants. Considering the felt need for seedlings and to improve the socio-economic conditions of the low-income families a two-year pilot project was carried out in Banshkhali and Chakaria Thanas of Chittagong-Cox's Bazar region. At the end of the Pilot project, a 5-year Project proposal was developed with the assistance of the Royal Netherlands Government.

According to the CARE the purpose of the project is to enhance the agroforestry production in the homesteads of 13,200 low income rural families in the project area. By the end of the project period the following target were to be achieved

- Tree resources of 13,200 families will be increased in three coastal thanas

- Agricultural production of 50% of the total families i.e. 6600, will be increased.

- Sustainable local tree seedling supply and management services will be established in three coastal thanas.

- The capacity of the local partner NGOs to provide agroforestry training to local communities is to be enhanced by means of networking with at least 6 partner NGOs.

  The project is being implemented with the participation of the local people and to develop their own skills so that the activity may be continued after the completion of the project. In particular CHAP has the following approaches.

  - It does not provide any material inputs but emphasizes training and technical support
  - It emphasizes participatory extension approaches

The nurseries produce the seedlings, for which there is great local demand, like coconut seedlings, egg-plants and chili etc. Due to involvement in the nursery business, incomes of the

families have increased. 25% of the families could earn more than 6000.00 Taka each from their nurseries in 1993 under this project (Table 2).

CHAP nurseries/micro-nurseries are comparable to the core farmers of VFFP nurseries and without going through the process of orientation/ reorientation they have gone straight to working in the nursery business.

- It promotes organic farming and discourages chemical farming
- It emphasizes the promotion of concepts rather than practice.

Under the CHAP the following achievements were be made in the last two and half years:

- In the first year, 60 nurseries were established, all of them made a profit in the first season. On average Tk. 2122.00 profit was earned.
- 164,104 seedlings were produced by these village nurseries. By the end of this season a total of 246,285 seedlings are expected.
- 61,351 seedlings have been planted by community members.
- On overage 14 trees have been planted by each of the 4382 community households.
- 2,123 budding activities have been carried out in 751 households. The propagators earned Tk. 10,500.00 from their services.
- It was learned that in connection with the rural energy problem and woodfuel supply no work has been carried out although some studies were conducted by the CARE.

Development of private nurseries

In recent years there has been a large expansion in the establishment of nurseries almost everywhere in the country. Thousands of private nurseries are in operation in different regions/parts of the country. These nurseries lack back stopping and incentives from any government and non-governmental organizations. Indeed, the governmental/non-governmental nurseries frequently compete with these nurseries.

In some places these nureries show high adoption rates for innovative technologies developed to secure the market. They are absolutely market driven and have a good reputation in the locality. Private nurseries are generally cost competitive since they have less expese for the land, water and other facilities, and basically the entire family of the nursery owner is involved in the nursery business.

There has been no programme to upgrade these private nurseries by providing the needed support services required by them. In the areas where there are nurseries often one find intensive tree planting compared to those areas without nurseries.

The private nurseries have the following characteristics:

- Established by the local entrepreneurs through their own initiatives.
- Family members are often involved .
- Basically involved in production and selling of the seedlings.
- Market demand driven approach.
- Care for quality and reasonable price
- Cost of production lowest since most of the inputs are locally available.
- Private nurseries are located at suitable points near roads or river ways.
- Selling of tall seedling is common.

APFR & TSP OF BARC/Winrock International

Under the Agroforestry and Participatory Forestry Research and Training Support Program BARC/Winrock International 17 different publications have been completed up to now.

The publications cover research reports, studies, training support, manuals, handbooks proceedings of seminars, workshops, Bangladesh agroforestry plan including an annotated bibliography on agroforestry in Bangladesh during the period between 1990-1995. Agroforestry related publications are more common. The publications of research report/studies cover both forest land and non-forest land. The findings relating to non-forest land are considered in this section. However little information is available on woodfuel production and related activities.

The objective of the program is to strengthen coordination and support collaborative research, training, dissemination of research results and networking in the field of agroforestry and participatory forestry in Bangladesh. Bangladesh Agricultural Research Council (BARC), the national coordinating agency for agricultural research in Bangladesh, is the host agency with whom Winrock International operates in partnership to implement the programme. The program is supported by grants from the Ford Foundation and PACT of Bangladesh.

BARC has arranged a good number of seminars and workshops on agroforestry production systems. It is a coordinating organization and it provides necessary back up support including small grants for research activities. BARI (Bangladesh Agriculture Research Institute) has worked on agroforestry systems on private land and also produced a few reports on the woodfuel situation in certain areas of the country.

Findings of the research reports/studies relevant to woodfuel production under participatory/agroforestry programme in the non-forest land are discussed in the proceeding sections.

8.3. Production of Woodfuel

In order to improve woodfuel production in the non-forest land, it is important to know the present state of woodfuel production and to identify those factors which play an important role in the production process. Non-forest land can be categorized into homestead land farmland and marginal land, which are available and have a great potential in relation to woodfuel production. Woodfuel production in non-forest land is described below.

Homesteads

Groves, clusters of trees, palms, bamboos, canes and other plants grown naturally or planted in and around homestead lands are termed "homestead forests". Homesteads may occur in a linear pattern along the roadsides/canal banks, in clusters or in scattered form and are surrounded by agricultural fields. Depending on the pattern of occurrence of homesteads, homestead forests do occur. Depending on the number of households living in the homesteads and their inter-relationship the homestead forests may be jointly or singly owned.

Homestead land occupied an estimated area of 0.976 million ha, of which crown covered areas constituted 0.27 million ha (BES-1975). The following categories of tree coverage occurred at the time of study.

- Homesteads with very light tree crown cover 5%
- Homesteads with light tree crown cover 15%
- Homesteads with medium tree crown cover 25%
- Homesteads with dense tree crown cover 35%

In Table 3, population distribution and regional percentage of forest in Bangladesh is given. There is a great variation in the village groves in different regions. The stock volume and the stand table of trees of 20 +cm dia in village groves (homestead forests) are shown in Table 4.

Characteristics of homestead forests

- Homestead forests occur in the proximity of the households, in the backyard and along the boundary of the homesteads.
- They fulfills all the three functions of production, protection and environmental functions of the forests.
- Occurrence of various species are common.
- Crown cover and density of the trees varies.
- Generally trees of different ages are found.
- Multi-storied production systems exist.
- Horizontal and vertical differentiation visible.
- Lowest production costs compared to any other method.
- Integral component of homestead production & economy.
- Often joint ownership.
- Established, managed and utilized by the farmers (owners).
- Care and supervision involves very little or no extra costs.
- Different planting techniques are noticeable.
- Women are also the beneficiaries.
- Protection is effective and sustainability ensured.

The method of planting varies in the rural areas. Different types of special silvicultural techniques viz. *pre-planting, under planting, storied planting, combined planting* are practiced in different parts of the country. Depending on the availability of land, the planting pattern varies. Trees may occur in blocks, in strips, in clusters or individually. Socio-economic status of the planter is an important criterion of success. Experience made with the industrial plantation trials of the Dhaka Match Industries (DMI) showed that absentee land lords gave insufficient care and the landless homestead owners generally not in a position to provide necessary protection and care for the planted trees. On the other hand, an active farmer residing with his own family at the homestead and for whom tree farming means extra income/benefit for the family is usually a successful planter. Several factors appear to promote tree planting as it appeared from the trial plantation activities of DMI as well as other private initiatives.

- Availability of land
- Undisputed ownership
- Availability of desired and quality seedlings
- Ability to protect and care
- Easy access to the market
- Fair price for the tree/tree products
- Appreciation in the locality
- Fast growing species
- Multipurpose species

Rich people generally plant valuable timber trees, coconut etc. and they are in a position to purchase quality seedlings of their choice, whereas the poor or marginal farmers often collect naturally grown seedlings from nearby sources and plant these trees using very simple techniques.

Under the Village and Farm Forestry Project it was also found that the numbers of trees on homestead land were directly proportional to the socio-economic levels of the households; larger families having more trees than small and marginal ones.

Problems encountered in tree planting were, among others: lack of space in the homesteads, by shortage of money and the unavailability of the desired seedlings, cost of protection of young tree seedlings, lack of technical know-how, buying and collection of seedlings from commercial nurseries etc.

Based on survival of the planted seedlings, farm size, distance of the planting site from the house, it was found that the survival was inversely proportional to farm size and wealth and inversely proportional to distance of the planting site from the house (Hocking 1995).

Farm land

Bangladesh is primarily a flood plains of the Ganges-Bhrahmaputra-Jamuna and Meghna river System with only some hilly areas in the southeastern and northeastern parts of the country. In relation to seasonal flooding, the following land types occur.

- high land : normally not flooded
- medium high land: normally flooded up to 90 cm
- medium low land : normally flooded between 90 cm and 180 cm
- low land : is normally flooded between 180 cm and 300 cm
- very low land : normally flooded deeper than 300 cm.

Among the land classes, high and medium high land are suitable for tree planting. Planting of trees in private farm land is not very common in Bangladesh, although one finds scattered occurrence of some trees like Babla (Acacia nilotica), Khejur (Phoenix Sylvestris), Koroi (Albizzia species), Shishu (Dalbergia sissoo), Palmyra palm (Borassus flabellifera), Mango (Mangifera indica) and Jackfruit (Artocarpus integrifolia) etc., in the high-lying areas. High-lying areas and relatively less productive areas are used for planting trees. Often inter-cropping is combined to produce intermediate crops for quick return.

Generally unused, under-utilized lands are made available for plantations. Also, the marginal land along the boundary of the homesteads, approach roads, pond sides, field ridge are planted. In most of the cases trees with small and light canopy are preferred. Sometimes, one finds bamboo groves in some corners of private plots. In general, less effort and labour are devoted to planting trees in marginal land. A more systematic approach and inputs are required for wider planting/block planting.

In Kushtia block plantation/small groves of Ipil Ipil raised by the contract growers of Bangladesh Tobacco Company (BTC) can be seen. In Barisal/Patuakhali DMI have raised tree farms of industrial species in the form of block plantations in waste lands, unutilized and under-utilized land.

The action-research conducted under the Village and Farm Forestry Project in the northwestern part of Bangladesh identified different problems associated with by the introduction of trees in the farmland. The problems were of a technical, management and an institutional nature and covered, among others, the following problems:

- loss of crop yield
- size of seedlings for planting
- theft of seedlings
- cattle damage
- legal obstacles

Various solutions were suggested to overcome the above mentioned problems. During the period 1987 - 1993 a total of 153,117 trees were planted through eleven local NGOs. The degree of participation, number of trees planted and survival rates however increased in subsequent years. It was found that the farmers were aware of the benefits of trees. They became interested in planting trees when they gained confidence in security of tenure of both the trees and land (Hocking & Islam, 1994). The only input they required was the supply of good quality seedlings. Through the Village and Farm Forestry Programme, village based private nurseries have been developed.

One finds good timber species of Shishu (Dalbergia Sissoo) planted in the high land area of Kushtia and Jessore districts by the farmers. People prefer nitrogen fixing trees, since these trees improve the soil.

Bhuiyan (1994) observed that the farmers in the northern and western region of the country tend to sacrifice some agriculture production loss in favour of growing trees because of acute timber and fuel wood shortages and also because of the higher productivity of the system.

In every locality one finds some persons who are basically tree minded. Their activities are highly appreciated by the local people. They can play a very important role as a motivator to promote tree planting in the locality.

Marginal Public Land

The marginal lands available along the roads and highways, district council roads, thana and union council roads, and 2 million big and small tanks with prominent high banks amount to about 80,000 ha. These marginal lands have limitations for other uses but could be appropriately used for tree plantation and agroforestry or silvo-pastoral practices (Bhuiyan, 1993).

To augment the supply of fuelwood, a few big projects were launched under the participatory forestry programme with the assistance of ADB in Bangladesh. Large scale fuelwood plantations with appropriate species have been raised by the Forest Department in the Non-forest land along the sides of roads/highways, railways, embankments, council roads. During the period 1980-1991 under different phases of the Community Forestry Development Programme 2,323 km road/highways, 655 km railways, 584 km embankments and 3,456 km council roads were planted. The Community Forestry Project (CFP) was the largest tree planting project of the Government of Bangladesh (GOB), covering 23 of the 64 districts of the country. CFP was the first project of its kind in Bangladesh. From the evaluation survey of the Community Forestry Project it was learned that :

- CFP beneficiaries preferred fruit trees over other type of trees;
- Community Forestry Growth Centres (CFGC) increased awareness, knowledge, participation and perception of the local people. Additional need of such centres and better programming was felt;
- Training proved to be the most effective CFP component in increasing awareness, knowledge, participation and perception of the project.

Under Thana Afforestation and Nursery Development Project 17,760 ha areas were planted. Besides, about 100 large scale nurseries and 345 Thana nurseries have been established to meet the local demand for the seedlings.

Presently the marginal land are also being leased to the non-governmental organizations, who plant trees with the assistance of the World Food Programme.

The trees are planted generally in rows or in strips and standard methods of planting are used. The spacing is generally 2 m apart. Considering the availability of land in wider slopes sometimes a triangular method of planting is practiced for the efficient utilization of growing space to accommodate the maximum number of trees. The factors promoting tree planting in community land appear to be as follows :

- formation of groups
- availability of land
- tenurial rights
- additional income/regular income
- intensive protection and care is required for initial years

It is important to ensure the sustain ability of the production system even in linear strip plantations so that every year an equal quantity of woodfuel can be procured and this practice will cause less shade effect compared to the even - aged plantation.

Involvement of the adjacent farmers (since the tree planting on the road side may have some effect on the neighboring farm land) in the selection of species and sharing the benefits appears to be another important consideration to promote tree planting along the road embankments.

Factors Promoting Tree Planting

Based on the experiences gathered in tree planting activities by different organizations/persons in the non-forest land, it appears that the following factors have promoted tree planting in the non-forest land in Bangladesh:

- availability of land for tree planting
- availability of desired tall and quality seedlings and at reasonable costs
- single ownership of land and the land grown plantation products
- fast growing, regular biomass yielding species, which have good market value as woodfuels
- fair price for the plantation products and easy access to the market
- presence of good tree farm/plantations established by the local farmers
- tree planting campaign by the local and political leaders
- presence of nurseries with various types of seedlings at the locality
- involvement of non-governmental organizations in tree planting
- establishment of private nurseries

- plantation products-based small enterprises development in the locality
- intermediate gains in the form of inter-cropping, fuel, leaves, twigs, branches etc.

Factors not Promoting Tree Planting

There are also a good number of factors, which have not promoted tree planting in Bangladesh. Among others, they are as follows :

- lack of quality and appropriate imput & service delivery
- efficient and effective extension strategy recognizing the capability & responsibility of women
- unavailability of any credit scheme or incentives for growing trees
- lack of trained and skilled manpower
- damage by cattle
- dispute over land
- little information about cost benefit of plantations
- lack of integration of tree planting with other production components
- freely and relatively easy availability of fuels biomass

8.4. Woodfuel in the National Energy Balance

Contribution of Woodfuel

No reliable or complete information on the present supply of and demand for all types of energy available (FMP, 1992). Based on its study in 1980-81, the Planning Commission of Bangladesh estimated the energy balance of the country for 1989-90. The sources of energy both commercial and traditional, their supply and consumption are shown for the financial year 1980-81 and 1989-90 in Table 8.

The contribution of different sources of energy in the Energy Balance of Bangladesh for 1989-90 is shown in Fig. 1. It appears from this figure as well as from Table 9 that modern fuel or commercial fuel contributes 26.8% or 194.00 Peta Joule energy and the traditional sources of energy namely, agricultural residues, tree residues, fuel wood and cow dung constitute 73.26% of the total amount of energy supplied. Among these traditional sources, the products/fuels of tree origin deserve a special position because of the many favourable properties woodfuels have compared to agricultural biomass. Energy harvest per acre from forests can be 20 times or more than that for annual crops because it represents many years accumulated growth (Burwell, 1978 cit. Nautiyal). This has important implications for management and transportation. Moreover, from the users point of view, woodfuel is much more favoured than any other biomass and can equally be used in the urban, semi-urban and rural households. Unlike agricultural residues woodfuel is also used for commercial purposes. Of the total tree biomass fuelwood accounts for 76.42%, whereas tree residues account for 23.57%.

The comparative contribution of natural gas, petroleum, coal, electricity and fuelwood, which are all used for domestic, industrial and commercial consumption are shown in Fig. 2 and 3. In the year 1989-90 the total commercial energy consumed for domestic, industrial and commercial purposes was 85.4 Peta Joule, whereas for the same purposes 88.2 Peta Joule energy was supplied from fuelwood alone. In 1980-81 the contribution of natural gas, petroleum, coal and electricity in the overall consumption was 52.2 Peta Joule, whereas in the same year the contribution of fuelwood alone was 60.0 Peta Joule. In other words, the contribution of fuelwood

is much higher than the combined contribution of the modern fuels in domestic, industrial and commercial consumption.

The contributions of fuelwood including tree residues in 1980-81 and 1989-90 were 64.9 PJ and 94.5 PJ respectively, whereas the comparable contributions of natural gas, petroleum and electricity in 1980-81 and in 1989-90 were 20.8 and 37.8 PJ respectively. In other words, woodfuel contributes more than double the amount of the combined modern fuels viz. natural gas, petroleum & electricity in domestic consumption.

The per capita fuel consumption in rural Bangladesh is given in Table 6 where it appears that tree fuels provide 44% of the biomass energy, amounting to 225 kg per capita. Fuelwood, branches and leaves account for 6%, 14% and 24% respectively of the rural household energy.

In 1980-81 fuelwood made up 10.4% of the total energy balance of the country. This increased to 12.8% in 1989-90. It is noteworthy, that of all the traditional biomass fuels only woodfuel is consumed as a commercial fuel. This is very important considering the ever increasing number of rural industries/small enterprise development in the rural, sub-urban areas. The consumers of the following industries/ micro-industries/cottages use woodfuels and tree residues in some form or other:

Food processing (cooking, baking, gur and, sugar making, confectionery, dairy product, fish drying, sweetmeat etc.), agri-processing; viz. paddy parboiling, tea leaf curing, tobacco curing, bidy making, ginger drying, turmeric drying, catechu making, rubber sheet making, brick manufacturing, pottery making, lime manufacturing, tile manufacturing, road tarring, tar making, salt making, silk cocoon processing, laundry, tyre retreading, herbal medicine preparation, hotel and restaurant etc.

The consumption of fuelwood in 1991 was estimated at 7,790 million m^3, of which 6.09 million went for domestic cooking and 1,694 million m^3 was used for industrial/commercial consumption (Table 7). The total quantity of 7,790 million m^3 fuelwood was produced in both forest and non-forest lands.

Production from Forest and Non-Forest Land

The major portion of fuelwood comes from non-forest land and almost the entire quantity produced in the non-forest land originates from homestead land. It may also be mentioned that the proportion of fuelwood compared to total wood is much higher in the non-forest land compared to the forest land. The major suppliers of fuelwood are the homestead forests. In 1980 of the total supply of 6.95 million m^3 fuelwood, 6.21 million m^3 was produced in homesteads (non-forest land) and 0.74 million m^3 fuelwood was supplied from national forests.

Presently homestead forests supply about 75 % of the fuelwood in the country, while government forestry programmes supply the remaining 25 percent. Tree branches, twigs, leaves, tree residues are generally used for domestic consumption.

It should be pointed out that forest production systems aim at producing quality timber and as such fuel wood production is less and timber production is higher compared to the homestead production system. Moreover, a significant portion of fuelwood is collected illegally by forest encroachers, and this often remains unrecorded.

However, according to the Farm Forestry Survey (1988), a about 10.74 million holdings consumed 2.40 million metric tons of fuelwood, twigs, leaves etc. with a value of Tk. 1479 million. 85% of the quantity required was met from own source and the balance was met by purchase. The total quantity of fuelwood sold by the households was 0.11 million ton valued at Tk. 75.15 million.

Homestead production is somehow under sustainable production though fear was expressed in 1981 about the rapid depletion of the resources. However, the subsequent sample checking and remeasurements of the village forest inventory proved that the depletion rate was not as fast as was expected.

The recent Village Forest Inventory (1992) showed again that the village forest production remains more or less steady in so far as the standing stocks are concerned, as such the production is on a sustainable basis.

Woodfuel is a traded commodity, however, all fuelwood consumed in the country does not enter the market. That which is domestically used is often collected at the sources by the owners using their own labour and practically no costs are involved after all the available low quality fuels are collected and dried, stored for future consumption.

Woodfuel and other biomass are the traditional and major sources of energy for most of the people living in the rural and sub-urban areas of the country. There is no alternative source of energy which is readily available. This suggests that in the years to come woodfuel and other biomass sources will remain major sources of energy.

Wood Energy Development

Woodfuel occupies a very important place in meeting the energy demand of the country. However, in spite of this it has not received adequate attention and remains an under developed energy source.

In the National Energy Policy declared recently (September, 1995), the important role of biomass, including woodfuel, which contributed 65.5% of primary energy in 1990 has been stated. It also highlighted that the direct and total replacement of biomass by commercial energy will be prohibitive for financial reasons and due to infrastructure constraints and that biomass fuel will continue to play an important role in the energy balance for many years to come. However, it has also been mentioned that the biomass soures are being consumed beyond their regenerative limits. Unplanned and uncontrolled use of biomass fuels are causing environmental degradation. In this context the woodfuel production has been considered. This becomes obvious from the Environmental Policy (III 2.4) and the Afforestation/Reforestation (III 2.5) para of the National Energy Policy which are presented below.

"III. 2.4 Environmental Policy

- Ban on the use of woodfuel for brick burning is to be enforced strictly
- Use of woodfuel for making bitumen for road carpeting is to be banned.
- Use of woodfuel in urban areas and for brick burning shall be discouraged and at a later stage restricted by making alternate fuels e.g. coal, peat, LPL etc.) available for such purposes.

- Alternative fuels are to be supplied in rural areas at an affordable price to encourage increase in recycling of agricultural residues back to the soil in order to achieve and maintain sustainable agricultural production.
- Watershed management should be an integral part of any hydropower project. Concerned government agencies should address soil conservation and afforestation/reforestation issues and should undertake activities to arrest soil erosion and siltation within the dam area. (Page 45, III 2.4 Environmental Policy)

III. 2.5 Afforestation/Reforestation

- Afforestation/reforestation programmes are to be primarily aimed at bringing the forest coverage of the country to an environmentally acceptable level.
- Availability of fuel/wood as sources of energy is to be considered only after afforestation has attained a sustainable level and an excess amount is available after meeting demands for its alternative value added uses such as a source of timber.
- Motivation is to be strengthened to establish afforestation as a social and moral obligation for every citizen.
- Research on identification of fast growing species of trees, having better fuel and/or timber values shall be strengthened keeping local climatic and soil conditions in view.
- Extension programmes, especially those related to community or villages forestry, shall be planned and implemented through participation of the population living in that locality.
- Phasing of afforestation/reforestation programmes shall be such that the areas like the north-western part of the country, where deforestation has already assumed an alarming proportion, are taken up and continued on a priority basis. (Page 46, III. 2.5 Afforestation/Reforestation)".

The above policy is based on conservation and environmental considerations. Considering the fact that the rural poor have to depend on leaves, twigs and branches of the trees as well as on other biomass, there is a need to ensure a sustained production of woodfuels for those, for whom modern fuel sources will not be feasible for many years to come. Allocation of land, particularly utilization of marginal land with fast growing, high yielding and regular biomass supplying trees involving the NGOs, as is being currently implemented should be continued further.

Besides, available vacant low or non-productive government land should be allocated to the poor families to produce their own woodfuels. This should be facilitated through the provision of credits, providing necessary marketing assistance and possibly with the promotion and development of small enterprises based on plantation products.

In order to solve the fuelwood problem, improvement & development of homestead forests, the major source of fuelwood supply is a must. However, there has been no programme specifically to improve the overall productivity of homestead forests, nor to introduce yield increasing technology (FMP, 1992). Moreover, the sale of wood and other products is not at all organized to ensure a fair price for the products or even to exchange information and knowledge. As such in the Forestry Master Plan (1992) it has been recommended to establish an effective system of forestry extension for disseminating new and improved technology, research information, and knowledge for the benefit of farmers and rural community, for arranging delivery of improved planting materials and other inputs and for creating public awareness about roles and the contribution of forestry.

In order for biomass fuel to receive a greater recognition & allocation as a critical energy source in the country, particularly in meeting the demand of the households and small scale rural industrial sectors in the different constraints need to be overcome. Among others, the following steps should be taken:

- Importance of the woodfuels in the national economy, involvement and dependency of the rural people, their incomes, employments etc. need to be properly assessed.
- Socio-economic impacts of increased/decreased production and supply of woodfuels should be studied. It is important to highlight the comparative advantages of woodfuels over other biomass fuels.
- For energy planning purposes, demand and supply of woodfuels should be monitored on a regular basis.
- Institutional arrangements are to be established to implement wood energy development programmes to ensure sustainable development of woodfuels to meet rural energy needs.
- Appropriate strategy needs to be developed to ensure sustained supply of woodfuels involving all types of non-forest land.
- There is a need to develop a Wood Energy Cell under the Forest Department to provide effective extension services to develop and manage the tree resources of non-forest land.
- Basic research should be conducted on growth, yield and economic benefits of fuelwood species/plantations.

8.5. Supply of Modern Fuel

Status of Supply

The estimated quantity of known and exploitable commercial energy resources of the country are as follows :

- Coal (Barapukaria): Net recoverable reserves of 70 million tonnes (one million tonnes per year from 2000).
- Natural gas (17 gas fields): Net recoverable reserves (10.44 TCF as on June 1993) of 9.96 TCF as on June 1995; natural gas liquid 13.7 T.C.F. tonnes per day (as on June 1993).
- Hydropower at Kaptai : 1000 GWH per year

Potential reserve of primary commercial energy resources are :

- Coal-in-place reserve (1 billion tonne reserve at Jamalganj; 450 million tonne at Khalaspur).
- New deposits are unknown, recoverable reserve of coal deposits are to be estimated.
- Coal bed methane (0.5 TCF in one seam at Jamalganj)
- Peat (170 million tonnes at Faridpur, Khulna); Natural gas (9.3 TCF)
- Hydropower (300 GWH year at Matamuhuri minihydro; 10 GWH year at Sylhet, Chittagong and Chittagong Hill tracts.

The commercial energy consumption in Bangladesh is estimated to be equivalent to 65 kg oil or 90 kilo watt hours. Presently there is a shortage of about 2 million tonnes and the present and future shortfalls in modern fuel are estimated as follows :

- Present Shortfall = 1.99 million ton
- Shortfall by 2000 AD = 2.7 million ton
- Shortfall by 2015 AD = 36.688 million ton
- Shortfall by 2021 AD = 61.880 million ton

Present gas reserves are estimated at 9.96 trillion cubic feet. At the present rate of consumption these may last until 2015 AD. The coal reserves of the country are estimated to be 70 millions ton and the demand for the imported petroleum is about 2.4 million tons. Considering the importance of different gas consuming sectors and inadequate supply of gas, the following pattern of utilization of the gas has been suggested recently.

- For electricity production = 45 - 50%
- For chemical fertilizer production = 25-27%
- Industries = 13-18%
- Commercial and domestic = 8-10%

To meet the demand for modern fuel by the year of 2000 AD, a total amount of US$ 2720 million and by the year of 2005 AD, a total amount of US$ 3770 million need to be invested.

It may be mentioned that about 26.8 % of the total energy consumption of the country is met by modern fuels. Among these modern fuels considering the percentage of total consumption, natural gas stands in the first position (12%) followed by petroleum (10.1%), electricity (2.8%) and coal (1,8%). Considering the wide spectrum of use, petroleum has most diversified use followed by electricity. During the period between 1980-81 to 1989-90, the total consumption of natural gas has increased 2.76 times, from 30.1 PJ to 83.2 PJ, petroleum 1.27 times (from 6.3 PJ to 19.4 PJ) and coal consumption has increased 2.254 times (from 5.5 PJ to 12.4 PJ). Moreover considering the present rate of consumption, it is estimated that the gas reserves will be totally exhausted by the year 2025 AD.

Though petroleum is most suitable due to easy transportation, the country cannot afford to depend on imported petroleums to cater to its energy balance. Even now Bangladesh has to spend most of its hard earned foreign currency to meet its part requirement for commercial energy.

Electricity is the costliest form of energy. About 75% of primary energy is lost during the process of conversion. It is also not desirable to meet most of the energy demand by electricity on a sustainable basis. Other sources of supply of commercial energy like hydropower, wind energy, solar energy etc., are very limited.

The Liquid Petroleum Gas (LPG) cylinders are presently used by some well-to-do families in the urban as well as in the rural areas, particularly by the families having fewer family members. The LPG cylinders cost about Tk. 3000.00 per piece, which can rarely be afforded by the low income groups. Moreover, these cylinders need to be refilled. For this purpose, the cylinders are to be transported to the nearby filling stations. This involves extra costs and engagement of labour and indeed it is costlier than the urban household consumption. According to a recent news report there is no possibility to solve the present crisis with LPG. The demand for LPG is much more than the production capacity in the LPG plant. The only oil refinery of Bangladesh, the Easter

Refinery, currently 15,756.79 metric tonnes of liquid gas. From this quantity 1.26 million cylinders are filled. In the financial year 1993-94 the supply was 12,635 metric tonnes equivalent to 1.010 million cylinders. Although the actual demand could not be assessed it is thought that the figure would be at least twice as much as the production quantity of the Eastern Refinery.

Present government price rate for LPG gas cylinders has been fixed at Tk. 154.00 and the sales price within 40 km range of the LPG plant has been fixed at Tk. 194.00. But, it is sold even in the Chittagong region at the rate of Tk. 220.00 while in the northern region of the country, the rate is much higher.

Liquefied petroleum Gas (LPG), available in cylinders for domestic use, is beyond the purchasing power of the low income group and there is already a big gap in the demand and supply of the LPG. The initial investment cost is very high. Moreover, regular filling by transporting the cylinders in the nearby urban areas/stations is not feasible for the poor farmers. It involves cost as well as transportation problems precluding their use by the poor.

Considering the inadequacy of the infrastructure, additional costs involvement and considering the natural calamities like cyclone, flood, drought, etc., the modern fuel supply to the extent needed may not be feasible in the years to come, particularly for the rural poor, who constitute the majority of the population.

Socio-Economic Consideration Favouring Woodfuel

There are several factors, which favour the use of woodfuels as are well as responsible for the continuous use of woodfuels for household cooking. These are particularly applicable for the case of the rural/sub-urban areas of Bangladesh.

Even within the urban areas which have come under the gas supply network, a significant percentage of the people have no access to modern fuel gas. In the slum areas where very poor people live, one finds people are forced to use very poor quality fuels, including papers, to cook their food, as they have no access to modern fuel nor they can afford gas cylinders. Even in the periphery of the capital city Dhaka, fuelwood is used for household cooking as well as in the hotels and restaurants and the price is increasing day by day. All types of woodfuels are sold in Dhaka. The residues from sawmillions, wood yards, veneer and plywood millions, furniture as well as a number of other forest product enterprises, are used as fuel in Dhaka as in other parts of the country. Even the low quality residues of softwood species like Simul (Bombax ceiba), Kadam (Anthocephalus cadamba), Chatian (Alstonia scholaris) etc. and their barks, endcuts, dusts, rejected portion of timber/wood products are sold and there is a ready market for the low quality wood fuel products.

Considering the fact that the natural gas reserves will be exhausted some day and given that there already is an inadequate supply of gas, a new pattern of utilization of gas has been proposed under the National Energy Policy of the Government of Bangladesh which was declared recently. Bangladesh can hardly afford to buy huge quantity of commercial fuels to use for domestic consumption and this leaves no other option than the continued use of woodfuel for household cooking in the near future.

Rural people have generally fewer sources of income. They can ill-afford to spend scarce money on energy. The poor people move often to various places in order to collect fuel. FMP survey (1992) revealed that the poor people of the land holding category < 0.20 ha spend 20-30 hours per week to collect domestic fuel for their own needs. Since the poor cannot afford to buy or

engage servants like the rich people for fuel collection they collect it themselves. Family involvement to collect fuel is highest in the land holding < 0.20 ha and lowest in the land holding >3.0 ha. The time spent for collection of fuel thus varies depending on the socio-economic status of the people and on the availability of the resources.

Abedin et al (1991) reported that the landless and marginal farmers of Barind Tract suffered more than the medium and large farmers due to fuel shortage. They also found seasonal variation in household fuel use. Resource-poor farmers suffer more from fuel shortage than the medium or large farmers during the rainy season.

Alam et al (1988) found that on average 60% of farmers collected fuel for domestic consumption. The number was greater for the poor groups of farmers. They collected fuel form the crop field, orchard, homestead and nearby places. Mostly the children (65%) collected the fuels. Besides, the farmer themselves (40%) and their wives (33%) were involved. The rich group of farmers collected fuel from their own resource bases whereas the poorer group of farmers collected fuel from the neighbouring crop field and gardens from distant. Most of the farmers interviewed (63%) were found to adjust their fuel crisis by collection and storing in advance (25%), reducing cooking frequency to once a day (8%) and buying fuel (17%).

Based on a field survey carried out in 1993 in the working areas of the three non-governmental organizations, BRAC, POUSH and UBINIG, it was found that the monthly expenditure of the families for fuel range between Tk. 100-500.00. Majority of the respondents (66.6%) spent Tk. 200 or less. This relatively low expenditure was due to the fact that the amount of fuels they purchase is only a part of their total consumption. Moreover, only the families having relatively high incomes purchased fuels and the family members are not usually involved in collection.

Cooking habits, like consumption of parboiled rice in almost all regions except Chittagong and Sylhet, require additional fuels for boiling paddy with husk as well as cooking parboiled rice (Islam 1991).

Taste preference in cooking appears to be another factor related to woodfuel use. Among woodfuels *Mango* (Managifera indica) and Tetul (Tamarindus indica) are preferred by hotels, restaurants and in the households. Tetul fuelwood, in particular, is used to cook delicious food and it is expensive. Majority of the respondents of the FMP (1992) fuelwood survey belonging to different land holding group stated that they burned grass and agricultural residues as fuel, particularly in the winter months.

The rate of urbanization and the establishment of small food/agri processing enterprises, food shops and hotels have already created an increasing demand for woodfuel. Brick burning is a energy intensive operation and consumes a large quantity of woodfuel. Although fuelwood has been prohibited for brick burning in Bangladesh most of the brick fields continued to use it (FMP, 1992). Fuelwood is also used for melting bitumen for road tarring.

Fossil fuel would not be able to cover the wider areas of rural and sub-urban areas. In those areas woodfuel will remain a reliable source of energy and the price developments in the recent years show steady increase in the price of woodfuels. Woodfuel will continue to remain a source of energy for those areas.

However, the need for this renewable source of energy to meet the country's demand on a sustainable basis deserves proper attention. Considering the ever-increasing demand for the fuel, more and more attention will be focused on woodfuel. If more trees are grown in the non-forest land, than there will be less pressure on national forests and the country can save large amounts of foreign exchange on fuel imports. Moreover, the time needed by the rural people, particularly by the women to collect fuel will be greatly reduced and the time could be utilized for other household activities and family care and, above all, the continuous anxiety to secure fuel will be greatly relieved.

As such, the wood energy related programme should be receiving top priority in the total context of the energy sector development. In this connection, the different options identified by the Bangladesh Energy Planning Project to augment the supply of fuelwood may be mentioned (BEPP 1987). The non-forest land related options are cited here.

- Planting of trees in private household areas and on farm land (village forests)
- Planting of fast growing trees and seasonal tree crops on privately owned fallow land;
- Strip plantation on public lands (by the sides of railway lines, roads, canals etc.).

8.6. Woodfuel Production Alternatives

Economic & Environmental Impact

Woodfuel production is carried out on particular types of land. Basically these are high lands, wastelands and marginal lands and all of these are usually less productive for agriculture crops. In order to compare woodfuel production with other land management systems, one should be aware of the costs and benefit of that systems, which is indeed lacking. Occasionally non-forest - marginal lands are used for short term crops, grass and vegetable production. Vegetable production has increased manyfold in Bangladesh and the entire production is on a short-term basis and brings a good dividend. This production process cannot be substantially profitable only interms of woodfuel production. However, this may be profitably managed as an agroforestry production system.

There is no reliable information/data available on the cost benefit analysis of woodfuel production in non-forest lands. However, a few case studies reveal that good additional income can be obtained from the trees through a combined production system. Abedin and Quddus (1991) reported the economic aspects of traditional agroforestry systems. Some of the systems related to woodfuel production are discussed as follows:

Acacia nilotica based system

In this system, the farmers usually keep 50-60 Babla (Acacia nilotica) trees per hectare in sugarcane fields. Babla does not reduce the yield of sugarcane. On the contrary, it helps to increase the yield. In the plots of rice and wheat the farmers keep only 20-30 trees so that the yield is not reduced. A 5-6 year old Babla trees is sold for about Tk. 200.00 and it is mainly used for fuel. It is a good species for fuelwood as well as for timber and poles.

Dalbergia sissoo based system

Large farmers owning more than 10 ha of land sometimes plant 1200-1600 trees/ha and after 15-20 year the trees can be sold at a competitive price of Tk. 5000-700.00 each. However, after 2-3 years, the crop yield of the agricultural field declines and after 10 years, cultivation of field crops is no longer possible. However, the yield reduction is largely compensated for by the high price obtained for the trees. Vacant lands can be leased at the rate of Tk. 7500.00 per ha. Poor farmers cannot take advantage of the situation since it involves a large initial investment. Small farmers also cannot wait for 15-20 years till the final tree harvest. The farmers usually keep 45-75 trees per ha and cut and sell them earlier than planned as a result of food or cash shortages.

Artocarpus heterophylla based system

Artocarpus heterophylla is planted on crop field boundaries and within the crop fields. The tree gives fruits 5-6 years after planting. A 15-20 year old tree produces 30-40 fruits worth of Tk. 200 to 250.00 on average. Besides, 25 kgs fuelwood is obtained annually from lopping. The trees are usually felled after 15-20 years and for each standing tree the farmer can expect about Tk. 1500 to 2000.00.

Under the Village and Farm Forestry Programme, a farmer asosciated with the Community Development Association, a local NGO in Dinajpur district, could earn Tk 8675.00 by selling 5 Ipil Ipil (Leucaena leucocephala), 4 Minjiri (Cassia siamea), 12 Ghora neem (Melia azaderach) and 14 Eucalyptus (Eucalyptus camadulensis) trees, which he planted in 1988 in his agricultural field. It has been reported further that the production of agricultural crops was not hampered by tree planting, rather it benefited the farmer financially.

PROSHIKA, a leading national NGO in the social forestry sector harvested (from a one mile roadside plantation strip), Pigeon pea worth Tk. 10,000.00. The cost of production varied between Tk. 1000-1500.00. Besides the short-term gain, major income would come from the planted fuelwood species Babla (Acacia nilotica).

Woodfuel may not be a cost effective source of energy for urban cooking when fossil fuel is available at a subsidized rate. For example, for domestic cook for a whole month, irrespective of the cooking frequency and quantity, a fixed rate of Tk. 200 to 300.00 is paid in the urban area. The costs would be much higher if woodfuel was used for this purpose. As such woodfuel cannot be a cost-effective alternative to the subsidized fossil fuel, as it is now.

However, the homestead forests are the most cost effective source of woodfuel production. The characteristics of homestead production, the proximity, no additional care etc. make it an unparalleled production system which has survived for centuries. Homestead production of energy biomass constitutes an integral part of the total homestead economy. However, the population pressure, unemployment, less income generating opportunity etc. are infringing on the scope of the homestead production system and tend to liquidate the system. The homestead production of woodfuel is the most cost-effective. The active farmers residing with their own families at the homesteads are quite involved in tree farming.

Planting trees in the raised and sedimented portion of land along the canal bank, for example, which is suitable for agroforestry production, also could offer a cost-effective source of wood production. Individual strips, small groves in the unutilized/under-utilized marginal land of the farmer are of course other cheap and cost-effective sources.

In terms of sustainability of production and impact on the environment, the woodfuel production with inter-cropping certainly can improve the resource bases. In particular, planting soil improving species would improve the fertility of soils and would make land more productive. Such species will ensure a sustainable base for wood supply and would have long term positive impact on the environment.

Wood energy plantations improve the micro-climate and the environment as a whole. Besides, they provide comfortable shade and climate to humans and their domestic animals. With the felling of trees, of course, there may be a negative impact but this could be compensated for by a sustained production system which ensures that an equal quantity of woodfuel, which is removed from the sources will be replanted.

Woodfuel Flow Characterization

In Bangladesh woodfuel occurs in the form of:

- primary/direct products as logs, branch wood, twigs or as converted, split or dried primary processed materials;
- residues in the production process during primary and secondary processing
- rejected materials during and after use.

Woodfuel is collected by the small traders involved in the fuelwood business. Different tiers of enterprises are presently involved in the firewood business depending on the quantity procured and the locations of the procurement. Among the persons involved are tree owners, primary collectors, secondary collectors & big and small consumers. In general, different sequential activities and various conditioning factors are related to the collection/trading of woodfuels. Among others, they are as follows.

- availability of the fuelwood trees, particularly desired species and in reasonable quantity, possibly at suitable locations.
- time and distance factors to harvest, convert and transport the logs at one point, suitable for further deliveries.
- price bargain, ownership, mode of payment, final settlement (sometimes leaves, foliages are also negotiated)

The standing trees are purchased and sometimes they are kept standing for some period if the purchaser comes from the same locality, or they may be harvested as early as possible. Transportation of harvested/converted logs is one of the most important considerations for the primary collectors. Transportation cost is cheapest during the rainy season when a boat may be needed to reach the nearest homestead. In poverty stricken situations or in the off season, the price of trees goes down, and the traders take advantage of that situation and buy trees from the farmers and harvest at their convenience. Fuelwood marketing continues throughout the year, though in the dry season bulk quantities are sold when the commercial activities such as brick making, lime processing, tobacco curing, gur making etc take place. During the dry season traders usually build up their stocks for the coming wet season when the demand for woodfuel is very high for domestic cooking.

Primary suppliers purchase the trees, harvest those and convert them into small pieces of wood. Primary suppliers collect the harvested logs from the tree bases and bring these to the road sides or river sides or in the neighborhood of loading points for track/trawler/boat cargo to supply these fuel logs to the central markets, generally in the urban areas.

Price determination mostly depends on the rates fixed by the secondary suppliers/middlemen as well as bulk consumers rather than primary sellers. Most of the bulk consumers calculate their costs and profits in connection with their processing activities, as such they determine mainly the price of the fuel. The big consumers make contract with the professional/secondary suppliers, who subcontract with the primary suppliers.

At local market places, the owners of the fuel shops/depots collect the fresh logs, split them, dry them, store them and sell them to the local consumers. Considering the purchasing power of the consumers, small bunches of different qualities of woodfuel are sold in the local market. Depending on the availability of woodfuel, the prices vary. In the areas having a high proportion of village groves like the southern part of Bangladesh, the woodfuels are generally cheap and cost about half of the price paid in Dhaka.

The woodfuels, which are generated during the primary and secondary processing of logs and timber products and which comprise rejected materials, are collected from the source areas and then resold to the commercial and domestic users. There is no study on the percentage of wastages which occurs during the production process, but the quantity should be substantial.

Log residues, including barks, are put together in small bundles and sold for the minimum affordable price to the poor people in various places, including the suburban areas.

Different cost components account for the ultimate price for the landed fuel in the local market. These cost components may vary. Among others, they are as follows;

- price of the standing tree;
- cost of conversion & transport to the collection point;
- profit margin of primary supplier;
- sorting, handling & further transport costs to secondary suppliers point;
- storing, handling, splitting, drying,
- selling cost (including profit margin).

The above components greatly influence the price. However, a sudden increase in the price may occur due to a shortfall in the supply or an increased demand for woodfuels.

Socio-Economic Impact of Wood Energy

Woodfuel production & processing involves a good number of operations in which the poor people are involved. Most of the operations are labour intensive. It involves the owner of the tree, purchaser, wood cutter and the people involved in woodfuel transportation, conversion, storage, grading, sorting, bunch making, cleaning, selling. At different stages of operation middlemen are involved. Thus woodfuel conversion and consumption provides opportunities for employment and income generation for many peoples particularly for the poor.

The products/by-products are used by a variety of consumers. The converted/split logs, when dried are used by relatively by rich families or by the hotels, shops and other establishments/ organizations. The residuals are again used by the poor.

In matters of domestic consumption, women are concerned most about woodfuel since they prepare the food. Their concern also leads to their preference for species which yield regular fuel e.g. groves yielding leaves and if these are located in or nearby the homestead. The easy collection and regular yield of fuels are important considerations. The yearly pruned branches like those of the raintrees (Samanea saman), Kadam (Anthocephalus cadamba) etc. are also preferred by the women.

Children and the poor generally collect various types of woodfuels, particularly from the neighboring forests or from the resource bases. However, they collect those components of the tree biomass, which would not bring them in conflict with others who are selected products consumers. Generally, they collect leaves, twigs, rotten parts of the trees, broken and fallen branches of trees. The additional fuels viz. leaves, twigs broken branches are either sold to the poorest section of the people or stored in their own home to meet future fuel needs in the near future, particularly in the rainy season. Collection of fuels by the poor and the children mean income savings, otherwise extra expenditure will be incurred.

8.7. Research and Development Needs

An integrated approach is required to develop a successful Wood Energy Programme. Such an approach should include the entire production, procurement and distribution of the woodfuel using the most efficient and appropriate methods. The knowledge and experience of the rural people must be given due consideration while developing wood energy programmes.

In Bangladesh, the scarcity and the ever growing need for fuel have triggered useful innovations/ practices in the production, processing and marketing of the products. An in-depth study is very much needed to understand the following issues:

- Wood market structure, particularly micro-structure of woodfuel business in Bangladesh
- Ownership of and income from homestead forests
- Pattern of utilization, particularly multi-dimensional use and optimum utilization.
- Studies on growth, yield, properties and economy of the fuelwood species suitable for growing in the different agro-ecological regions of the country.
- Integrated support service and input needed by the grower, and promotion and development of the woodfuel based enterprises in the rural/ urban areas. Incentives/ assistance (input supply, management service, buy-back gurantee, credit etc) needed by the growers.
- Promotion and development of woodfuel based enterprises by improved technology and better utilization

Table 1. Achievements of the VFFP 1987 - 1993.

		Homestead	Cropland	Total
1.	No. of participants	70,983	3,240	74,223
2.	No. of trees planted	936,061	168,172	1,104,233
3.	No. of trees grown	779,559	115,04	894,599
4.	Acres under planting	-	3,114	-
5.	No. of species planted	82	40	-
6.	Fruit trees renovated	33,957	-	-
7.	No. of village forestry growing centers established	-	-	240
*	No. of seedlings produced	-	-	1.3 million
*	No. of species in the nursery	-	-	82
8.	No. of mother trees established/ Identified within the village	-	-	4,000

Source : Village & Farm Forestry Programme (VFFP) Experiences, K. Islam (1994).

Table 2. Income from CHAP nurseries.

Parameters	Year	
	1993	1994
No. of families earning below Tk. 1000.00	40%	5%
No. of families earning in the range of Tk. 3000-6000.00	25%	40%
No. of families earning more than Tk. 6000.00	none	25%

Table 3. Population distribution and regional percentage of forests in Bangladesh.

Region	Population	National Forest (%)	Plantation Forest (%)	Village Groves (%)
Region-1: Rangpur, Dinajpur, Bogra, Rajshahi, Pabna	25	1	0	24
Region-2: Dhaka, Mymenshing and Tangail	24	7	2	18
Region-3: Kushtia, Jessore and Faridpur	13	0	0	15
Region-4: Sylhet, Comilliona	14	6	10	4
Region-5: Khulna	5	42	0	7
Region-6: Barisal, Patuakhali, Noakhali	12	3	14	23
Region-7: Chittagong	6	16	43	9
Region-8: Chittagong Hill Tracts	1	25	31	0
Total	100	100	100	100

Source : BFRI, Research in the Forest Management No. 4, Vol. 1.

Table 4. Stock Volume and Stand Table of Trees 20+ cm dia in Village Groves, Bangladesh 1991.

Species	Stem	Total	Per Capita (m^3)	Sawlog Volume	Fire Wood
Mango	52,397	18,623	0.205	5,620	13,003
Jack	25,513	5,240	0.058	2,155	3,085
Rain	11,164	5,251	0.058	1,473	3,778
Simul	5,781	2,685	0.029	868	1,817
Bat	745	783	0.009	183	600
Madar	6,208	1,553	0.017	178	1,275
Koroi	10,101	3,365	0.036	940	2,426
Chakua	22	6	0.000	3	3
Jam	5,152	1,438	0.015	355	1,083
Jiul	5,003	725	0.008	103	622
Gab	5,887	954	0.010	170	784
Tetul	2,529	923	0.010	241	683
Bel	1,835	396	0.004	80	315
Pitali	2,729	671	0.007	145	526
Chaatim	820	223	0.002	65	159
Kadam	3,000	679	0.007	174	505
Debdaru	945	152	0.001	34	118
Jarul	2,275	414	0.004	76	337
Sal	283	44	0.000	8	36
Segun	435	83	0.001	18	65
Garjan	94	22	0.000	8	14
Palash	16	5	0.000	0	5
Lichu	836	243	0.003	71	171
Others	54,139	10,727	0.118	1,994	8,733
Total	197,910	55,205	0.601	14,961	40,244

Source : Village Inventory Survey, Forestry Master Plan Study, 1992

Note :
1) Volumes in thousand cubic meter
2) Number of stems in thousand
3) Volume per capita based on 1991 population
4) Figures may not add up due to rounding
5) Services in local name

Table 5. Projected fuelwood demand and supply (Fig. in 1000 m^3).

Zone	Demand	Supply	Balance'93	Balance 2013
N. West	2,007.68	882.00	-1,125.67	-1,504.02
N. Central	1,811.63	763.00	-1,048.63	-1,375.22
West	1,163.53	546.00	-617.53	-814.70
South	848.18	860.00	-12.82	-164.76
South-East	1,366.59	857.00	-509.59	-390.66
N. East	1,002.82	391.00	-611.52	-810.17
C.H.T.	76.87	1,880.00	-1,808.13	+1,385.91
Total	8,271.80	6,179.00	-2,092.82	-3,345.10

Source : Forestry Master Plan, 1992.

Table 6. Per capita fuel consumption in rural Bangladesh.

Item	Quantity/ Capita KG	Percent of Quantity	Energy/Capita 100 Kcal.	Percent of total Energy
Fuelwood	30.39	6.0	93.87	6.0
Branches	71.78	14.0	221.73	14.0
Tree Waste	125.21	24.5	377.51	24.3
Bamboo	21.84	4.0	65.85	4.2
Agri-residues	187.61	36.4	565.64	35.5
Cow dung	74.90	14.6	209.05	13.5
Charcoal	2.46	0.5	19.90	1.5
Total	514.19	100.0	1,53.55	100.0

Source : Wood Energy Report, FMP, 1992g. Cited in Economics & Marketing FMP, 1993

Table 7. Estimated 1990 Consumption of Fuelwood and Residues by End-use and Application.

Type of End-uses	Type of Energy Used					
	(in million tonnes)			(in Peta Joule)		
	Fuelwood	Residues	Total	Fuelwood	Residues	Total
I. Domestic Cooking						
Rural	0.821	24.110	24.931	12.40	301.37	313.77
Urban	3.472	2.232	5.7040	52.42	27.90	80.32
Subtotal	4.293	26.342	30.635	64.82	329.27	394.09
Percent of Grand Total	13.320	67.700	81.020	13.32	67.70	81.02
II. Agrobased industry						
Paddy parboiling	-	2.7450	2.7450	-	34.31	34.31
Paddy processing	-	1.7170	1.7170	-	21.46	21.46
Tea processing	0.079	-	0.079	1.20	21.46	21.46
Sugar milling	-	0.324	0.324	-	4.05	4.05
Sugar cane gur	-	0.839	0.839	-	10.49	10.49
Palm gur	-	0.139	0.139	-	1.74	1.740
Tobacco curing	0.066	0.046	0.112	0.99	0.57	1.56
Baking	0.081	-	0.081	1.23	-	1.23
Subtotal	0.226	5.810	6.036	3.42	72.62	76.04
III. Non-agrobased industry						
Brick burning	0.754	-	0.754	11.39	-	11.39
Road tarring	0.023	-	0.023	0.35	-	0.35
Soap	0.009		0.009	0.14	-	0.14
Pottery	0.034	0.012	0.046	0.51	0.15	0.66
Lime	-	0.034	0.034	-	0.43	0.43
Others	0.026	0.049	0.075	0.39	0.61	1.00
Subtotal	0.846	0.095	0.941	12.78	1.19	13.97
Industry Total	1.072	5.906	6.977	16.20	73.81	90.01
Percent of Grand Total	3.33	15.170	18.500	3.33	15.17	18.50
IV. Commercial	0.121	0.040	0.161	1.82	0.50	2.32
Percent of Grand Total	0.380	0.100	0.480	0.38	0.10	0.48
V. Grand Total	5.486	32.286	37.772	82.84	403.58	486.42
Percent of Grand Total	-	-	-	17.03	82.97	100.00
in million m^3	7.790			7.79		

(GOB, 1991)

Conversion factors : Fuelwood 1000 tonne = 0.0151 PJ, Residue 1000 tonne = 0.0125 PJ, Fuelwood 1 tonne = 1.42m^3

Table 8. Energy Balance of Bangladesh by Source for 1980-81

Source of Energy	Commercial Energy (in Peta Joules)												Traditional Energy (Peta Joules)										Total amount of energy	
	Nat. gas		Crude oil		Petr.prod.		Coal		Electricity		Total commer. energy		Agri. resid.		Tree resid.		Fuelwood		Dung		Total Biomass Supply			
	1980 -81	1989 -90	1980 -81	1989 -90	1980 -81	1989 -90	1980 -81	1989 -90	1980 -81	1989 -90	1980 -81	1989 -90	1980 -81	1989 -90	1980 -81	1989 -90	1980 -81	1989 -90	1980 -81	1989 -90	1980 -81	1989 -90	1980 -81	1989 -90
SUPPLY																								673.1
Primary Product.	49.4	163.4	0.0	0.0	0.0	2.7	0.0	0.0	2.3	3.3	51.7	169.4	317.3	316.6	23.6	27.2	60.0	88.2	77.7	71.7	1435.8	503.7	1487.5	113.8
Import	0.0	0.0	54.0	53.5	21.4	48.0	6.0	12.3	0.0	0.0	81.4	113.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	81.4	-6.3
Exports	0.0	0.0	0.0	0.0	-9.5	-6.3	0.0	0.0	0.0	0.0	-9.5	-6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-9.5	-12.6
From stock	0.0	0.0	0.3	-5.9	3.0	-6.8	-.0.5	0.1	0.0	0.0	2.8	12.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	768.0
Gross supply in PJ.	49.9	163.4	54.3	47.5	14.9	37.7	5.5	12.4	2.3	2.3	126.4	264.3	317.3	316.6	23.6	27.2	60.0	88.2	77.7	71.7	478.6	503.7	605.0	100.0
Gross supply in percent	8.2	21.4	9.0	6.2	2.5	4.9	0.9	1.6	0.4	0.4	21.0	34.5	52.4	41.5	3.9	3.0	9.9	11.6	12.8	9.4	79.0	65.5	100.0	
TRANSFORMED IN																								-4.4
Refinery	0.0	-1.0	-54.3	-47.5	51.9	44.1	0.0	0.0	0.0	0.0	-2.4	-4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-2.4	-53.2
Thermal Power Station -	-18.3	-69.3	0.0	0.0	-10.1	-8.8	0.0	0.0	7.3	24.4	-21.1	-53.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-21.1	-22.2
Losses and Own use	-1.0	-9.9	0.0	0.0	-2.4	-4.0	0.0	0.0	-3.3	-8.3	-6.7	-22.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-6.7	687.7
Net supply in PJ	30.1	83.2	0.0	0.0	54.3	69.0	5.5	12.4	6.3	19.4	96.2	184.0	317.3	16.6	23.6	27.2	60.0	88.2	77.7	71.7	478.6	503.7	574.8	
Net supply in percent	5.2		0.0		9.4		1.0		1.1		16.7		55.2		4.1		10.4		13.5		83.2		99.9	
CONSUMPTION																								446.9
Domestic	3.5	9.3	0.0	0.0	16.2	23.6	0.0	0.0	1.1	4.9	20.8	37.8	241,6	243.0	23.6	27.2	41.3	67.3	77.7	71.7	384.2	409.1	405.0	133.2
Industrial	7.7	14.0	0.0	0.0	12.3	7.0	5.0	9.5	3.7	10.0	28.7	40.5	75.7	73.6	0.0	0.0	16.9	19.1	0.0	0.0	92.6	92.7	121.3	8.9
Commercial	1.5	3.1	0.0	0.0	0.0	0.0	0.0	0.4	1.2	3.6	2.7	7.1	0.0	0.0	0.0	0.0	1.8	1.8	0.0	0.0	1.8	1.8	4.5	27.7
Transport	0.0	0.0	0.0	0.0	20.8	25.1	0.5	2.6	0.0	0.0	21.3	27.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.3	11.9
Agricultural	0.0	0.0	0.0	0.0	1.4	11.0	0.0	0.0	0.1	0.9	1.5	11.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.3
Others	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.2	0.0	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	58.7
Non energy use	17.4	56.7	0.0	0.0	3.6	2.0	0.0	0.0	0.0	0.0	21.0	58.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.0	687.7
Total Consumption in PJ	30.1	83.2	0.0	0.0	54.3	69.0	5.5	12.4	6.3	19.4	96.2	184.0	317.3	316.6	23.6	27.2	60.0	88.2	77.7	71.7	478.6	503.7	574.8	100
Total Consumption in %	5.2	12.1	0.0	0.0	9.4	10.1	1.0	1.8	1.1	2.8	16.7	26.8	55.2	46.0	4.1	4.0	10.4	12.8	13.5	10.4	83.2	73.2	100	

Conversion fators:

Natural Gas	1	MMCF	= 0.00099 PJ	Electricity 1 Gwh = 0.0036 PJ
Crude Oil	1000	tonne	= 0.0427 PJ	Agricultural and tree residues1000 tonne = 0.0125 PJ
Petroleum products	1000	tonne	= 0.0427 PJ	Fuelwood1000 tonne = 0.0151 PJ
Coal	1000	tonne	= 0.0270 PJ	Dung1000 tonne = 0.0116 PJ

(GOB, 1990 cited in FMP 1992)

Conversion fators: 1 Peta Joule = 1 Giga Joule (GJ) x 10^6

1 GJ corresponds approximately to the combustion energy of 0.1m^3 (or 71 kg) of wood

Table 9. Energy Balance Table 1990.

In peta Joule (10-15 Joule)

Description	Commercial Energy						Biomass Fuels					
	Nat. Gas	Crude Oil	Petr. Prod.	Coal	Elec-tricity	Total Commer.	Agri. Resid.	Tree Resid.	Fuel wood	Dung	Total . Bio-mass	Total Energy
I. SUPPLY												
Primary Production	163.4	-	2.7	-	3.3	169.4	316.6	22.5	88.2	71.7	499.0	668.8
Imports	-	53.4	48.0	12.3	-	113.7	-	-	-	-	-	113.7
Exports	-	-	-6.3	-	-	-6.3	-	-	-	-	-	-6.3
Stock Exchange	-	-5.9	-6.8	0.1	-	-12.6	-	-	-	-	-	-12.6
Total Primary	163.4	47.5	37.6	12.4	3.3	264.2	316.6	22.5	88.2	71.7	499.0	763.2
Primary percent	21.4	6.2	4.9	1.6	0.4	34.5	41.5	2.9	11.6	9.4	65.4	99.9
II. TRANSFORMATION												
Refinery	-1.0	-47.5	44.1	-	-	-4.4	-	-	-	-	-	-4.4
Thermal Power	-69.3	-	-8.8	-	24.4	-53.7	-	-	-	-	-	-53.7
Losses & Own Use	-9.9	-	-	-4.0	-	-8.3	-22.2	-	-	-	-	-22.2
Total Final - Supply	83.2	-	68.9	12.4	19.4	183.9	316.6	22.5	88.2	71.7	499.0	682.9
III. CONSUMPTION												
Domestic	9.3	-	23.6	-	4.9	37.8	243.0	22.5	67.3	71.7	404.5	442.3
Industrial	14.0	-	7.0	9.5	10.0	40.5	73.6	-	19.1	-	92.7	133.2
Commercial	3.1	-	-	0.4	3.6	7.1	-	-	1.8	-	1.8	8.9
Transport	-	-	25.0	2.5	-	27.5	-	-	-	-	-	27.5
Agricultural	-	-	11.0	-	0.9	11.9	-	-	-	-	-	11.9
Others	-	-	0.3	-	-	0.3	-	-	-	-	-	0.3
Non-Energy Use	56.8	-	2.0	-	-	58.8	-	-	-	-	-	58.8
Total Final-Consumption	83.2	-	68.9	12.4	19.4	183.9	316.6	22.5	88.2	71.7	499.0	682.9
Final Energy percent	12.2	-	10.1	1.8	2.8	26.9	46.4	3.3	12.9	10.5	73.1	100.0

Conversion fators:

Natural Gas	1	MMCF	=	0.00099 PJ	Electricity	1 Gwh	=	0.0036 PJ
Crude Oil	1,000	tonne	=	0.0427 PJ	Agricultural and Tree residues	1,000 tonne	=	0.0125 PJ
Petroleum products	1,000	tonne	=	0.0427 PJ	Fuelwood	1,000 tonne	=	0.0151 PJ
Coal	1,000	tonne	=	0.0270 PJ	Dung	1,000 tonne	=	0.0116 PJ

Source: (GOB 1990 Cit. National Energy Policy 10=995)

Table 10. Annual fuel shortage in different farm categories at the study locations.

Farm Category	Shortage Period (no. of days/years)						
	Patuakhali	Jessore	Rangpur	Rajshahi	Ishurdi	Tangail	Overall
Landless	190	120	150	240	105	127	155
Marginal	70	120	180	270	75	78	132
Small	68	120	90	240	25	46	91
Medium	50	90	150	270	20	64	107
Large	90	90	0	150	11	12	59
All farms	95	108	114	234	47	87	113

Source ; Abedin, M.Z. & Quddus M.A.1988 Household fuel situation.

Table 11.Relative contribution of various materials to total fuel use in different farm categories.

Fuel Material	Percent Contribution in different farm categories				
	Landless	Marginal	Small	Medium	Large
Fuelwood	5.00	11.00	8.00	13.00	19.00
Branches of trees	16.00	12.00	15.00	12.00	13.00
Leaves	20.00	17.00	11.00	8.00	5.00
Straw	4.00	5.00	5.00	7.00	6.00
Husks & bran	7.00	8.00	8.00	8.00	7.00
Crop residues	18.00	11.00	9.00	6.00	7.00
Jute sticks	4.00	6.00	9.00	12.00	13.00
Pigion pea plants	0.00	0.10	0.00	0.00	0.02
Cow dung	22.00	21.00	28.00	28.00	21.00
Bamboo	3.00	5.00	5.00	6.00	7.00
Kerosene	0.18	0.04	0.18	0.29	0.11
Electricity	0.03	0.00	0.17	0.14	0.17
Others	2.00	2.00	2.00	1.00	1.00

Source : Abedin, M.Z. & Quddus M.A. 1988.

Table 12.Proportional distribution of total household fuel use according to source of fuel management at different households.

Farm Category	Percent distribution of fuel use by sources of fuel management			
	Owned	Collected	Purchased	Row Total
Landless	27	56	17	100
Marginal	59	25	16	100
Small	79	8	13	100
medium	86	4	10	100
Large	89	0	11	100
Overall	67	18	15	1,000

Source : Abedin, M.Z; Quddus. M.A. 1988.

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Fig. 1: Contribution of Different Sources of Energy in Bangladesh, 1989-90.

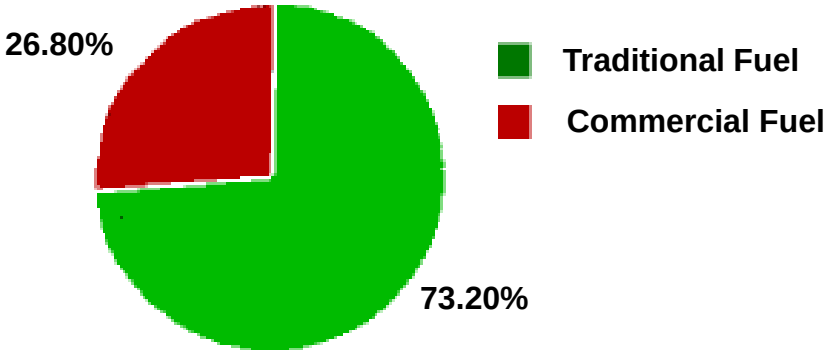

Fig. 1a.: Total Energy Sources.

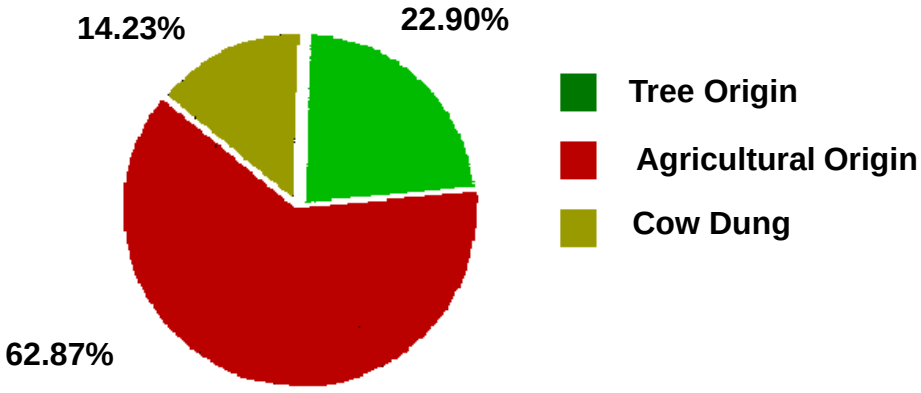

Fig. 1b.: Traditional Energy Sources.

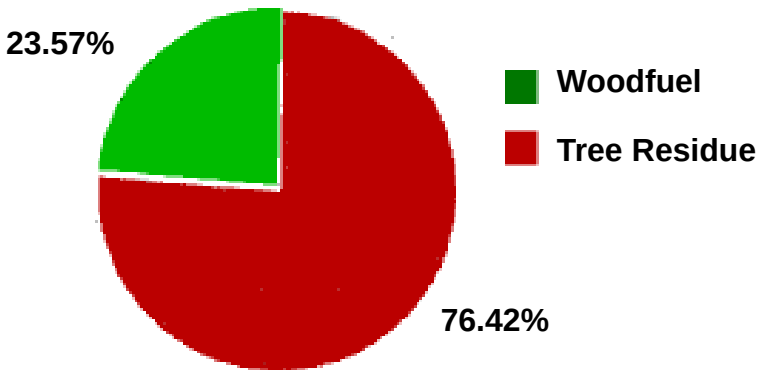

Fig. 1c.: Tree Biomass Sources.

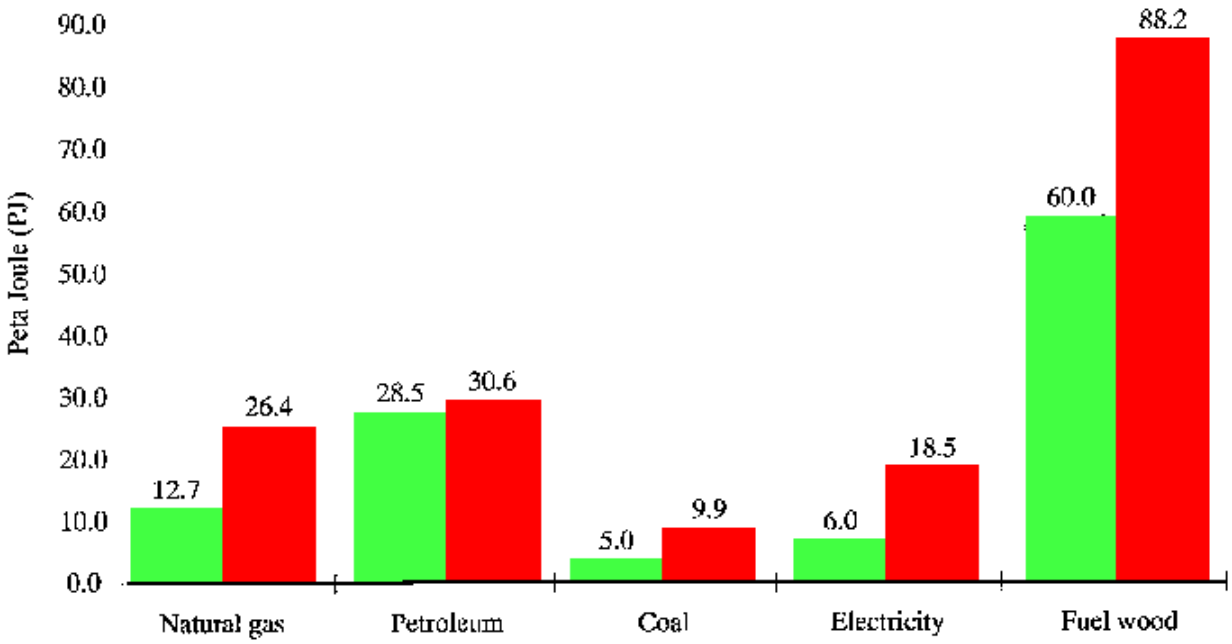

Fig. 2: Domestic, Industrial & Commercial Consumption of Energy in 1980-1981 and 1989-1990.

Fuelwood and dung stacked at riverside for sale

Small twigs and dung stacked for home consumption

Firewood stacked for use in pottery industry