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REGIONAL WOOD ENERGY DEVELOPMENT PROGRAMME IN ASIA
&
ASIA-PACIFIC AGROFORESTRY NETWORK

Summary Report

of Training Workshop on

INTEGRATING WOODFUEL PRODUCTION INTO AGROFORESTRY EXTENSION PROGRAMMES IN SOUTHEAST ASIA

23-30 April 1995, West Java, Indonesia

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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PREFACE

We can safely state that woodfuel is one of the major products from trees in Asia, and similarly in other parts of the world. However, fuelwood is often classified as a “non–wood product”. Sometimes, fuelwood is even listed under the so–called “minor forest products”. At the same time, we know that more than half of all energy comes from wood in most countries in Asia. In Africa it is even more. To what extent fuelwood originates from forests, agroforest systems, homegardens, community plots, linetrees, hedges, or other, will differ from place to place. But woodfuel comes from trees (or more generally: from woody biomass), and even timber normally ends up as a fuel. Still, it is observed that the importance of trees as a source of woodfuel is not always appreciated by forest–experts both inside and outside FAO.

In the FAO–Forestry Paper No. 122 on “Readings in Sustainable Forest Management”, published in 1994, only 2 out of 17 contributions, give evidence of an appreciation of the importance of woodfuels as a product in the context of addressing sustainability in forest management. In the same paper extensive reference is made to wood–products, like roundwood and timber, and the other non–wood products.

This observation contrasts with the FAO publication on Sustainable Agriculture and Rural Development in “The Road from Rio: Moving Forward in Forestry”, also published in 1994, which states: “A broad estimate suggests that forestry currently provides the equivalent of 60 million work–years worldwide, of which some 80% (about 48 million) is in developing countries, where about half are in fuelwood/charcoal–related activities.” This statement is in line with our observation that woodfuel production is a major economic activity in rural areas of most member countries of RWEDP and APAN.

Comparing the two policy papers from FAO, it seems as if the importance of woodfuel and its relevance for forestry is sometimes better appreciated by the agricultural sector than by the forestry sector! This brings us straight to the subject of integrating woodfuel production in agroforestry extension programmes, as a joint effort of the Regional Wood Energy Development Programme (RWEDP) and the Asia–Pacific Agroforestry Network (APAN).

The present workshop is the first one of two sub–regional workshops on Woodfuel in Agroforestry, funded by RWEDP. Ten more national workshops in related subjects are to follow in due course with support from RWEDP. When we say related subjects, it could be agroforestry or community forestry, or other tree production systems, but the woodfuel component will be the prime interest. It is not incidental that the first workshop took place in Bogor, Indonesia, as this place is a very active center hosting various agriculture– and forest–oriented organisations, and many activities have already taken place there. It is fortunate that strong delegations from all RWEDP member countries in South–East Asia were able to attend this workshop.

We appreciate the good cooperation between RWEDP and APAN in developing the concept of the present workshop. Quite a lot of interaction has taken place between Mr. Tara Bhattarai of RWEDP and Mr. Hans Beukeboom of APAN, and others, to develop the programme of the workshop. We would like to thank the host organization of APAN, the Forest Nature Conservation Research and Development Centre (FNCRDC) and the Indonesian Ministry of Forestry and APAN supporting staff for their cooperation in organizing and supporting the event. Further we would like to thank participants and resource persons for submitting case studies and papers, and Mr. Hans Beukeboom, Mr. Rene Koppelman and Dr. James French for compiling and editing this report. Another good example of the same cooperation is the joint RWEDP–APAN publication on "Woodfuel Productivity of Agroforestry Systems in Asia", by Michael Jensen, published in April 1995 by RWEDP as Field Document No. 45.

We trust that the Summary Report of the present workshop serves both RWEDP and APAN members, and most likely others as well.

On behalf of RWEDP	On behalf of APAN
Willem S. Hulscher Chief Technical Adviser	Chun K. Lai Regional Coordinator

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ACRONYMS

AFRD	Agency for Forest Research and Development (Indonesia)
APAN	Asia-Pacific Agroforestry Network
ARECOP	Asia Regional Cookstove Programme
BLPP	Balai Latihan Pegawai Pertanjan (In-service Agricultural Training Centre, Indonesia)
FAO	Food and Agriculture Organization of the United Nations
FAO/RAPA	FAO Regional Office for Asia and Pacific
FARM	Farmer-centered Agricultural Resource Management
FNCRDC	Forest Nature Conservation Research and Development Centre (Indonesia)
FPSERDC	Forest Products and Socio-Economics Research and Development Centre (Indonesia)
GO	Government Organization
LPTP	Lembanga Pengbangan Teknologi Pedesan (Institute for Rural Technology Development, Indonesia)
NGO	Non Government Organization
PDR	Peoples' Democratic Republic
PR	Peoples' Republic
RWEDP	Regional Wood Energy Development Programme
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organization

1. BACKGROUND

Developing countries in the Asia-Pacific region meet 30 to 80% of all their energy needs with woodfuels (fuelwood and charcoal). Biomass for cooking, specifically woodfuels, dominates domestic energy use in the majority of the countries. In all of them, cooking represents a very significant, if not the largest, single use of energy. In addition, woodfuels are also used in many types of applications for industries and enterprises in the Asia-Pacific countries. Per capita consumption of woodfuels has declined because of increasing energy consumption, improved access to alternative commercial fuels and increasing resource scarcity. However, the total use of woodfuels, together with alternative biomass energy resources, has not declined, and in many countries has increased in absolute terms, because of population growth in the region.

Due to population pressure, many agricultural land resources have been degraded by misuse and mismanagement. Shortened fallow cycles on traditional shifting cultivation systems, farming on steep hill sides, excessive logging of forests, frequently occurring forest fires, overgrazing by livestock, and encroachment on forests and marginal lands have all been recognized as causes of this land degradation.

With over 90% of the 400 million ha of total arable land in 27 developing countries in the region already under cultivation, pressure on tree resources has reached unacceptable levels. Both in terms of needs for wood, be it fuel or construction wood and wood products, and in terms of mitigating impacts of intensified landuse on soil properties and ecosystems, integrating woody perennials into farming systems or improving existing agroforestry systems are the only viable alternatives in areas with high landuse pressure.

The sub-regional training workshop on *Integrating Woodfuel Production in Agroforestry Extension Programmes in South-east Asia* was organized to increase awareness of the potential that integrating woodfuel production into agricultural systems has in order to sustain the supply of woodfuel. It was envisaged that this task of incresing awareness would be best, at least initially, camed out at a sub-regional level, involving professionals from both energy and (agro)forestry institutes. These professionals, it was hoped, would then be able to organize national training courses for extension and other programmes afterwards in order to disseminate awareness on integrating woodfuel production into agroforestry systems throughout their countries.

1.1. Organizing institutions

The sub-regional training workshop was held at the in-service training center (BLPP) of the Indonesian Ministry of Agriculture in Ciawi, Bogor, West Java, Indonesia, from 23-30 April 1995. This was a joint effort of the Regional Wood Energy Development Programme (RWEDP) in Bangkok, Thailand, the Asia-Pacific Agroforestry Network (APAN) in Bogor, and the Indonesian Agency for Forestry Research and Development (AFRD).

AFRD is the agency in the Ministry of Forestry dealing with forestry research and development issues. The Forest Nature Conservation Research and Development Centre (FNCRDC), under AFRD is the host of the APAN secretariat in Bogor.

Regional Wood Energy Development Programme

The RWEDP has been operational since 1983. It is located in Bangkok, and is generously funded by the Government of the Netherlands. In 1994 the third phase of the programme was started. This phase is to last 5 years, and 15 countries in Asia participate.

During its previous two phases, RWEDP has covered a broad range of subjects, including wood fuel flows, production, processing and conversion. 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 past activities have contributed significantly to increasing awareness on the wood energy situation in most of the member countries.

In its current phase, RWEDP now focuses on strengthening efforts in policy analysis, energy strategy formulation and wood energy assessment while also addressing the need to improve the efficiency of wood and biomass energy utilization. Over 2000 staff of government, non-government and private organizations will be trained in various aspects of wood energy development over the next five years.

The redefined development objective of RWEDP is to contribute to the sustainable production of wood fuels, their efficient processing and marketing, and their rational use for the benefits of households, industries and other enterprises. The three immediate objectives of RWEDP during the current phase are:

1. To contribute to an improved database on wood energy at regional and national level and to improve the capacity of institutions to generate, manage and assess such data at regional, national and sub-national level.

2. To contribute to the development and adoption of improved wood energy policies, plans and strategies in member countries.

3. To improve the capabilities of government, private and community-based organizations in implementing wood energy strategies and programmes.

Organization of this training workshop contributes to the achievement of immediate objective number 3.

Asia Pacific Agroforestry Network

APAN was formally established in May 1991 with support from the Government of Japan (GCP/RAS/133/JPN). The APAN Regional Secretariat is hosted by the Forest Nature Conservation Research and Development Centre (FNCRDC), under AFRD in Bogor, Indonesia. APAN Phase II was approved in late 1992 by the Government of Japan for a four year period (1993-1997) and provides funds for core support of the APAN Regional Secretariat functions and regional networking activities in 11 countries. Other funding for APAN comes from the UNDP supported Farmer-centered Agricultural Resources Management (FARM) Programme for Asia (RAS/92/078) which was launched in September 1993. The FARM programme consists of seven sub-programmes, of which agroforestry is executed by APAN. The seven sub-programmes are integrated to form a coherent sustainable agricultural programme, with national counterparts (GOs and NGOs) and appropriate UNDP, FAO and UNIDO inputs. FARM funding is used to catalyze and supplement ongoing and future projects, programmes and networks.

APAN Phase II objectives have been defined as follows:

1. To strengthen the established regional network of focal institutions and individuals active in agroforestry research, development and training in member countries.

2. To document, synthesize, exchange and disseminate information on known successful, stable and productive agroforestry systems on a regular basis among network members by distributing APAN publications, and by organizing expert consultations, workshops and field visits on specific agroforestry themes.

3. To improve the opportunities, materials and quality of agroforestry training for participants from member countries, at regional and national level.

4. To link with and support innovative and ongoing field level agroforestry activities (e.g., demonstration areas, FARM "field laboratories", innovative farmer practices) in participating APAN countries.

1.2. The participants

A total of 24 participants from 8 countries attended the training workshop including nationals of China, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Thailand and Vietnam. A large number of the participants had professional training in forestry, while others had backgrounds from law to energy and mechanical engineering. Most (11) had obtained a BSc., 6 had an MSc., 6 had undefined educational backgrounds and one had a Ph.D. (See Appendix 3, Participants profile). Female representation was 25%, an equal percentage represented energy related institutes, while 75% worked in forestry institutes. The majority of the participants worked with government organizations, three at NGOs and one at a university. Average age of the participants was around 40 years. A list of participants and their profiles are included in Appendices 2 and 3, respectively.

1.3. Training workshop objectives

The objectives of the training workshop were as follows:

1. To facilitate the networking of participants from government, non-government and private organizations who can contribute to integrating woodfuel production in agroforestry extension programmes in South-east Asia.

2. To enhance the capacity to plan and implement integrated agroforestry extension programmes in RWEDP and APAN member countries in South-east Asia through the exchange of information and experiences on integrating woodfuel production, distribution and marketing within the framework of agroforestry programmes.

3. To develop country capability to design and implement national workshops/ training courses that aim to integrate wood energy production, distribution and marketing in agroforestry extension programmes, and to enhance economic development through promoting sustainable landuse practices.

4. To identify and plan follow-up training activities at the national level, within the scope of work of RWEDP.

1.4. Participants' expectations

In the first plenary session participants were given an opportunity to express their expectations of the training workshop. A high proportion of participants' stated expectations were related to increasing knowledge on processing and utilization of woodfuel. An equal proportion of participants expected to gain insights into how to integrate woodfuel production in to agricultural systems (from both agroforestry and energy perspectives). Improved networking between different institutions and nations was also expected by a large number of participants. Participants also expected to learn more about woodfuel production and marketing, and participatory extension methodologies.

1.5. The training process

The training workshop lasted six days. This comprised two days of introductions and presenta-tions as preparation for two days of field trips, followed by two days of working groups. Papers and case studies were presented in four sessions. A detailed programme is included in Appendix 1. Papers presented are included in Appendix 4.

Box 1: The training process

1. RWEDP and APAN overview and discussion of the importance of woodfuels in participating countries
2. Participatory approaches to agroforestry extension
3. Woodfuel production and utilization
4. Woodfuel planning and marketing in Indonesia
5. Field exercise
6. Discussion of the relevance of the field exercise in national context
7. Establishment of a proposal for national workshops on related subjects

The first session gave general overviews of RWEDP, APAN and the importance of wood-fuel in energy consumption patterns in participating countries. The second session included presentation of a framework for farmers' household decision making, agro-forestry extension strategies and three case studies from participants from the Philippines, China P.R. and Indonesia. The third session consisted of three paper presentations covering the concept of woodfuel, species selection, production of wood in different agroforestry systems, combustion and processing aspects of woodfuel (including waste of wood based industry), the use of woodfuel at the household level and small-scale industry, and discussions related to the dissemination of improved woodstoves and other combusters. The fourth session explained the local situation in Indonesia, giving data on: the role of fuelwood in national energy consumption; policies of the ministry of energy; fuelwood marketing; and price policies of the State Forest Enterprise, which is, by far, the largest individual producer of fuelwood for the market.

During the field trip emphasis was laid on fuelwood utilization by small-scale industry, fuelwood production in forestry plantations, and fuelwood trade by middlemen. Observations from the field trip were synthesized by filling in a worksheet for describing the present situation, constraints and possible solutions. This framework was later used for describing conditions in participants' home countries. Finally, proposals were made by country working groups for follow-up training courses at the national level.

2. WOODFUEL PRODUCTION AND UTILIZATION

People tend to ignore the importance of woodfuel as a source of energy and income from forest estates, rubber plantations or agroforestry sites. Yet much of the wood in the world ultimately is destined for woodfuel markets and will ultimately be converted to flames. Also, waste from pulp and timber is used as fuelwood. For many people the proportion of wood used for energy in national energy balances is surprisingly high, since the association of trees with energy is not often made.

In the first session of the training workshop, emphasis was laid on these aspects, with presentations by Wim Hulscher (RWEDP), Tara N. Bhattarai (RWEDP), Chun K. Lai (APAN) and Ulla Blicher-Mathiesen (APAN).

2.1. The importance of woodfuel in energy utilization

The use of woodfuel is significant in all the participants' countries. Energy derived from wood and biomass varies between 22 and 90% of the total national energy use, with an average of around 50% (Table 1). In spite of the prominence of woodfuels, most politicians involved in national energy planning are more interested in so-called “modern” energy, e.g. oil, gas and nuclear energy. They have little time, if any, for traditional energy sources. They do not realize the importance of woodfuel and are unaware that the demand for this energy source in all participating countries is rising.

Even in rapidly industrializing countries like Thailand, the total use of woodfuel is still increasing, although the proportion of woodfuel in total energy consumption is going down. The reason for this is that, although the demand for modern energy for the fast-growing industrial sector is increasing rapidly, the use of traditional energy by the rural population is also increasing due to population growth.

Use of wood energy instead of oil is, in fact, a blessing for national economies since this reduces the need to import oil. Keeping in mind that an average of 50% of the total energy consumption consists of traditional fuels, purchase of fossil fuel substitutes would require an astronomical amount of foreign currency.

Table 1: Biomass energy use in countries as a percentage of overall energy use. Data given by participants.

Country	Wood energy	Other biomass energy*
Indonesia	40	10-15
Myanmar	80	10
Philippines	70	13
Thailand	30	5
Vietnam	40	10
China P.R.	35	>10
Lao P.D.R.	50	15
Malaysia	12	10

** agricultural waste, dung etc.*

For years there has been a misunderstanding that this growing demand of fuelwood was one major reason for deforestation. Now studies have shown that only a small proportion of fuelwood used comes from forests. Instead, most of it is taken from homegardens or other non-forest lands. Even in areas with fuelwood shortages, domestic cooking does not cause deforestation. Only in very hostile environments can domestic cooking woody vegetation, to vanish.

In many places in South-east Asia people are experiencing woodfuel or biomass fuel shortages. Part of this shortage is an unexpected consequence of the green revolution. During that period many high yielding varieties were successfully introduced. Unfortunately, high yielding crops generally give less residue than traditional varieties, and these residues were used for cooking. This, and growing population increased the demand for fuelwood.

To solve the fuelwood shortage, we have the following options:

- planting more trees
- improving combustion efficiency
- better planning and distribution of woodfuels

The first option is pretty straightforward: by planting more trees the amount of available fuelwood increases. Possible constraints are policy regulations (e.g. forbidding cutting of trees) and availability of areas to plant trees without negatively influencing crop production. In these cases agroforestry might be a good alternative.

The second option stresses the need for energy saving. By using traditional three stone stoves, a lot of energy is wasted. The energy balance while cooking a meal on these stoves is approximately two thirds of the energy under the pot while only one third of the energy is in the pot. This is based on a combustion efficiency of the stove of only 5–10%.

The third option is applicable in areas where most people using woodfuels live a long distance from the tree resource. Overall, there is no woodfuel shortage, but distance between consumers and the production area is so great that local shortages arise. The long distances involved make transport costs very high, especially for primary energy. Conversion into secondary energy, such as charcoal, can save

Box 2: Definitions of stages

Fuelwood:
All wood that can be burnt directly, e.g. stemwood, debris

Woodfuel:
All fuels derived from wood, e.g. charcoal, wood gas, stemwood etc.

Primary energy:
The raw material, e.g. wood

Secondary energy:
The converted raw material at the conversion site, e.g. charcoal, cut and split wood

Final energy:
The converted raw material available to users at consumption point.

Useful energy:
After all conversions, e.g. heat for cooking.

transportation costs. This conversion is, however, also energy consuming. Definitions of different types of energy are mentioned in Box 2.

Every step between these phases consumes energy. By avoiding one phase (between primary and final energy for instance) or shortening the process between the different phases (shorter transport distance, better combustion), much energy can be saved.

No woodfuel shortages here!

2.2. Forest resources in member countries

The total forest area in the eight participating countries is about 313 million ha. Out of this, China alone has about 115 million ha of natural forests, mostly in the temperate zone and the remaining 198 million ha is distributed in the other seven RWEDP member countries in South-East Asia. China also has an additional 27.7 million ha of other wooded land, which can be significant from the point of view of wood energy production.

Besides these natural forests, a large area of plantation forests exist. Although the tree plantation area has been increasing in the sub-region (taking into account all new plantations under different schemes, such as agroforestry, community forestry, social forestry, national afforestation /reforestation, etc.), the success rate of most of these plantations has been repeatedly questioned. The latest figure on the survival rate at the global level stands at only 70%. The ratio of deforestated land to established plantations for Asia as a whole stands at 2:1, which is much better compared to 6:1 for Latin America and 32:1 for Africa. But the high rate of deforestation must still be reduced significantly, as quickly as possible.

2.3. Woodfuel and agroforestry

Wood and other biomass produced as byproducts from agroforestry systems contribute substantially to the national energy balance of many countries. Studies reveal that only 15 percent (2.5 million out of 25.3 million tons) of the fuelwood used in 1989 in the Philippines and about 50 percent of the fuelwood and charcoal consumed in the rural areas of Thailand in 1984 were derived from forests while the rest came from other sources. Similarly, Vietnam with no significant non-forest plantations, still meets 75% of its woodfuel requirement from outside forest sources. In South Asian countries, where forest area per rural inhabitant is lower than in South-east Asia, woodfuel production from agroforestry systems is even higher. Homestead "forests" provide about 85 percent of all wood consumed in Bangladesh. In Pakistan, about 90 percent of the woodfuel comes from non-forest lands, private farmlands and wastelands.

Consideration of the above facts, leads us to suggest the following propositions:

- Agroforestry, in the form of home gardens and farm forestry, is the most important source of woodfuel for domestic consumption in many areas in the region.
- Agroforestry (on public and private lands) should be the key strategy for woodfuel production in South-east Asia, while improved natural forest management should be a complementary strategy.

These propositions support the advancement of agroforestry practices in the sub-region and promote sustainable landuse. Therefore, countries in this part of Asia may benefit by incorporating wood energy development as an additional strategy in their respective agroforestry extension programmes.

2.4. Discussion

During the discussion period many questions were raised regarding the source and accuracy of the data contained in the presentations on forest resources. It appears that data used in this report (see Appendix 5a.) were derived mostly from the available statistics from various international agencies (i.e. FAO, World Bank, World Resources Institute, etc.), who, in turn relied upon official data provided by the concerned government agencies of member countries. So, in most cases the figures do not include wood produced illegally which often goes unregistered and does not show up in government statistics. Therefore, it is clear that these data should be interpreted only as indicators of production and consumption at the country level.

The discussion following APAN's presentation, "perspectives from the Asia-Pacific Agroforestry Network", focussed on the field data, policy and purpose of the demonstration plot established by APAN. Considering the scope of this training workshop, only a brief introduction to the field sites was given. Not much emphasis was laid on exact data because the plots differ in each country. Even within the countries, there are great differences between the demonstration plots with regard to agroforestry and land tenure systems used. One question that arose was whether the APAN programme includes a focus on small-scale industries or not. It appeared that, although APAN did not specifically refer to small-scale industries in its objectives, much attention was given to marketing aspects of agroforestry systems. Within that framework, rural industry plays an important role.

3. PARTICIPATORY APPROACHES TO AGROFORESTRY EXTENSION

Where there is a need for increasing woodfuel production on farmers' land, both for initiating production and improving current production, extension is a tool to meet this goal. The more extension is based on farmers' needs and understanding, the higher the rate of success. To help design appropriate participatory interventions, a framework has been developed for analyzing farmers' household decisions (Fig. 1). An overview of various extension methods and some case studies to illustrate alternative extension approaches under different circumstances are also included in this chapter. Presentations in this session were given by James French (APAN), Leonardo Moneva (Mag-uugmad foundation, Philippines), Yongliang Zhu (South-West Forestry College, China P.R.) and Ibnu Singgih Pranoto (LPTP, Indonesia).

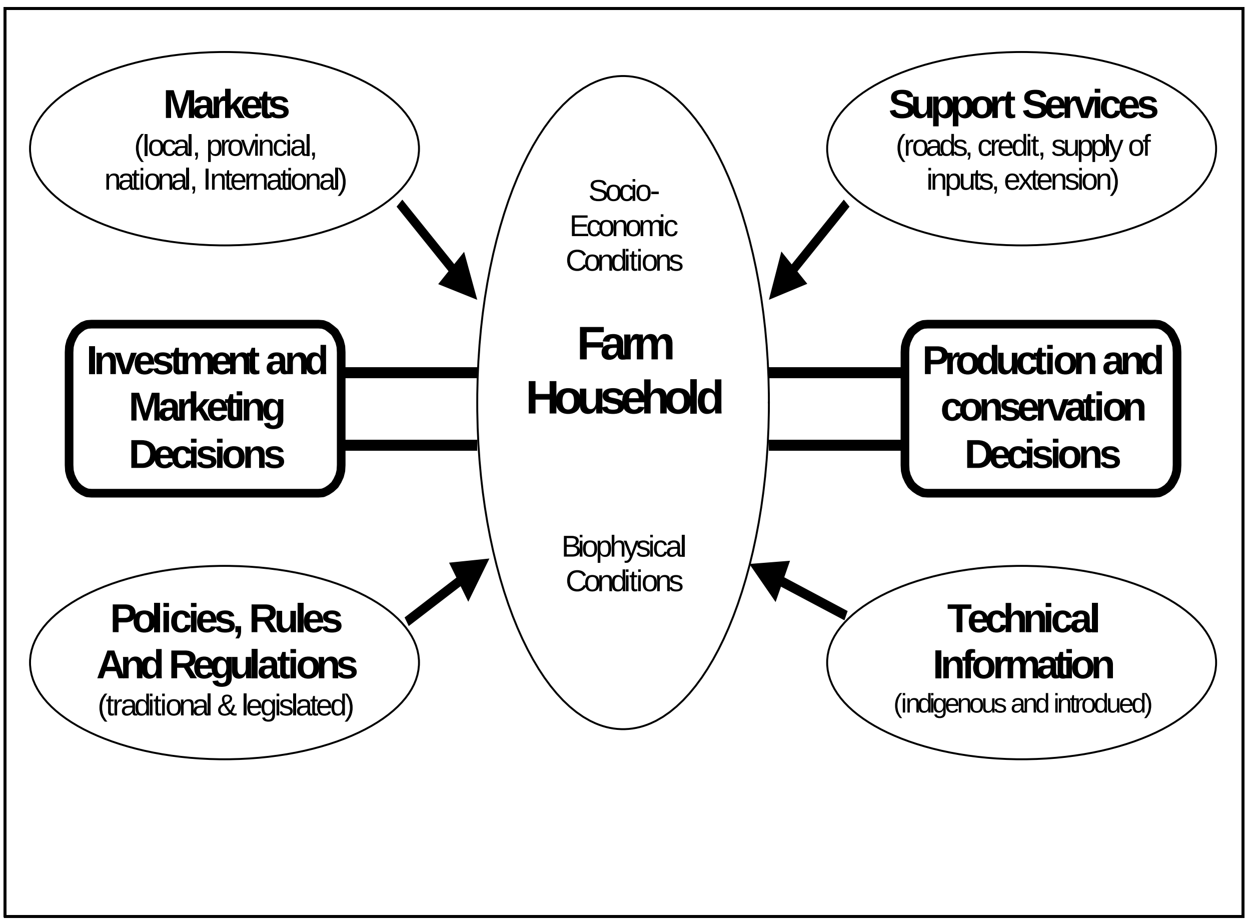

Fig. 1: Interaction between all factors influencing household decisions.

3.1. Framework for understanding farm-household-level decision making

Perhaps the most important factor that rural extension services have to consider while introducing new agricultural practices is the process of decision making at the farm household level. This is the level at which resource allocation decisions are made. “Farm management decision are made on the basis of the roles and responsibilities of the different farm household members.” These decisions are influenced by on-farm and off-farm factors. It should be pointed out that farmers do not use a linear decision making process. Rather, they consider many factors simultaneously. The framework presented above is a tool to help understand complex farm management systems so that appropriate extension and development strategies can be developed.

On-farm factors

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. Household composition and allocation of responsibilities to different family members is also important in making farm management decisions. The family's financial position influences the process of decision making: subsistence farmers tend to have less tolerance for risk. Biophysical factors also have direct influence on selection of a crop and are, for the most part, beyond the control of the farm family.

Off-farm factors

Farm families need outside information for making investment and marketing decisions. Farmers make rough budgets on paper or in their head before making a decision. Farmers seek market information from other farmers, middlemen, retailers, wholesalers, processors and manufacturers. Small-scale 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. Household decisions are also affected by policies, rules, and regulations that are enforced by the state and community. These may be either at the local or the national level. External support services such as credit, input suppliers, and extension are often needed to take advantage of market and production opportunities. Finally, access to reliable technical information is a significant factor in decision making.

Farm management decisions

Given these factors, farmers must make choices regarding management of the production process. Decisions related to management of perennial crops for fuelwood, for example, may be related to stabilization of 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.

3.2. Alternative extension approaches

It is apparent that in many development programmes, traditional extension is not stimulating development to a significant extent. This is serious because extension services are redundant if not tailored to the needs of farmers. Traditional top-down extension services are only suitable for a given period of development or under specific sets of conditions. This tends to be in the relatively early stages where government induced programmes are needed to meet national objectives such as food security or import substitution. Once a reasonable proportion of the rural community has moved from subsistence agriculture to a market-driven economy, then governments can gradually invest less in traditional extension. Under these conditions, governments can take up a greater role in encouraging industrial investment in rural areas and acting as a stimulator to commercial organizations and farmer groups. They may also need to act as a watch-dog to protect the rights of small-scale farmers and prevent undue exploitation by the powerful few.

Governments should encourage commercial and farmer organizations to deliver needed services when these mechanisms have a comparative advantage in responding to the evolving needs of farmers. Depending on the status of the farm household and the environment, extension approaches may be categorized into various systems as presented in Table 2.

Table 2: Overview of the distinct extension systems used in agroforestry extension wood

System	Methods	System can be used for	Risks
Top-down	! Instruction ! Guidelines ! Enforcement	! Communication of policies, rules and regulations ! Technical information	! Cost of system exceeds benefits ! Farmers do not listen
Participatory	! Farming System Research ! Participatory Rural Appraisal ! Diagnosis and Design ! Etc.	! Diagnosis of needs ! Group organization ! Planning	! Costs of external facilitators becomes prohibitive
Farmer to farmer	! Field schools ! Farmers exchange ! Demonstration	! Sharing farm management practices that work	! Geographic distance between farmers too large
Commercial	! Market information ! Farm management plans ! Investment feasibility	! Management of farm household resources ! Analyses of alternative farm investments	! Monopolies take over control of markets ! Poor farmers do not get equitable benefits

3.3. Case studies

Three case studies on extension with reference to fuelwood production were presented, two of them by NGOs, and one by a university.

Philippines

The Mag-uugmad foundation is active on the island of Cebu in the Philippines. This organization started on a small-scale in 1981 with 5 farmers on a soil and water conservation programme. At present, 1,500 farmers are involved in the programme. In the beginning only a few of the technologies offered were adopted by farmers, such as simple structural barriers to control erosion and hedgerows for woodfuel and fodder production. At this stage, farmers became more interested in soil fertility management. A farmer-based extension system was designed to help farmers identify their own constraints and help them overcome these problems. Components of the programme like hedgerows and cover crops could immediately address farmer problems such as shortage of fuelwood and fodder. The extension system uses five tools:

- *Model Farm Development*
- *Alayon Formation*, a traditional form of cooperation in the village, wherein farmers group themselves and work on each others farms on a rotation basis.
- *Participatory Farm Planning*, a process wherein groups of farmers help each other in preparing their farm plans based on the farm household economy.
- *Small-scale Experimentation* conducted by farmer-extensionists.
- *Training and cross visits* for farmers from distant villages.

For many years, commercial demand for fuelwood and charcoal in urban areas in Cebu has provided the necessary incentive for farmers to grow trees and shrubs around the agricultural landscape and thereby improve their land-use practices. In most of the Mag-uugmad sites *Gliricidia sepium, Leucenia leucocephala* and *Cassia sinea* have been planted in small woodlots and plantations or as part of agroforestry systems.

Widespread misperceptions in official circles about how woodfuel producing trees are grown and harvested has led to punitive regulations on the woodfuel trade. Such measures undermine participation in tree planting programmes, eliminate an affordable source of cooking fuel for the urban poor, and deny thousands of rural households the opportunity to earn income through planting and harvesting trees and shrubs on their own lands.

The Mag-uugmad foundation has been successful in implementing soil conservation practices and developing the sustainable production of fuelwood. The organization of *alayons* has helped the farmers to overcome implementation problems. Accumulation of economic gains from farm production and the sustained practice of *alayon* has narrowed the income gaps among farmers, and has facilitated political empowerment.

China P.R.

The case study from China was an example of top-down extension and planning for woodfuel production.

The fuelwood problem has attracted the attention of governmental agencies and research institutions as well as farmers. Fuelwood plantations have been encouraged. It is estimated that 6.6 million cubic meters of fuelwood are produced in the province of Yunnan, meeting 28% of total demand.

Woodfuel production by farmers is mostly practiced in two systems:

- Tree planting around houses: Farmers grow trees around their houses or in upland areas as hedgerows. Three or four years after planting, they cut the tree to a height of about 1.5 meters. Then the stake sprouts vigorously and branches are pruned every year for 20 to 40 years. Local people call the tree (*Cassia siamensis*) the “thousand knife tree” as it can be cut many times.

- Taungya model in fuelwood production: In Southwestern Yunnan *Alnus nepalensis* is planted with upland rice. In this system, the tree and rice are cultivated together for the first 2 to 3 years. Then the trees are managed as a fuelwood plantation. Around 8 to 10 years later, the tree is harvested as timber or fuelwood.

Despite these popular production systems, there is still not enough fuelwood produced to meet the demand. Reasons for this can be found in:

- Tradition and habits: Farmers in most areas of Yunnan rarely grow trees for fuelwood as they collect fuelwood in forests or elsewhere.

- Land tenure: In China, land is state owned. Agricultural lands are allocated to a farmer for a certain period according to the number of family members. This system makes it unattractive for farmers to make long-term investments like planting trees.

- Forest policies: Logging is strictly controlled in China. This policy can cause problems if improperly carried out. For instance, in many areas, farmers are forced to cut trees they have planted within their homesteads. In some cases they even have to pay for the logging.

- Technological problems: Production of trees on farmers’ land is perceived as competition for food production rather than supplementary income generation.

- Agroforestry extension problems: In China extension services for agriculture and forestry are separated. The result is that the concept of agroforestry is difficult to spread.

The following guidelines for agroforestry approaches in solving fuelwood problems were suggested:

- Stress the importance of agroforestry techniques among governmental officers and extension workers. Agroforestry curricula can be developed in agricultural and forestry institutions. Training courses and workshops are also valuable.
- Conduct agroforestry demonstrations in fuelwood production.
- Conduct research in fuelwood production. Attention should be given to research on integrating fuelwood production with farmers' agricultural activities on sloping lands.

Indonesia

The case study from Indonesia also described a participatory approach to integrated rural development. The site is situated in a mountainous area of Central Java, with altitudes between 600 and 1,500 meters. The average rainfall is 2,700 mm, the soil is of average quality, and there are many rocks. Land under perennial vegetation is being transformed into annual crop production areas. This is one of the reasons explaining a rising shortage of fodder for livestock. Other reasons include: a plague of jumping lice attacking *Leucenia leucocephala*, the main multi-purpose tree grown in the area; and inadequate management of marginal lands. Related to these reasons, a fuelwood shortage has arisen resulting in fuelwood prices that are higher than for kerosine.

The objectives of the Integrated Rural Development project are:

- To integrate perennial fodder crops and/or multi-purpose trees with other agricultural activities, helping to ensure and sustain local interest
- To increase general productivity and income
- Develop sustainable upland management methods

Participatory approaches such as PRA are used among farmers to design agroforestry techniques. Farmers adopt new farming practices because they have had an input in developing these systems. Goal Oriented Project Planning (GOPP) methods are used to:

- Introduce *Lacuna pulverulenta* which is resistant to jumping lice
- Establish nurseries by farmers groups for perennial fodder crops and other multi-purpose trees
- Test and develop the use of alternative energy sources such as biogas
- Conduct training courses on soil and water conservation, regreening and production of perennial fodder crops.

3.4. Discussion

After the presentations, open forum discussions were held. One of the first concerns of the participants was that none of the case studies evaluated the role of women. In the case of Yunnan province in China, it appeared that there were 26 ethnic groups in the area, each with different gender roles. This would have required a different case study design and this was beyond the scope of this presentation. Chun Lai from APAN agreed that gender issues are important, especially in woodfuel production and utilization. To analyze gender roles, participatory extension approaches are important, as demonstrated in the different presentations. For further information he suggested making reference to the background papers in the training binder.

Participants were also interested in the relation between government and NGO programmes. In both Indonesia and the Philippines there is growing cooperation. It was observed that governments are providing only limited extension services on indigenous woodfuel production systems. This may be due to lack of a participatory approach or lack of awareness of traditional systems.

Fuelwood trees have the following dimensions in my country

4. WOODFUEL PRODUCTION AND UTILIZATION

The session on woodfuel production and utilization consisted of three presentations. These included: species selection; productivity of fuelwood in agroforestry systems; technical background on woodfuel characteristics and small-scale utilization of woodfuel. Presentations were give by Michael Jensen (FAO/RAPA, Thailand), Tjutju Nurhayati (FPSERDC, Indonesia) and Jenifer McAvoy (ARECOP, Indonesia).

4.1. Production

Species selection for woodfuel production in agroforestry systems depends, to a large extent, on the local situation with regard to climate, soils, production and management priorities and capabilities, size of landholding, interaction with other crops, and the quality of fuelwood demanded by the market. It is difficult to recommend specific species for universal application, but some general criteria for selection are as follows:

- Adaptability to local environment (climate, soils, pests); local species are preferred over exotics.
- High wood productivity and high branchwood productivity allows for continuous pruning.
- Multi-purpose, i.e. have other useful outputs.
- Produce thornless wood in small diameter size that is easy to cut and transport.
- High pruning, coppicing, or pollarding tolerance.
- Compatibility with other farm crops.
- Good burning properties: low moisture; ash and sulphur content; high density; and no sparks.
- Easy propagation and management; including seed availability and farmer-“friendly” technology requirements.
- If intended for sale, the preferences of end users should be taken into account.
- Any other preferences expressed by farmers.

The level of woodfuel production in different agroforestry systems varies, depending on species and system used, and farmers' production priorities. Considering the statistics on agricultural products, precise data on woodfuel production are surprisingly scarce. This situation is mainly caused by the fact that woodfuels are most often collected for home use and less often purchased or sold. When woodfuel is traded, it is usually only on a small-scale and does not enter official statistics.

In Appendix 5c. the wood productivity reported from a number of agroforestry systems is presented. Most data are from experimental plots and should be viewed more as potential rather than actual production figures from existing farming situations. As far as possible, both fuelwood and total wood production is presented in order to give a more reasonable basis for comparison among systems. It should be stressed that, in most agroforestry systems, emphasis is not only on producing fuelwood but also supplying fodder, grains, tubers, vegetables, various animal products, etc. It is likely that if farmers focus more on woodfuel production, higher woodfuel output could be achieved. Similarly, if a farmers' preference is for fodder or other products, his management practices will differ and woodfuel productivity will be lower than indicated.

As for the calorific value of fuelwood species, a lot depends on the physical and chemical characteristics of the wood. Wood with a high moisture content will use part of its energy to evaporate the moisture. This energy will not be released as heat, resulting in low heat output. Wood with a high resin content, on the other hand, will have a high calorific value. Also the lignin content of the wood is an indicator of calorific value. Hardwood generally has a relatively high resin content. The lignin content is species-specific, but is generally high in coniferous wood.

4.2. Utilization

Conversion of fuelwood into charcoal is called *pyrolysis*, a process which takes place when the oxygen flow is controlled. In this process gasses (non calorific and calorific) and tar are released, leaving the main product, charcoal. Depending on the level of technology, temperatures for production can vary between 500 and 1,000°C. Charcoal produced at temperatures higher than 700°C is called white or active charcoal, and is of a higher commercial value. Most charcoal produced in rural areas is of lower value, and is called black charcoal. Fuelwood generally has a low heating value per ton compared with other energy sources. This makes transportation costs per unit of energy relatively high. Charcoal has approximately 45% higher heating value per ton, resulting in a significant reduction of transportation costs per Joule.

In Indonesia woodfuel is extensively used in small-scale industries. These include: brick and roof tile industry; limestone industry; and post harvest processing of agricultural products such as palm sugar and cacao. A large portion (60–70%) of the rural community also uses woodfuels for cooking, at a rate of 0.75 m^3 per capita per year. The introduction of improved cookstoves could result in a spectacular saving of woodfuel at the national level. Scattered data indicate that many biomass users are forced to be self-sufficient in terms of their fuel needs due to lack of access to forests.

Because securing biomass for fuel is largely the domain of women, fuelwood scarcity has major implications for the roles of women in rural communities who, faced with increasingly degraded natural environments, have to allocate increasing time and energy for collection of fuel. As woodfuel collection becomes too time consuming, farmers also use more and more agricultural residue as fuel instead of returning it to the soil as natural fertilizer. Obviously, this is not a sustainable practice.

Implementation of improved woodstove programmes do not stop in the laboratory, since even the most technically sound and energy efficient stoves will not be successfully adopted by users if they do not suit their customs and cooking habits.

Some considerations in designing improved biomass stoves are:

- Type of fuel to be used (stemwood, branches, charcoal, agricultural residues, dung, waste briquettes, etc.)
- Function of the stove (cooking/space heating)
- Function of smoke in the kitchen (Preserving roof, drying of crops)
- Cost of construction materials and local now-how in working with these materials
- Presence and layout of the kitchen, portable/fixed stove

- Traditional cooking habits and desire to improve these
- The setting: rural, semi-urban or urban
- Capacity for dissemination, production and installation

In regions where logging and plywood are major industries, sawdust waste disposal is often unregulated and contributes to pollution. In fact, sawdust has vast economic potential if manufactured into briquettes. Stopping dumping could eliminate environmental deterioration of rivers where sawdust is most often disposed. There is a great potential for woodfuel production using waste from various wood industries and felling. The development of charcoal and waste briquettes has high potential for local income generation and for stimulating rural employment as a part of national economic development. The introduction of alternative energy sources to the marketplace moves the population up the “energy ladder”, from wood to charcoal so that coal, kerosene or gas do not have to be the only alternatives. The energy ladder illustrates a process that takes place when populations shift income levels, or when kerosene or gas fuel becomes more widely available. Those that utilize biomass tend to take advantage of other forms of fuel that are more convenient as their incomes rise.

4.3. Discussion

In open forum discussions, the first question was related to Indonesia's programme to introduce gasifiers for rice hull utilization in villages. This programme did not succeed because villagers could not provide the required continuous supply of rice hull throughout the year. Gas generators were also too expensive to install.

It was pointed out that drift wood and waste wood from construction had not been included. These appear to be a source of fuelwood that is difficult to find reliable data on.

The smoke problem with traditional woodstoves was also addressed. In China many rural people suffer from eye diseases due to this. This effect is more pronounced in mountainous regions since woodstoves are also used for space heating. The problem is that in-house smoke traditionally has useful functions such as higher heat release, roof conservation, crop drying and pest control. To change these habits is difficult. In each case balance must be found between health factors and utilization factors. This is one of the reasons that dissemination of improved cookstoves is difficult in some areas. One way to minimize these problems is to let local artisans produce the improved cookstoves, to meet local needs.

One participant noticed that the calorific value of charcoal is only slightly less than the value of coal. The question was raised whether charcoal could be an alternative for fuelwood. Various resource persons pointed out that production of charcoal is very energy consuming. Direct burning of raw material is still the most efficient way to use fuelwood. Besides, calorific value is not a good indicator for use. The preference of the user is more important for selection of the type of fuel. For these reasons, RWEDP focusses mainly on direct burning of wood as an energy source, although charcoal can be very useful when it comes to utilization of wastewood and adding value for special markets such as barbecuing.

5. WOODFUEL PLANNING AND MARKETING IN INDONESIA

Although this was a regional training workshop, emphasis was given to woodfuel energy aspects in Indonesia to make the field exercise more relevant. Presentations were made by Maritje Hutapea, from the Indonesian Energy Department and A. Ng. Gintings, from the Agency for Forestry Research and Development, Indonesia.

5.1. Presentation

The energy policy of the Indonesian Department of Energy aims at :

- Ensuring the supply of domestic energy
- Improving the efficiency of oilfuel
- Developing non-oil energy resources
- Stimulating the utilization of renewable energy sources.

The main goal is to maintain self sufficiency in energy until the year 2019. Strategies to reach this goal are:

- *Intensification.* Increasing and expanding explorations of energy resources available in Indonesia, both conventional (including oil and gas) and otherwise.
- *Diversification.* Developing and using non-oil energy resources to reduce dependence on fossil fuels in the overall energy consumption.
- *Conservation.* Economizing energy use by using energy efficiently and wisely through public campaigns and educational programmes. Wasteful energy use is to be identified and regulations formulated to control it.

Consumption of biomass energy in Indonesia is rising every year. Surveys conducted in 1980, 1986 and 1990 indicate increased woodfuel consumption from 0.63 to 0.75 and 0.86 m^3 per capita per year respectively. These fuels are derived mostly from home gardens (64%, according to the Energy Department). The remainder is derived from forests or other sources such as waste wood. The Energy Department of Indonesia is developing a programme of rural energy planning as well as developing projects to introduce and commercialize biomass energy systems and equipment. This is done by means of demonstration projects for gasification (thermal or biological), dendrothermal electricity plants, and woodstoves.

The Regional Energy Planning Project is surveying local energy use to obtain:

- A computerized regional database
- Energy demand tables per district
- Energy supply/demand balance per province
- Financial and economic models for analyzing the financial feasibility of energy projects
- Projection of future energy demands.

Sixty percent of the Indonesian population of 193 million is rural. Woodfuel is the most important energy source for households and traditional industries in the countryside. In the years coming, woodfuel consumption is predicted to increase more rapidly then production (Table 3). According to a survey done in 1969 by the Forest Product Research Institute in Solo, woodfuel consumption was 0.74 m^3/capita/year. In 1977 the consumption of woodfuel in East Java and Bogor was around 0.76–0.81 and 0.53 m^3/capita/year respectively. Consump-tion of charcoal is included in these figures. Woodfuel usage by industry, such as brick, roof tile, and lime, is projected to grow 3% per annum over the next ten years.

Table 3: Projected fuelwood demand in million m^3

		1995	2000
Java	household	58.0	58.0
	industry	13.0	15.1
	sub-total	71.0	73.1
Outer islands	household	52.5	56.8
	industry	3.9	4.5
	sub-total	56.4	61.3
Indonesia	household	110.5	114.8
	industry	16.9	19.6
	Total	**127.4**	**134.4**

Source: Forestry studies 1990, quoted by Gintings, in: Woodfuel marketing in Indonesia.

As mentioned earlier, Perum Perhutani, the State Forest Enterprise, is the largest manager of production forests on Java. It is also the largest single supplier of fuelwood. In West Java alone it sold approximately 100,000 SM[1] per year. The fuelwood is sold by auction, and sometimes by direct sale. In all cases, the wood is sold in piles beside accessible roads. Minimum prices are set by Perum Perhutani headquarters in Jakarta (Table 4).

Table 4: The price of fuelwood in West Java in 1995 (Rupiah, 1 US$ ≈ 2,230 Rp.)

Species	**Diameter 2-4 Cm.**	**Diameter 5-8 Cm.**	**Diameter 9-15 Cm.**	**Root and Stump after cutting**
Teak, length ½ M	-	26,000	32,000	-
Teak, length 1 M	15,000			
Non teak hardwood: length 1 M	7,600	14,000	14,700	14,700
Non teak soft wood, length 1 M	6,300	11,900	13,200	13,200

[1] SM= Stapel Meter, Stère, a pile of stemwood of 1X1X1 meter, which comes to about 0.65-0.70 M³ solid wood

5.2. Discussion

During discussions it became clear that data on production and use of fuelwood were inconsistent. This is partly because of the low interest in fuelwood among national forestry and energy departments. It is also because of the small-scale use of fuelwood, and its easy replacement by other fuels. If, for instance, a meal is cooked once a week on agro residues or other waste, the use of fuelwood will be reduced by 15%. It is important that figures become more accurate because calculations based on the existing data, will have a high degree of error and these results are used in formulating national policies.

6. FIELD EXERCISE

6.1. The framework

Prior to the field exercise a framework (see table 5) was presented by Chun Lai for collecting field data. Examples of how this was used in a training course in China were also presented. The framework helped focus the process of inquiry and assist in synthesising the findings. After discussion with the participants, the framework was modified to include human resources. Participants were divided into three groups with representatives from each country in each group. They were given specific tasks to look for in the field. These were: Production and Utilization; Marketing; and Extension, Support Services and Human Resources. Each group worked out issues to tackle in the field.

Table 5: Framework for collecting field data

	Production and utilization	**Marketing**	**Extension and support services**	**Human resources***
Current situation				
Possible constraints				
Possible solutions				

**Included after the first discussion*

6.2. The field sites

In the two day excursion, several aspects of woodfuel production and utilization were highlighted. Sites and persons visited were related to utilization of fuelwood, conversion into woodfuel, fuelwood trade, and fuelwood production from forest plantations. Of course this picture is not complete but it was the best that could be done in two days given the heavy West Java traffic.

Limestone factory

The first stop was Surya Jaya limestone factory in Rajamandala. This factory consumes 40 SM of fuelwood every 24 hours in a continuous process. The price of fuelwood delivered to the factory is Rp. 9,000-10,000 per SM. The fuelwood consists of different species, mostly knotty stemwood,and is delivered by middlemen. The owner of the factory was not concerned about the source of the fuelwood, whether derived from farmers' lands or illegal cutting.

Ready for the market

The factory itself mines raw limestone material from the surrounding mountains. No data regarding cost and quantity were available. Every six hours the limestone kiln is emptied. Production is 8 tons of burned stone per day. The factory provides work for approximately 20 persons.

State forest plantation

Later, the group was welcomed at a State Forest Enterprise production area in Indramayu district. This area consists of 33,200 ha of which more than 20,000 ha[2] is devoted to the production of *Tectona grandis* and *Acacia mangium*. The latter species was recently introduced since teak production is very low on the poor soil and rainfall is limited to 1,000 mm/year. Most of the *Acacia mangium* wood is sold as firewood, but there is a growing market for construction wood. The plantation provides 8,470 m^3 of fuelwood per year from *Acacia mangium* and *Tectona grandis*. This is from 180 ha clear cut and 629 ha thinning. This production does not satisfy local demand so farmers have an opportunity to sell their firewood to small-scale industries as well.

Roof tile factory

The third site the group visited was Subur Jaya roof tile factory, a short distance from the State Forest Enterprise. This small industry had three ovens, each with a capacity of 10,000 tiles. Each production cycle used 10-11 SM of fuelwood. There were also two middlemen present who collected fuelwood from farmers. The factory bought 80% of its fuelwood from Perum Perhutani and 20%

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[2] Data according to Perum Perhutani

from these middlemen. The price they paid to Perum Perhutani was 20% higher than the price paid for farmers' wood. The reason for this difference is that the quality of wood from the plantations is consistent (all of it is *Acacia mangium* wood and in the same diameter class) where as the farmers' wood is irregular sized, and consists of various species. The State Forest Enterprise can provide wood throughout the year with some problems during the rain season, while the farmer's supply is seasonal, with abundant supply during the rainy season. Alternative fuels for the factory, such as diesel oil, would give better quality roof tiles but, according to the owner of the factory, the price difference of the fuel made it economically not feasible.

Drying wood in sawmill

The first site visited on the second day was a medium scale sawmill, providing employment for 105 people. This sawmill makes pallets of *Pinus mercusii* and occasionally rubber wood; the wood waste is used for drying lumber in ovens with a fairly high combustion efficiency. The residue is burnt in a stove at the back of the oven and the hot smoke is led through pipes within the oven. Air circulation in the closed oven is forced with fans, turning the airflow every 3 hours. Vapor can escape from valves in the roof. These are opened by the operator. The frequency of opening depends on the insight of the operator. Depending on the thickness of the wood, the drying period of the wood varies between 6 to 15 days. The sawmill produces more residue than the ovens consume. Left-overs are sold for $^{2}/_{3}$ of the price paid for *Acacia mangium* firewood that is used in the roof tile factory visited the day before. The sawdust is sold to a factory which produces briquettes from it.

Fuelwood middlemen

The three middlemen met with the participants at lunchtime and provided useful data regarding fuelwood production and marketing by farmers. West Java farmers, with an average farm size of 0.25 ha, cannot provide the amount of fuelwood required by industry. The middleman inquires about the availability of fuelwood among farmers. When he estimates he can collect a 30 m^3 volume truckload of wood, he rents a truck and starts collection. The farmer is paid Rp 13,000 (± US$ 6) per SM. Occasional labor for transport of the wood to the road is paid in fuelwood. Fuelwood is sold as standing trees, cutting is organized by the middle men. Since conflicting regulations exist regarding transport of wood, official permission has to be obtained and some extra payments have to be made at all control posts the truck passes. At the factory a selling price of Rp 22,500 (± US$ 10) per SM is claimed. This is $^{1}/_{3}$ higher than the price the roof tile factory paid for its farmers' wood.

Charcoal from sawdust industry

In the afternoon a large factory was visited where sawdust was being processed into charcoal briquettes. The factory needed a daily supply of 280 tons of sawdust, an amount that is difficult to collect. For this reason, the factory was not working at full capacity. Sawdust was collected from 48 sawmills in the region. The sawdust was heated, dried and pressed into briquettes. These briquettes were then converted into charcoal in kilns. Approximately 95% of the production was exported to South Korea and Taiwan.

Forestry Research Institute

Later in the afternoon the group visited the Forest Product Research Centre of the Ministry of Forestry. Here small-scale sawdust briquetting was demonstrated. In this case, the sawdust was transformed into charcoal. Then the powder had to be mixed with a binder prior to briquetting. The briquettes were pressed with a small template, producing 12 briquettes at a time. Apart from that a wood gasifier was demonstrated, as well as some small kilns for the production of charcoal. Prior to the field trip, the Forest Product Research Center organized a demonstration of improved woodstoves and other utilization of woodfuels at BLPP.

6.3. The synthesis process

Participants organized themselves in the three thematic groups mentioned in 6.1 to synthesize their field observations. Discussions were held for two hours to fill in the framework they developed before the field trip. The use of the framework was meant to give some directions for asking questions at the site so that the short time spent at each site would be as productive as possible. Summaries of the frameworks completed by each group are presented in tables 6, 7 and 8.

Table 6: Synthesis of the Production and Utilization Working Group's Observations

Current situation	Possible constraints	Possible solutions
Woodfuel delivered by middle man	Lower price for farmer	Transparent market, good market information
Woodfuel is always available	Some constraints with transport during rainy season	Prepare a stock for rainy periods
Production of teak and acacia by government	• Lack of market control of price • Lack of manpower to prevent illegal logging	• Stimulate bigger share for farmers • Higher wages to in-crease motivation
Middle man buys from farmer, sells to industry	• Difficult to collect during rainy season • Inadequate government regulations • Lack of capital	• Better transport vehicles • Improve policy and government regulations • Improve agroforestry extension services

Table 7: Synthesis of the Marketing Working Group's Observations

Current situation	Possible constraints	Possible solutions
Wood comes from middle man which give farmers the opportunity to supply wood to industries and guarantee continuous supply	Increased price while involving more people	Farmers cooperatives; sources closer to users
Lots of teak wood as fuelwood	• Need a cutting permit • Difficult for farmers due to permits	Simplify government regulations
Continuous supply	• Problems during rainy season • Fuelwood species change in course of the season	-
Market prices	Fluctuation of prices due to supply/demand	Government to regulate involvement of middlemen to stabilize prices

Table 8: Synthesis of the Extension, Support Services and Human Resources Working Group's Observations

Current situation	Possible constraints	Possible solutions
Village chief issues wood transport permit	Increased cost for middlemen	Review and develop rules and regulations affecting (in-) formal trade
No adequate information available on e.g. management of *Acacia mangium*	No proper decisions can be made	Improve information available to extension workers and farmers
Forest department and farmers sell their fuelwood to small scale industry	Farmers do not deliver a consistent quality	Increase awareness among farmers regarding quality needs of industry

Synthesizing the woodfuel situation

7. DISCUSSIONS OF NATIONAL LEVEL ISSUES

7.1. Filling in a framework to explain national woodfuel situations

The framework was also found to be a useful tool to evaluate aspects of woodfuel production by farmers at a national level. Participant groups were broken into national discussion groups to fill in a framework based on their national circumstances. Before the group work started it was stressed that the earlier working groups were industry biased, now the focus should be on the farmers' points of interests in woodfuel production. Specifically, this included:

Woodfuel production: how do farmers contribute to woodfuel production?
- by whom in the family and in what form?
- woodfuel: main product or by-product?
- types of woodfuel production?

Woodfuel utilization: can farmers respond to and fulfill the woodfuel demand?
- who is using woodfuel?
- what are the demands regarding quality and quantity of woodfuel?
- are there improved technologies for woodfuel utilization?

Marketing and extension: can farmers make significant profit by growing woodfuel?
- levels of (wood)fuel price
- government incentives and disincentives
- cost of transport

By identifying problems and opportunities in their own countries, the foundations were laid for the design and/or identification of national training courses or workshops.

The conclusion of this exercise was that, in most countries except Myanmar, fuelwood is produced and used by rural people. Almost every country, except Malaysia, is suffering fuelwood supply shortages. Many possible solutions were discussed, mainly in the field of improving woodfuel production under agroforestry systems; improving extension work, which is generally focussed on raising food crop production; and streamlining government regulations with regard to tenure of trees, production incentives and transportation restrictions. Many participants felt that the low educational level of farmers was a constraint. Another important conclusion was that many farmers cannot meet production targets required for commercial woodfuel needs. A possible solution for this was the development of farmers' cooperatives for woodfuel production. As an illustration, a part of the framework developed by the participants from the Philippines is included in table 9.

Table 9: Part of the framework prepared by the participants from the Philippines.

	Extension and Support Services	**Marketing**
Current situation	• DENR is the only government agency providing technical, financial and material support to farmers	• Middlemen are central in market chain: consumer price of fuelwood is 300% of price paid to farmers
Constraints	• Inadequate government programme on fuelwood production • Lack of involvement of other agencies	• Price controlled by middlemen • Inadequate supply of fuelwood
Recommendations	• Enhance government programme • Inter-agency cooperation	• Form cooperatives of woodfuel producers • Provide tax incentives to farmers
Opportunities / potentials	• Better services for the farmers • increase production • Better standard of living	• Increasing price of fuelwood for farmers

7.2. Proposals for national training workshops

The last day of the training workshop was dedicated to the preparation of draft proposals for workshops at the national level for the eight participating countries, addressing some of the problems indicated during the previous days. Tara Bhattarai started the session by explaining the objectives of RWEDP and strategies to reach these objectives. Many of the activities of RWEDP focus on organization of a total of 72 training activities. To avoid overlap between these different training activities, organizers were requested not to deviate from the objectives RWEDP sets for distinct exercises. The project is already on target for training in 1995 so participants were asked not to make any plans for training this year but to postpone them to 1996. Since most participating countries also had a set budget for 1995, it was felt to be better this way.

Participants were given guidelines to structure their proposals. After the two hours session they came up with the following draft proposals:

Training of extensionists in fuelwood plantation technologies in tropical China

Justification

Tropical regions in China are suffering from a serious shortage of fuelwood. Fuelwood production is mainly through large-scale afforestation programmes. Through more than 10 years of research on fuelwood plantation management, advanced technologies have been developed. The proposed training workshop is to improve knowledge and skills of trainees who are involved in disseminating these technologies to farmers in this region.

Objectives

- To improve the knowledge and skills of extensionists on fuelwood plantation technologies.
- To identify needs for improvement of training programmes in fuelwood plantation management.
- To identify ways to integrate fuelwood production in large-scale afforestation programmes.

Criteria of Success

- The selected extensionists attend the training.
- Improvements in training programmes for farmers are identified.
- Various ways to integrate fuelwood production into afforestation programmes are identified.

Work Plan

Activity	Time and duration	Place	Participants
Training for extensionists from the five tropical provinces in China.	October, 1996. 5-7 days	Research Institute of Tropical Forestry (RITF) in Guangzhou, China	About 30 exten-sionists (6 per province)

Inputs Required

- Internal resources available:
    - Resource people from the RITF, and the Dept. of Forestry College in Kunming, Yunan Province. The RITF has a well equipped training center.

- External support required:
    - US $ 8,300 or 60,500 CNY to cover meals, accommodation, travel expenses for participants. (FAO/RWEDP)

Expected Outputs and Applications

Development of means for integrating fuelwood production in afforestation programmes. Technologies learned from this workshop will be disseminated by extensionists.

Indonesian national training workshop on integrating woodfuel production

Justification

In Indonesia, woodfuel still has an important role in fulfilling the country's energy needs, particularly in rural areas. Some consumers get woodfuel directly from their private land, forests, etc. while others have to buy their woodfuel. However, the main problem is that the woodfuel marketing system is not efficient. Beside marketing problems, the sustainability of woodfuel production should also be considered for the long term.

Objectives

- To train extension workers, NGOs, and farmer cadres to improve woodfuel marketing and to achieve sustainable production

Criteria of Success

- Pre- and Post-evaluation of participants' knowledge
- Participants' responses and their willingness to adopt new practices

Work Plan

Activity	Time and duration	Place	Participants
National training workshop on integrating woodfuel production for upland regions.	September 1996 3-7 days	Bogor/ Solo	Around 30 participants (extension workers, NGOs, farmer cadres, etc.)

Input Required

- Internal resources available:
  - Resource Persons
  - Training Facilities

- External support required:
  - Resource Persons
  - Financial Assistance=US$ 10,000

Expected Outputs

- The trainees are able to implement the knowledge gained from the training
- Establishment of a network among participants

Training workshop in Lao P.D.R for wood energy

Justification

The National Agroforestry Working Group was established in Lao PDR in 1994. But until now, no training related to wood energy has been conducted in the country. Because consumption of woodfuel has started to increase, we need to establish a wood energy group.

Objectives

- Review the national use of woodfuel in Lao PDR
- Find new technologies for wood fuel production and utilization

Work Plan

Activity	Time and duration	Place	Participants
Two wood energy training courses	July and August 1996	North and South	2 x 20 persons

Inputs required

- Internal resources available:
  - Resource persons
  - Training aids

- External support required:
  - Resource persons
  - Training materials
  - Financial US$ 5,000(RWEDP)

Expected outputs

- Improved skills for wood energy development in the future
- Ability to manage wood energy

Malaysian training workshop on environmentally sound and economic production of energy from wood residues and non-industrial plantations

There is an abundant supply of wood residues in Malaysia. These are usually far away from industrial and urban areas where energy demand is high. In recent years, the burning of wood residues in the open has been discouraged because of environmental concerns. Converting residues into charcoal briquettes as a source of clean and efficient energy is seen as a solution to the current disposal problem. Therefore, future biomass conversion technologies must be energy efficient, environmentally sound and economically viable. These should become an integral part of agroforestry extension programmes.

Objectives

- To develop efficient, reliable and cost-effective conversion technologies for unused bio-mass residues.
- To demonstrate the application of developed technologies to industries and to promote adoption of these technologies.

Criteria of Success

- Participants from wood and agricultural industries, research institutes, universities and other organizations are involved in wood-waste utilization.
- Shared experience and ideas among participants on how to improve the available techno-logies.

Work Plan

Activity	Time and duration	Place	Participants
Training on environmentally sound and economic production of energy.	1996 7 days	Forest Research Institute of Malaysia (FRIM) with field trips to industrial sites.	About 30 participants from wood industries and other related agencies.

Inputs required

- Internal resources available:
  - Resource people
  - Malaysian Government (through FRIM): Manpower to conduct the training workshop.

- External resources needed:
  - Financial assistance: US$ 15,000 to cover meals, travel expenses and accommoda-tion for participants, training materials (books, leaflets, etc.)

Expected outputs

- Wood residues will be better utilized.
- Environmental problems will be reduced.

Training workshop on alternative fuelwood substitution in Myanmar

Justification

In Myanmar, 1995 is *the Fuelwood Substitute Year.* Fuelwood substitution is an important operation going on in the country. A steering committee and working committee have been formed. Also a science and technology development law has been enforced.

Government organizations and private organizations (NGOs) are involved in research and development of fuelwood substitution.

Objectives

- To reduce deforestation in crisis areas.
- To improve environmental protection/preservation awareness.
- To share experience, ideas and technology.

Criteria of Success

- Enhanced research and development activities.
- Accelerated fuelwood substitution in the country.

Work Plan

Activity	Time	Place	Participants
Workshop to promote research and development activities.	Jan/Feb 1996 7 days	Forest Research Institute, Yezin, Myanmar with field trip.	About 15 participants from Myanmar (from GO & NGOs) and 15 from South-east Asia countries.

Inputs required

- Internal resources available:
  - Resource persons
  - Training facilities
  - Accommodation and transport facilities

- External support needed:
  - Resource persons
  - Training materials
  - Financial assistance of US$ 30,000 (RWEDP)

Expected outputs

- More efficient and effective programmes and activities
- Improved utilization of woodfuel.

Training workshop on integrating woodfuel production in to agroforestry programmes in the Philippines

Rationale

The Department of Energy (DOE), in cooperation with relevant institutions, particularly the Forest Management Bureau, is now paying serious attention to wood energy development in the country. In line with this, DOE, FMB and other agencies/institutions with wood energy mandates have realized that they need to develop their capabilities to address wood energy development.

A national seminar-workshop on Wood Energy Policies, Planning and Strategies was conducted in March 1995 in Cebu City. Technical and financial support was provided by FAO, particularly RWEDP. To fully understand wood energy systems including: production; utilization; distribution; marketing; and extension and support services, a national training workshop on integrating woodfuel production in the country is necessary.

The DOE, through its Non-Conventional Energy Division, in cooperation with its Affiliated NonCon Center, USC in Cebu, and FMB, is organizing a “National Training Workshop on Integrating Woodfuel Production into Agroforestry Programmes.”

Target Participants

The target participants of this training are people involved in activities related to the production, processing, marketing and utilization of woodfuels. These include:

- Staff of relevant units with experience in forestry, agriculture and wood energy development.
- People involved in implementation of agroforestry and wood energy programmes and projects from both the government and non-government organizations.

Objectives

- To update and deepen knowledge among relevant sectors on the current status, problems and potentials of wood energy production and utilization in the country.
- To network participants from governmental, non-governmental and private organizations who can contribute to woodfuel production in agroforestry programmes and community-based projects in the Philippines.
- To enhance the capacity to plan and implement integrated agroforestry programmes in government and non-government organizations. This will be done through the exchange of information and experiences on integrating woodfuel production, distribution and marketing within the framework of agroforestry programmes.

Workplan

Activity	Time and duration	Place	Participants
National Training Workshop	1996 (7 days)	Cebu City	35 participants from GOs, NGOs

Inputs required

- Internal resources:
  - US$ 3,000 (GOP)
- External resources:
  - US$ 15,995 (RWEDP)

Expected outputs

- Enhanced knowledge on status, problems and potentials of woodfuel production in the country.
- Network of participants from NGOs, GOs private organizations and community based projects on woodfuel/agroforestry integration.
- Implementation of a plan for integrating woodfuel production into agroforestry programmes.

Training on efficient woodfuel production and utilization in Thailand

Justification:

In the past several years, Thailand's economy has grown very fast. This has resulted in increasing energy demand. Traditional energy e.g. woodfuel, is being used at an increasing rate. Presently, many areas of the country are experiencing woodfuel shortages, especially the Northeast. Although LPG can be substituted, rural people still cannot afford the required investment. The government is now promoting community forest programmes for multi-purpose trees. Production and utilization of woodfuel, however, is still inefficient. Thus training on efficient woodfuel production and utilization is essential.

Objectives

- Raise awareness of village headmen on efficient woodfuel production and utilization.
- Disseminate information on efficient woodfuel production and utilization to rural communities.

Criteria of Success

- Application of efficient woodfuel production and utilization techniques among participants

Work Plan

Activity	Time and duration	Place	Participants
Training and study tour on efficient woodfuel production and utilization	February 1996 4 days	Mahasara-kham Province	about 30 village headmen

Inputs required

- Internal resources available:
  - Energy specialists
  - Forestry specialist
  - NGOs
- External support required:
  - RWEDP support of US$ 8,000

Expected outputs

Village headmen have good knowledge on efficient woodfuel production and utilization and disseminate this to the village or community.

Training workshop on woodfuel production, utilization and marketing, integrated with agro-forestry extension programmes in Vietnam

Until now, no training workshops on woodfuel production, utilization and marketing have been organized in Vietnam. Woodfuel currently meets 50-60% of all energy needs. Biomass for cooking dominates domestic energy use in Vietnam. Woodfuels are also used in small-scale industries and enterprises. Incorporating woody perennials into farming systems and/or improving AF systems are viable alternatives in Vietnam, especially in rural areas. An in-country training workshop is essential to network concerned participants, including provincial and regional officers, representatives of institutes, private companies, and ministries to share ideas on how to promote woodfuel production, utilization and marketing through agroforestry extension programmes. Participants will have two days for field activities, two days of report presentation and group discussion, one day of identifying problems/solutions and planning follow-up activities. The training location will be decided by NWFDWG, but preferably near the areas of woodfuel production, utilization and marketing.

Objectives

- Networking of concerned participants from GOs, NGOs and private organizations. Priorities are given to women participants, technical officers at the provincial and regional levels, representatives of institutes, private companies and ministries.
- Enhancing local capacity to plan and implement integrated AF extension and training programmes within RWEDP and APAN frameworks in Vietnam.
- Identifying and planning follow-up activities at provincial and local levels, within the scope of RWEDP.

Criteria of Success

- Pre- and post-training evaluation of participants shows enhanced knowledge.
- Enhanced woodfuel production, utilization and marketing among project target groups.

Work Plan

Activity	Time and duration	Place	Participants
Identify resource persons to prepare training materials, papers, case studies	Aug.-Oct. 95	To be decided	Chairman of NWFDWG
National training workshop on woodfuel production, utilization and marketing	Feb. 1996	To be identified	Chairman of NWFDWG

Inputs required

- Resource persons from FSIV, APAN, IE and other concerned GOs and NGOs to contribute reports and various case studies to be used as training materials.
- Funding for 30 participants, with a training duration of 5 days.
- RWEDP budget of US$ 4,500 will be used for: food, lodging and transportation costs for participants and resource persons. It is estimated that 2/3 of total participants will come from provincial organizations far away from the training venue.
- Honorarium for trainers, facilitators.
- Local contribution: training materials, compiling and printing of papers, planning and reporting.

Expected outputs

- Participants will be able to actively share their ideas and see different patterns of woodfuel production, utilization and marketing.
- Participants will be able to plan and implement woodfuel development programmes at the provincial and regional levels, and overcome constraints to woodfuel development in their localities.

8. EVALUATION AND CONCLUSIONS

8.1. Pre- and post-course skill assessment

In the application form that participants filled in before the training workshop, there was a section on skills. On a scale from 0 (none) to 5 (very much) participants rated themselves on the topics shown in box 3 below.

At the end of the training workshop participants were asked to fill in another form with the same questions. The data on both forms were compared. The results indicate an overall increase in skill of one full point. Participants felt they had made significant progress on marketing. (item 7) Skills related to how to do priority ranking (item 11) were also significantly higher. Minor progress was made on items 3, 9, 10 and 12. These topics were not directly addressed during the training workshop.

Box 3: Items for self-rating

Woodfuel production

1. Knowledge of indigenous fuelwood species
2. Knowledge of introduced fuelwood species
3. Knowledge of local energy consumption patterns
4. Assessing current energy situation and production capacity
5. Knowledge of integrating fuelwood species in agroforestry systems
6. Hands-on experiences with planning and implementing woodfuel production programme in the field
7. Assessing marketing opportunities and problems for woodfuel products

Agroforestry extension

8. Knowledge of diagnostic techniques such as FSR, AEA, D&D, RRA, PRA, etc.
9. Experience in working directly with farmers
10. Doing household and group interviews
11. Identification, diagnosis and priority ranking of problems and potential solutions
12. Gender role analysis
13. Preparing agroforestry extension materials
14. Assisting farmers with marketing activities in the field
15. Monitoring and evaluation of farmers activities: Production, processing, marketing and utilization

Training

16. Knowledge of design and implementation of training activities
17. Hands-on experiences in conducting training/workshop activities

8.2. Course evaluation form

Participants were also asked to fill in an evaluation form with questions on the pre–course information, training course structure, achievement of objectives, logistics and participant interaction. The pre–course information was generally perceived as acceptable, but some participants wanted a more detailed programme for their own preparation. It was suggested that this information be sent one week before the participants' departure. Many participants expected to learn more about participatory extension approaches. This goal was not met. The field trip travel time was too long and was biased towards woodfuel utilization rather than its production in agroforestry systems. There was not much interaction with farmers. The information prior to the field trip was considered inadequate. It was suggested that a field guide giving general data for the field sites should have been prepared because, during the field trip, much information was lost due to language barriers. This criticism of the field trip was compensated with the overall satisfaction with the organization and content of the training workshop. People felt that the time allocated for the workshop was too short but, despite that, the objectives of the course were achieved.

Evaluating the training workshop

8.3. Talking ball

In the last plenary session the course was evaluated with the “Talking Ball” methodology. A ball was thrown around the meeting room and whoever caught the ball had to comment on the training workshop. In this session all the general remarks contained in the evaluation form and mentioned above were repeated. Some remarks on the quality of food, the isolated situation, limited facilities and basic accommodations were overshadowed by the nice appearance of the venue. Logistics were good, as well as the organization. The informal atmosphere was well appreciated and there was good interaction between different nationalities and disciplines. In general, participants were satisfied with the training workshop and left with the feeling that they had learned many new things about woodfuel production, utilization and agroforestry extension work.

And more fuelwood usage

APPENDIX 1. PROGRAMME

First day, Monday 24 April

TIME	ACTIVITY	STAFF RESPONSIBLE
07.00-08.00	**Breakfast**	
08.00-09.00	Registration	Secretariat
09.00-10.00	Opening ceremony	
10.00-10.30	**Refreshments/Coffee**	
10.30-11.30	Introduction: • Participants' introduction and expectations • Training workshop objectives	Chun Lai
11.30-12.00	Training workshop structure: schedule, logistics, establishment of working groups and other suggestions	Chun Lai, Hans Beukeboom
12.00-13.30	**Lunch**	
Session 1	**RWEDP and APAN overviews**	Moderator: Rozaida Latip
13.30-14.30	Introduction to RWEDP and policy related issues and constraints in woodfuel production	Wim Hulscher
14.30-15.30	Integration of Wood Energy in Agroforestry Extension Programmes in South-East Asia	Tara N. Bhattarai
15.30-16.00	**Refreshments/Coffee**	
16.00-17.00	Woodfuel Production in Agroforestry Systems: Perspectives from the Asia-Pacific Agroforestry Network	Chun Lai, Ulla Blicher Mathiesen
17.00-17.15	Announcements	Hans Beukeboom
18.00-19.30	**Dinner**	

Second day, Tuesday 25 April, morning

TIME	ACTIVITY	STAFF RESPONSIBLE
07.00-08.00	**Breakfast**	
Session 2	**Participatory approaches to agroforestry extension**	Moderator: Jessie Elauria
08.00-08.30	Framework for Understanding Farm Household-Level Decision Making and Design of Agroforestry Extension Strategies	Jim French
08.30-08.50	Impact of Soil and Water Conservation in Woodfuel Production: The Mag-uugmad Experience	Nards Moneva
08.50-09.10	Agroforestry in Fuelwood Production in Yunnan	Zhu Yongliang
09.10-09.30	Field Activities of IRDP for Promotion of Perennial Fodder Crops in Boyolali, Central Java, Indonesia	Ibnu S Pranoto
09.30-10.00	Open forum	
10.00-10.30	**Refreshments/Coffee**	
Session 3	**Woodfuel production and utilization**	Moderator: P. Verapong
10.30-11.00	Species Selection and Woodfuel Production in Agroforestry Systems	Michael Jensen
11.00-11.30	Woodfuel Utilization in Indonesia	Tjutju Nurhayati
11.30-12.00	The Woodstove Component	Jennifer McAvoy
12.00-12.30	Open forum	

Second day, Tuesday 25 April, afternoon

TIME	ACTIVITY	STAFF RESPONSIBLE
12.30-14.00	**Lunch**	
Session 4	**Woodfuel planning and marketing in Indonesia**	Moderator: Khin Maung Oo
14.00-14.30	Role of Woodfuel in National Energy Consumption	Nenny Sri Utami
14.30-15.00	Woodfuel Marketing in Indonesia and Introduction to Field Trip	A. Ng. Gintings
15.00-15.30	Open forum	
15.30-16.00	**Refreshments/Coffee**	
16.00-16.15	Guidelines for working groups	Jim French
16.15-17.00	Group work: Development of framework for field exercises	Facilitators
17.15-18.00	Demonstration of cookstoves, and snacks	Tjutju Nurhayati
19.-00-20.00	**Dinner**	

Third day, Wednesday 26 April

TIME	ACTIVITY	STAFF RESPONSIBLE
07.00-07.30	**Breakfast**	
07.30-10.00	Travel to Rajamandala	
10.00-11.00	Use of woodfuel in small scale limestone industry, Rajamandala	Tjutju Nurhayati, Hans Beukeboom
11.00-12.00	Travel to Sumedang	
12.00-13.00	**Lunch**	
13.00-13.30	Travel to study site	
13-30-17.00	• Woodfuel production from timber plantations, Sumedang • Woodfuel utilization in small scale industry (roof tile making) • Production of woodfuel by farmers and distribution by middlemen	A. Ng. Gintings, Hans Beukeboom
17.00-18.00	Travel to Bandung	
18.00	Check into hotel	
18.30	**Dinner**	

Fourth day, Thursday 27 April

TIME	ACTIVITY	STAFF RESPONSIBLE
07.00-07.30	**Breakfast**	
07.30-10.00	Travel to Sukabumi	
10.00-11.30	Wood drying with woodfuel in a sawmill, P.T. Majora Inkas	Tjutju Nurhayati, Hans Beukeboom
11.30-12.00	Travel to Cibadak	
12.00-13.30	**Lunch** and discussions with middleman	
13.30-14.00	Travel to charcoal making site	
14.00-15.00	Charcoal making from sawdust, P.T. Denhana	"
15.00-16.30	Travel to Bogor	
16.30-17.30	Exhibition of woodfuel technology , Litbang, Bogor	Tjutju Nurhayati
17.30-18.00	Travel to Ciawi	
18.00-19.30	**Dinner**	

Fifth day, Friday 28 April

TIME	ACTIVITY	STAFF RESPONSIBLE
07.00-08.00	**Breakfast**	
08.00-10.00	Group work: Finalize synthesis of field observations into framework	Tara Bhattarai, Hans Beukeboom, René Koppelman
10.00-10.30	**Refreshments/Coffee**	
10.30-12.00	Plenary meeting: presentation of results of different groups	"
12.00-13.30	**Lunch**	
13.30-15.30	Country working groups: Discuss field observations and frameworks within national contexts of participants	"
15.30-16.00	**Refreshments/Coffee**	
16.00-17.30	Plenary meeting: presentation of results of different groups	"
18.00-19.30	Dinner	

Sixth day, Saturday 29 April

TIME	ACTIVITY	STAFF RESPONSIBLE
07.00-08.00	**Breakfast**	
08.00-08.30	Introduction on national follow up training activities	Tara N. Bhattarai
08.00-10..00	Working groups to identify follow-up national training activities, drafts of mini-proposals	
10.00-10.30	**Refreshments/Coffee**	
10.30-11.00	Working groups to identify follow-up national training activities, drafts of mini-proposals	
11.00-12.00	Presentation of working groups	
12.00-13.30	**Lunch**	
13.30-15.00	Workshop evaluation and closure	
15.00-15.30	**Refreshments/Coffee**	
15.30-18.00	Visit to safari park	
18.00-	**Farewell dinner & party with Jaipong**	

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APPENDIX 4. PARTICIPANTS PROFILE

No	Name	Institution	GO	NGO	Univ	Country	Degree	Prof. Training	T	R	E	M	Gender	Age
1.	Zhang Shougong	CAF-Beijing	x			China P.R.	Ph.D	Forest Management		x			M	37
2.	Huang Shineng	CAF-Guang Zhou	x			China P.R.	B.Sc	Forest Management		x			M	32
3.	Yongliang Zhu	Forestry College-Kunming			x	China P.R.	M.Sc	Forest Botany		x			M	32
4.	Bouaket Sayasouk	FPWI division	x			Lao PDR	Other	Mechanics				x	M	42
5.	Thong-eth Phayvanh	Dept. of Forestry	x			Lao PDR	B.Sc	Forestry				x	M	37
6.	Bounma Luangamath	Dept of Forestry	x			Lao PDR	Other	BEPC/DEPC					M	46
7.	Bui My Binh	FSIV-Hanoi	x			Vietnam	B.Sc	Wood Processing		x			F	22
8.	Phi Kim Sinh	Inst. of Energy-Hanoi	x			Vietnam	B.Sc	Energy		x			M	37
9.	Dau Quoc Anh	VASI-Hanoi	x			Vietnam	B.Sc	Rural Development			x		M	57
10.	Khin Maung Maw	Ministry of Energy	x			Myanmar	BE	Mechanical Engineering				x	M	40
11.	Khin Maung Oo	Forest Department	x			Myanmar	B.Sc	Forestry				x	M	38
12.	Soe Win	Forest Department	x			Myanmar	B.Sc	Forestry				x	M	39

T: Training

R: Research

E: Education

M: Management

No	Name	Institution	GO	NGO	Univ	Country	Degree	Prof. Training	T	R	E	M	Gender	Age
13.	Maritje Hutapea	Min. of Mines and Energy	x			Indonesia	Ir.	Agricultural Economics	x				F	37
14.	Ms Ismuni	Ministry of Forestry	x			Indonesia	. . Ir.	Forestry Tecnology				x	F	46
15.	Ibnu S. Pranoto	LPTP		x		Indonesia	. . Ir.	Soil Science					M	34
16.	Agus Gunawan Wibisono	LPTP		x		Indonesia	Ir.	Agriculture		x			M	32
17.	Rozaida Latip	Forest Research Institute	x			Malaysia	Dipl.	Wood Tecnology		x			F	31
18.	Ahmad F. Abu Bakar	District Forest Office	x			Malaysia	Dipl.	Forestry				x	M	
19.	Jessie Elauria	Department of Energy	x			Philippines	Ph.D.	Energy Engeneering				x	M	39
20.	Emma Agot	Forest Mgmt. Bureau	x			Philippines	B.Sc	Agriculture			x		F	44
21.	Nards Moneva	Mag uugmad Foundation		x		Philippines	B.Sc	Agroforestry			x		M	36
22.	Sanit Suwansorn	PDA		x		Thailand	B.Sc	Law				x	M	40
23.	P. Verapong	Department of Energy Dev. and Promotion	x			Thailand	M.Sc	Energy				x	M	40
24	Wijit Ongsomwang	Royal Forest Department	x			Thailand	B.Sc	Forestry					F	29

T: Training
R: Research
E: Education
M: Management

APPENDIX 5. PAPERS PRESENTED

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A: INTEGRATION OF WOOD ENERGY IN AGROFORESTRY EXTENSION PROGRAMMES IN SOUTHEAST ASIA

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Introduction

The eight countries in Southeast Asia which have joined the third phase (1994-1999) of the Regional Wood Energy Development Programme (RWEDP) are: China, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Thailand and Vietnam. Of these, five countries (China, Lao PDR, Myanmar, Thailand and Vietnam) lie within the continent while Malaysia, the Philippines and Indonesia are redominantly or entirely insular countries. Virtually all forests in RWEDP member countries in this subregion, except China where most forests fall under the temperate zone, lie within the tropical zone and are commonly known as "tropical forests". The share of tropical and temperate forests in the total forest area of all eight RWEDP member countries in the subregion is 63% and 37%, respectively.

Table 1: Population, Extent of Forest Area and Loss and Roundwood Production in RWEDP Member Countries, South East Asia

Country	Population Projection		Forest Resources (1980-1990)				Roundwood Production in1992 (million m3)
	Population in 1995 (million)*	Av. Ann. Growth 1990-95 (%)	Nat. Forest (million ha)	Other Wooded Land (million ha)	Plantations (million ha)**	Area Loss 1981-90 (million ha)	
China	1,238.32 (27)	1.42	115.05	27.73	33.310	NA	296.56
Indonesia	201.48 (32)	1.78	109.55	x	8.750	12.12	85.63
Lao PDR	4.88 (20)	3.00	13.17	x	0.006	1.29	4.40
Malaysia	20.13 (45)	2.35	17.58	x	0.116	3.96	54.01
Myanmar	46.55 (25)	2.14	28.86	x	0.335	4.01	22.73
Philippines	69.26 (44)	2.07	7.83	x	0.290	3.16	38.65
Thailand	58.27 (23)	1.27	12.73	x	0.756	5.15	37.59
Vietnam	73.81 (20)	2.03	8.31	x	2.100	1.37	29.62
TOTAL	1712.70	1.61	314.08	27.73	45.663	31.06	669.19

Source: Population, Growth Projection and Extent of Forest Area and Loss from World Resources 1994-1995 (WRI, 1994); Total Roundwood Production from Food and Agriculture Organization of the United Nations Yearbook, Forest Products 1981-1992 (FAO, 1992); Rural Energy Systems in the Asia-Pacific (APDC, 1993) for missing information for Vietnam; and Forestry Development and Environmental Protection in China (MOF of China, 1992).

Note: * Figures in parenthesis under population column indicate percentage Urban Population in 1992.
** All figures rounded to nearest ten thousand except those for "Plantations" which are rounded to the

Woodfuel (fuelwood and charcoal) contribute positively to the national economy and energy balance of all eight countries to a varying degree. WRI (1994) projected a population of about 1,713 million in 1995, and an average growth rate of 1.6 percent per annum between 1990-95 (Table 1 and 2). For a majority of the people as well as for many different industrial, commercial and processing activities in rural areas, woodfuels and other forms of biomass (i.e., animal dung, crop residue, industrial waste, etc.) or other traditional sources are still the only available forms of energy. The domestic sector needs woodfuels (most often non-traded items) primarily for cooking, heating and processing of agricultural products mostly for consumption within the household. The commercial and industrial sectors require woodfuels for production or processing of items in bulk for the market. In rural and peri-urban areas, traditional sources are still preferred oven energy commercial or conventional sources (i.e., kerosine, coal, electricity, LPG, etc.). The reasons for this may probably be due to reliability of supply, and affordability of use; woodfuels are still comparatively less costly than other conventional energy sources in many peri-urban and rural areas. Therefore, a large number of rural industries and some specific commercial activities in urban centres (e.g. eateries, bakeries, smithies, etc.) still use a substantial amount of woodfuel for energy.

The energy balance of all eight RWEDP member countries in the sub-region show a mix of both traditional and conventional energy sources to varying proportions (Table 3). The share of traditional energy is decreasing as a proportion of total consumption in recent years in five out of the eight RWEDP member countries (e.g. China, Indonesia, Malaysia, Philippines and Thailand).

Table 2: Forest Area Change by Tropical Forest Ecosystem Type in RWEDP Member Countries, Southeast Asia

Country	Tropical Forest (million ha)		Tropical Forest Ecosystem Type (Area in million ha)											
	Total area 1990	Annual change (%) 81-90	Rain		Moist Deciduous		Hill & Montane		Dry Deciduous		Very Dry		Desert	
			A	C	A	C	A	C	A	C	A	C	A	C
China*	2.00	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx
Indonesia	109.55	1.0	93.83	1.0	3.37	1.0	12.08	1.1	0.07	0.9	0.00	0.0	0.07	0.4
Lao PDR	13.17	0.9	3.96	0.9	4.54	0.9	2.40	1.0	2.27	0.8	0.00	0.0	0.00	0.0
Malaysia	17.58	1.8	16.34	1.8	0.00	0.0	1.24	1.8	0.00	0.0	0.00	0.0	0.04	0.7
Myanmar	28.86	1.2	12.09	1.2	10.43	1.4	5.94	1.0	0.35	1.1	0.00	0.0	0.00	0.0
Philippines	7.83	2.9	3.73	3.1	1.41	2.7	2.69	2.6	0.00	0.0	0.00	0.0	0.00	0.0
Thailand	12.73	2.9	3.08	3.3	5.23	2.7	1.26	2.7	3.16	2.8	0.00	0.0	0.00	0.0
Vietnam	8.31	1.4	2.89	1.4	3.38	1.4	1.08	1.4	0.95	1.4	0.00	0.0	0.00	0.0
TOTAL	198.04		135.92		28.36		26.69		6.80		0.00	0.0	0.12	

Source: World Resources 1994-1995 (WRI, 1994); National Position Paper for China, Jiayu (1995).

Note: A Area, in million ha
C Change, in percentage
* Most Chinese forests lie in the temperate zone; only natural forest area is shown in the table; Jiay (1995) presents another 5.63 million ha plantation and economic forests in the Chinese tropics.

But, in absolute terms, the volume of traditional energy used (particularly woodfuels) might not have reduced significantly, if at all. In the remaining three countries (Lao PDR, Myanmar and Vietnam), the share was reported as increasing. The issue here is not to judge the economic status of a country by its level of commercial energy consumption, although most modern technologies and processing facilities tend to favour the use of commercial energy, but the limitation of information. Information covering areas such as to what extent a country is still dependent on traditional energy sources and what policy, strategy and programmes have been or should be pursued to produce and promote the efficient use of renewable energy sources. As more and more emphasis is being given in recent years to sustainable production and use of renewable energy sources, this is where forestry extension, including agroforestry, could play an important role. Although extension efforts on promoting people's participation in tree planting have been partly successful (i.e. community forestry or private forestry development programmes), its contribution to natural forest management has not proved significant as yet; only a few exemplary cases of achievement have been reported. Further more, types of trees grown by people in private lands to meet their own needs; decisions regarding choice of species and planting site based on long-time experience with the potential contributions of various multi-purpose trees, prevailing local socio-cultural practices related to tree planting, etc., are all important factors which affect forestry extension (e.g. trees planting around homesteads, development of fruit trees and orchards, establishment of rubber and oil palm plantations, etc.). Governments, so far, have been more effective in managing larger consolidated block plantations rather than scattered plots of variable size, primarily due to difficulties of protecting them from fire, grazing or encroachment.

Table 3: Production and Consumption of Energy in RWEDP Member Countries, Southeast Asia

Country	Commercial Energy				Traditional Energy	
	Total Consumption in 1991 (PetaJoules)	Per Capita Cons.in 1992 (Kg Oil Equiv.)*	Av. Annual Prod. Growth 1980-92 (%)	Imports as % of Merchandise Exports	Consumption in 1991 (petajoules)**	Fuelwood & Charcoal Prod.in 1992 (mill m^3)
China	27,345	600 (5.1)	5.0	4.0	2,018 (7)	203.8
Indonesia	1,914	303 (7.2)	3.5	6.0	1,465 (43)	146.3
Lao PDR	5	41 (2.5)	-0.9	46.0	39 (88)	4.1
Malaysia	825	1,445 (9.6)	12.6	4.0	90 (10)	9.2
Myanmar	68	42 (-0.6)	-1.4	9.0	193 (74)	18.6
Philippines	757	302 (3.1)	5.9	22.0	382 (34)	35.0
Thailand	1,281	614 (10.1)	27.6	10.0	526 (29)	34.8
Vietnam***	248	100 (0.12)	NA	NA	251 (50)	25.2
TOTAL	32443				4,964 (15)	477.0

Source: World Resources 1994-1995 (WRI, 1994); World Development Report 1994 (WB, 1994); and FAO Yearbook, Forest Products 1981-1992 (FAO, 1992); and Rural Energy Systems in the Asia-Pacific (APDC,1993),for missing information about Vietnam.

Note: * Figure in parenthesis indicate average annual growth percent during 1980-1992.
** Figure in parenthesis indicate percent share in total consumption.
*** RWEDP study of 1992 showed a 74% share of traditional energy in which woodfuel contributed about 40% (Field Document No. 33)

Trees from forests, community lands and privately owned lands, grown as fruit orchards, rubber and oil tree plantations, farm forests, woodlots, or single tree plots of multipurpose species around homesteads, have been the better known production sources of wood energy. National community, farm or social forestry development programes all incorporate tree planting in agriculture, livestock and/or fisheries development. These schemes are implemented with investments from the public and private sector, depending upon ownership or right of use of products, or the type of management agreement between the state and local community or amoung private individuals. Ownership of the land base is the single most important factor influencing the type of development (e.g., public, private or leasehold forests). These different approaches to forestry development have been pursued simultaneously in many countries primarily to sustain wood production and conserve natural resources. Although a particular scheme in a specific area or location may prioritize certain activities/objectives depending upon the needs of the people (e.g., watershed management, preservation of the environment, etc.), most ongoing forestry development programmes also have the objective of enhancing wood production, either explicitly or implicitly. Most schemes seem to include a component of private tree planting or participatory forest management in them to meet the basic needs of local people for fuelwood and construction timber.

Agroforestry, a system of land use recognized as a separate discipline since the 1970's, is a new multidisciplinary sector. It requires integration of activities affecting sustainable agriculture which used to be carried out independently by different sectoral line agencies under the government bureaucracy. It is gaining wider recognition among policy makers and planners as the productivity of agricultural land declines year by year (more prominently in hilly areas), as the forest area continually shrinks in the sub-region, and as national policies of member countries increasingly demand forestry extension. Virtually all countries are pressed with additional demand for agricultural land (for expansion of food production areas) as well as for extension of forest area. Forest management today also has to embrace components of biodiversity conservation and, at the same time, help check world climate change. This is achieved by absorbing atmospheric carbon dioxide (CO_2), in organic matter, and preventing release of CO_2 stored in biomass by deforestation. How these conflicting demands can be met without further degradation of remaining forests great challenge. Furthermore, the nonexistence of alternative energy sources which are reliable, affordable and cost effective substitutes for woodfuel is exacerbating the problem in the forestry sector in the short–term. This is where forestry extension in general, and agroforestry in particular can contribute positively. A properly planned and effectively implemented agroforestry system can enhance both production as well as promote sustainable landuse practices in the sub-region.

Forest Resources in Member Countries

Natural Forest

World Resources (1994) presented the area of tropical forest under two country groupings. The four countries in continental Southeast Asia (excluding China) share about 63.08 million ha and the three insular countries 134.95 million ha making up a total of 198.04 million ha. This was 72% of the forest area in Asia and 11% of the world's forests in 1992.

All forests under the broad classification “Tropical Forest” have been further divided into many different ecosystems, e.g., Rain, Moist Deciduous, Hill and Montane, Dry Deciduous, Very Dry, and Desert forests, on the basis of ecofloristic zones and vegetation maps (FAO 1993, in WRI 1994). These specific 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 eight RWEDP member countries is about 313 million ha. Out of this, China alone has about 115 million ha of natural forests, mostly in the temperate zone. China also has an additional 27.7 million ha of other wooded land, which is significant from the point of view of wood energy production (Table 1 and 2).

Tropical forests in general, and rain forest ecosystems in particular, are considered to be the richest ecosystems in terms of biological diversity. This important consideration is currently gaining wider global recognition, which now calls for the conservation of tropical forests through their sustainable management and use. The potential contribution of tropical forests to owner countries and society at large has yet to be fully quantified in economic terms. There is limited knowledge about the use and management of these huge resources. Only a few species and selected genetic materials of known importance are used at present but they already reveal the enormous potential contribution of tropical rain forest ecosystems. These benefits are being increasingly recognised and harnessed through biotechnology applications for the benefit of all human beings. These new types of uses, as well as many other uses which are not yet fully known, will become increasingly important in the future as more knowledge is acquired through research and development. This situation has been formally recognised at the highest political level at the Rio Earth Summit (UNCED, 1992) by the signing of the Biodi-versity Convention.

Another international instrument which was adopted at Rio is the World Climate Change Convention. This is designed to reduce the green house effect of gas emission in the atmosphere. This agreement makes the task of managing tropical rain forest ecosystems even more challenging and complex, particularly from the point of view of maintaining its long term sustainability so that this important resource can be used by present as well as future generations. Both of these conven-tions have now become effective with the completion of their first meeting (or conference of parties) in 1993 and in March 1995 respectively. These forums will be directing/guiding amendments in existing policy, priorities and future actions in the forestry sector to incorporate the specific needs of these conventions in the interest of the global environment. These may drastically deviate from the immediate priorities of owner countries. The non-legally binding principles on forests (also agreed at UNCED, 1992) is increasingly under pressure to be replaced by an additional convention on forests. This is to call for controlling tropical deforestation on the basis that the former two instruments are not sufficient to make countries strictly adhere to the principles of sustainable tropical forest management. A recent ministerial level meeting at FAO, Rome (March 1995) adopted a “Rome Statement on Forestry”. It affirmed the determination of 121 countries to apply their political will to attain the Earth Summit's objectives in the shortest time possible.

On the other hand, growing population and lingering poverty call most countries to pursue rapid economic development, which means exerting additional pressure on the remaining forests. Although the rate of de-forestation has been stabilized at an annual average of 1.2% in the Asia Pacific region, this figure is too high compared to the rate of tropical deforestation in other regions (e.g., South America and the Caribbean 0.8%, Africa 0.7%). During the period 1980-1990, about 31 million ha of tropical forest was lost in the seven RWEDP member countries (excluding China). Thailand and the Philippines lost about 2.9% of the forest each, which accounts for about 3.1 million ha and 3.7 million ha of tropical rain forest loss respectively.

Plantation Forest

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 China (probably the largest in the world), Indonesia, Vietnam and Thailand. But, the success rate of most of these plantations has been repeatedly questioned. The latest figures on the survival rate at the global level (which is based on FAO's inventories of 56 plantations and reported in WRI, 1994) stands at only 70%. China has stated that 75% of its plantations meet the desired quality without defining exactly what it meant (MOF of China, 1992). The ratio of deforestation to established plantations for Asia as a whole stands at 2:1, which is much better than the reported 6:1 for Latin America and 32:1 for Africa. But the high rate of deforestation must be reduced significantly, as quickly as possible.

Conversion of forest land into agricultural fields for expansion of crop production to feed the increasing population is still destroying many primary and/or secondary forests. These have immense social, economic and environmental value. Deforestation in hilly catchments is contributing to the process of lowland sedimentation, flooding and upland de-sertification. As a preventive action against soil erosion from farm lands, communities in catchment areas are being encouraged to incorporate tree crops into their traditional farming systems. Besides the protection value of trees, the multipurpose utilization potential inherent in numerous tree species has also prompted farmers to diversify production from farm lands, both for home consumption as well as for the market (e.g., fruit and other trees which yield products of cash value besides the wood). This practice, in reality, is based on traditional models of agroforestry virtually in all rural areas. Later on, as tree plantations became an important component of forestry development, many countries adopted agroforestry as a “new” strategy to establish large scale tree plantations at low cost and/or to ensure better protection against fires and grazing. The early initiative of Myanmar in establishing teak plantations under the “Taungya” system is a classical model of a cost saving strategy. China's farmland shelter belts and forest networks as well as its intercropping of agricultural crops with trees and planting trees around houses, along roadsides and river banks, etc. are, on the other hand more aimed at conservation and are based on market considerations.

Energy Consumption in Member Countries

WRI (1994) showed a significant decline in the proportion of traditional energy use since 1971 in Malaysia (from 22% to 10%), Thailand (from 54% to 29%), Indonesia (from 68%to 43%) and the Philippines (from 45% to 34%). In China it remained constant at 7%. But in the remaining three countries its share was increasing (Lao PDR from 82% to 88%; Myanmar from 72% to 74%; and Vietnam from 30% to 50%). These three countries also showed a significant decline in their per capita consumption of commercial energy since 1971, which now stands at -43%, -10% and -57%, respectively. On the contrary, Lao and Vietnam showed a decline in all forms of energy consumption by -11% and -33% respectively, during the period 1971–91 (Table 3).

Koopmans (1993) identifies the non-availability of accurate data as the single most important problem affecting 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 is very vague and broad. Usually it only presents totals at the country level and therefore is only useful for guiding policy formulation at national level. There is enormous variation in energy consumption in different geographical areas even for particular uses i.e., cooking or heating, and various different industries. There is wide variation in the amount and type of woodfuel required for specific or different types of users based on 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 during the previous two phases of RWEDP (1985-93).

Country and global-level statistics available today do not give a reliable breakdown of wood energy production or consumption. In most cases, available country level information does not even recognize the source of supply for woodfuels (i.e., whether the source is sustainably managed national forest, community woodlots or private trees). Most information also tends to place the different sources of biomass energy into one broad group called traditional energy, without explaining the supply situation or source. Population patterns in many countries make the work of wood energy planning difficult, as population density varies drastically from the national average in many countries. Generalized figures may adversely affect plans which aim to solve local level problems (e.g. Indonesia has an average population density of about 100 people per square kilometer whereas the Island of Java has 1,000 people per square kilometer). This is an important issue to be addressed while planning wood energy development. The share of woodfuel in total roundwood pro-duction in the eight countries in the sub-region comes to about 40% on average. Although the average figure does not seem very high, there are large variations between countries. For example Malaysia, because of its low (17%) share in total roundwood production, tends to distort the figures for larger countries with higher shares of woodfuel production (Table 4).

Table 4: Production of Roundwood and Woodfuel in RWEDP member countries in Sutheast Asia

Country	Total Roundwood Production in 1992 (million m^3)	Total Woodfuel Production in 1992 (million m^3)	Share of Woodfuel in Total Production (Percentage)
China	296.56	203.8	68.7
Indonesia	185.63	146.3	78.8
Lao PDR	4.40	4.1	93.2
Malaysia	54.01	9.2	17.0
Myanmar	22.73	18.6	81.8
Philippines	38.65	35.0	90.5
Thailand	37.59	34.8	92.6
Vietnam	29.62	25.2	85.1
TOTAL	669.19	477.0	71.0

Source: Derived from FAO's Yearbook, Forest Products 1981-1992 (FAO, 1992).

Wood Energy Demand/Supply

The eight countries in the sub-region when combined showed an annual average population growth rate of 1.6 percent between 1990 and 1995. China, with its high population and low annual growth rate of 1.42%, substantially lowered the sub-regional average. Most other countries had higher population growth rates, except Thailand which had only 1.27%. Although statistics on energy use patterns from most countries highlight the decreasing proportion of traditional energy sources from year to year, in absolute terms, use of woodfuels in most RWEDP countries has not decreased, and has often increased due to population growth. Urbanization is taking place rapidly throughout the sub-region, resulting in rapid transformation in energy type and mix in favour of commercial sources. These are perceived as modern, healthy, clean, easy to use, save cooking time, etc.. Traditional energy sources including woodfuels, however still hold an important position in the national energy balance of all eight countries.

Energy consumption in countries with rapidly growing demand from industries has increased on a per capita basis. Consumption has also increased in the domestic sector due to improved economic conditions. Demand for all types of energy is increasing with the growth in population as well as per capita energy consumption due to improving living standards in all countries in the sub-region (Table 5).

Table 5: Energy Transformation in Sources in RWEDP Member Countries in Southeast Asia

Country	Total Energy Consump-tion in 1991 (petajoules)	Commercial Energy Consumption (PetaJoules)				Traditional Energy Consumption Percentage of Total Consumption		Av. Annual Energy Consump-tion Growth (%) 80–92	Av. Annual Popula-tion Growth (%) 79–91
		1984*	1991*	Growth in Consumption	1991 PetaJoules	1971	1991		
China	29363	20,047 (137)	27,345 (66)	7,298 (36)	2,018 (7)	7	7	5.1	1.42
Indonesia	3,737	1,248 (207)	1,914 (337)	666 (53)	1,465 (43)	68	43	7.2	1.78
Lao PDR	44	3 (-63)	5 (-11)	2 (67)	39 (88)	82	88	2.5	3.00
Malaysia	915	390 (119)	825 (334)	435 (111)	90 (10)	22	10	9.6	2.35
Myanmar	261	78 (44)**	68 (39)	-10 (-13)	193 (74)	72	74	-0.6	2.14
Philippines	1,139	489 (66)	757 (147)	268 (55)	382 (34)	45	34	3.1	2.07
Thailand	1,807	613 (213)	1,281 (425)	668 (109)	526 (29)	54	29	10.1	1.27
Vietnam	499	210 (-43)	248 (33)	138 (66)	251 (50)	30	50	1.7	2.03
TOTAL***	37,765	23,078.	32,448	9,465 (40)					1.61 (Av.)

Source: World Resources, 1987 and 1994-95 (WRI,1987; WRI,1994); World Development Report 1994 (WB,1994); and Rural Energy Systems in the Asia-Pacific (APDC, 1993).

Note: * Figure in parenthesis indicate percent change since 1970.
** 1987 figure, percent change also since 1977 only.
*** Total may not match due to rounding up of figures.

Because of other reasons (i.e., socio-economic and infrastructure) distribution aspects of commercial energy is going to be a problem for many years to come in remote parts of virtually all countries. This is sure to add to the present level of demand for traditional sources.

Given all these factors and the present thrust for renewable energy sources, the use of wood energy in the future will continue. This is why expanded agroforestry practices is a viable strategy to enhance wood energy production and promote sustainable land use.

Wood Energy Supply Sources

In most countries in the sub-region, unchecked population growth is directly contributing to accelerated deforestation. Deforestation is taking place in the form of expanded slash and burn practices to produce more and more agricultural crops to feed the expanding population. Although the most commonly perceived views about the causes of deforestation single out the ever-increasing demand for woodfuels and timber in many developing countries, studies carried out recently (i.e., RWEDP study of 1993 in Cebu, Philippines; World Bank study of the Philippine Household Energy Consumption, 1989; etc.) reveal that woodfuel collection is not a primary cause of deforestation in many places. As woodfuel shortages become more acute, people tend to take part in fuelwood production using a variety of alternative actions, e.g., private tree planting, interfuel substitution, etc (Table 6).

Expansion of agricultural land to feed the additional mouths year after year is now believed to be the root cause of accelerated deforestation. Forests in many parts of the globe have served as a reserve pool of land to produce and accommodate the diverse needs of the increased population. They have played a role of shock-absorber to offset the immediate pressure exerted by population growth. In the short-term, planned clearing of forest lands for resettlement may contribute positively to national revenue as well as food production; a strong factor that encourages most politicians to gain easy/quick popularity and to get votes, but the overall effect is long-run adverse environmental consequences.

Further, forests have also been the source of numerous non-wood forest products. They provide both goods and services to the people. Where no alternative sources of income exist, they provide forest-based employment to people. The interrelationship between forest and farming systems is very close in agro-based rural economies. The opportunity provided by forests for employment and cash income (from trade of wood and non-wood forest products) as well as the positive role forests plays during times of distress is well recognized. In times of national crisis, the forest has acted as an easy insurance against loss of crops and dwellings. However, this important recourse is being depleted both in quality and

Table 6: Overview of Available Data on Fuelwood Sources in RWEDP Member Countries from Southeast Asia

Country	Total Fuel-wood Consumption (million ton)	Share of Forest Wood (%)	Share of Non-forest Wood (%)
Philippines	25.3	15	85
Thailand *	24.8	50	50
Vietnam**	33.0	25	75

Source: Koopmans (1993).

Note: * Includes fuelwood converted into charcoal.
** Viet Nam figure is an estimate, assuming share of forest does not exceed the mean annual increment (mai).

quantity. Continuing changes in land use associated with different types of infrastructure development are also contributing to further deforestation. Table 7 depicts the land use patterns in 1989, and Table 1 shows the changes in landuse during the period 1980-90 in the Southeast-Asian member countries.

Status of Forest Management

FAO (1993) categorically stated that:

"During 1961 to 1990 a steadily rising trend was observed regarding the area harvested for production of non-coniferous industrial round wood in all three tropical regions, but little progress seems to have been made in sustainable management of natural forests."

Forest degradation and fragmentation is continuing globally, threatening plant and animal diversity in both temperate and tropical forests. Cambodia, Myanmar, Thailand and Vietnam have been identified as the countries with accelerated deforestation rates.

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

Table 7: Land Use Patterns in RWEDP Member countries in Southeast Asia, 1989

Country	Area (million ha)*	Agricultural Land		Forest and Wooded Land		Permanent Meadows and Pastures		Other Land	
		Area (million ha)	(%)	Area (million ha)	(%)	Area (million ha)	(%)	Area (million ha)	(%)
China	932.64	96.5	10.3	126.5	13.6	400.0	43.0	309.6	33.0
Indonesia	181.00	21.9	12.0	109.8	60.0	11.8	6.5	37.6	21.0
Lao PDR	23.08	0.9	4.0	12.7	55.0	0.8	3.0	8.7	78.0
Malaysia	33.00	4.9	15.0	19.4	59.0	NA	NA	8.6	26.0
Myanmar	66.66	10.0	15.0	32.4	48.0	8.4	13.0	22.9	35.0
Philippines	30.00	7.9	26.0	10.4	35.0	1.2	4.0	10.0	34.0
Thailand	51.10	23.0	45.0	14.1	27.0	0.8	1.6	13.9	27.0
Vietnam	32.55	6.4	20.0	9.4	29.0	0.3	0.1	16.4	50.0

Source: World Resources 1994-1995 (WRI, 1994); Rural Energy Systems in the Asia-Pacific (APDC, 1993); and Country Report of Lao PDR presented in the Expert Consultation on Forest Resources Monitoring Systems, Feb 27-3 March, 1995.

Note:* Figure in parenthesis indicate total area of a country rounded to nearest ten thousand ha.
NA Not applicable.

FAO (1993) cites its 1980 Forest Resources Assessment (jointly undertaken with 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 forest area reported was under management. Out of this, a substantial area lies in India (32.5 million ha). The remaining 8.8 million ha of managed forests are distributed among 18 other countries including those in Southeast Asia. The 1988 report of the International Tropical Timber Organization (ITTO) presented a very bleak picture of tropical forest management. It recognizes only one million ha global total. It calls for urgent initiation of sustainable management practices in all tropical forests.

The other disappointing message it presented is the inadequacy of natural regeneration in areas covered by forest working plans, primarily due to inadequate protection against fires and grazing. Further, the net area of established plantations in Tropical Asia and the Pacific are 73% of the world total in 1990 but only Indonesia, Thailand and Vietnam contribute significantly among the 7 tropical RWEDP member countries excluding China (Table 1).

Status of Agroforestry Development

FAO (1993) reported the acceleration of non-industrial tree plantations during the decade of the 1980's, including an expansion of the area under agroforestry systems. Out of a total of 12.35 million ha of plantations in 1990 in the tropical countries of Southeast Asia, about 60% were established between 1981-90. Similarly, of China's total 33.31 million ha of plantations in 1990, a major proportion was established after the late 1970's or early 80's under different reforestation schemes, including agroforestry. Further, participatory forestry programmes under different labels are also, one way or another, promoting the integration of tree crops into various types of agricultural practices to promote sustainable farming systems. Establishment of scattered plots of trees in former agricultural fields; distribution of free tree seedlings to promote private tree planting; improved access to better quality planting stock of desirable species; establishment of tree growers' cooperatives to raise farmers' bargaining power for wood etc. have been promoted under participatory programmes. With these new developments, wood grown by the private sector and rural communities and under other “non-forest” plantations are increasingly important sources of woodfuel. But, in terms of the progress made to-date, virtually all commercial non wood plantations are managed by a few countries of the Southeast Asia sub-region (i.e. Indonesia, Malaysia, Philippines and Thailand). Wood is being produced as byproducts from these plantations and the primary products are organic rubber, coconut, palm oil and other cash crops.

These non-forest plantations meet the productivity and income aims of agroforestry. Although unintended, wood and other biomass produced as byproducts from these plantations contributes substantially to the national energy balance of many countries. Koopmans (1993) cites two case studies: the Philippines Household Energy Consumption Study by the World Bank, 1989; and the 1980 study on fuelwood, charcoal and densified fuels in Thailand by the National Energy Administration of Thailand. These studies reveal that only 15% (2.5 million out of 25.3 million tons) of the fuelwood used in 1989 in the Philippines and about 50%of the fuelwood and charcoal consumed in rural areas of Thailand in 1984 were produced as wood from forests. The rest came from other sources. Similarly, Vietnam, with no significant non-forest plantations, still meets 75% of its woodfuel requirement from outside forest sources. Therefore, different tree species that have been included in non-forest plantations (for productivity and income enhancement) contribute significantly to wood energy production.

Agroforestry practices, whether aimed to improve benefit-sharing or to promote sustainable land use in upland areas, integrate agricultural crops, pasture crops and trees (APAN, 1993). Agroforestry may take the form of community, leased or private plantation of trees in regular rows (in blocks), or scattered trees along farm boundaries or on terraces (single linear row of trees), where association with other crops may be permanent (home gardens) or temporary (shifting cultivation, intercropping in newly established tree plantations during the early years of establishment). Agroforestry has been classified into different systems based on the structure and functions. Different strategies pursued in the sub-region maintain, if not improve, the productivity of agricultural land, enhance food and feed production, and expand vegetation cover for environmental preservation. All include tree planting as an important component.

Some agroforestry programmes in the sub-region include:

- China
  - Programme for the Establishment of Fast-Growing and High-Yielding Timber Bases;
  - Three-North Shelterbelt Development Programme;
  - Programme on Soil and Water Conservation Forests in the Upper and Middle Reaches of the Yangtze River;
  - Coastal Shelterbelt Programme;
  - Plains Afforestation Programme;
  - Combatting Deforestation Programmes; and
  - Industrial Plantations.

- Indonesia
  - Non-wood plantation (tree garden);
  - Home-garden;
  - Intercropped Plantation;
  - Community Forestry;
  - Reforestation and Regreening Projects;
  - Watershed Management Programme;
  - Mangrove Social Forestry (Silvo-fishery);
  - Industrial Plantation.

- Lao PDR
  - Limited area covered with forest plantation, success rate poor, current priority is watershed management and wildlife conservation.

- Malaysia
  - Non-Wood Plantation;
  - Agroforestry Research (Mulu National Park, Sarawak);
  - Home-gardens.

- Myanmar
  - Fuelwood Plantation (Community Multipurpose Fuelwood Project, Departmental Fuelwood plantation);
  - Seedling Distribution (for home-garden and agroforestry development).

- Philippines
  - Non-wood Plantations;
  - Home-garden;
  - Community Forestry;
  - Industrial Plantation.

- Thailand
  - Village Woodlot/Farm Forestry (or Community Forestry) programme;
  - Industrial Plantation;
  - Fruit Orchards and Home-garden;
  - Royal Reforestation project to Commemorate the 50th Anniversary of the Accession to the Throne by HM the King;
  - Reclamation of Degraded Secondary Forest through Agroforestry;
  - Silvofishery in Kung Krabaen Bay Project.

- Vietnam
  - Home-garden;
  - Intercropped Plantation (*Hopea odoratte, Dipterocarpus alatus and Pahudia odorata*);
  - Silvo-Fishery-Agriculture on Forest Land (Community Forestry).

Conclusions

Selection of an appropriate agroforestry system depends upon the specific purpose one has in mind. From the view point of wood energy production, numerous factors play a role. Besides the edaphic and environmental factors in a particular geographical area, other issues, including technical, social, economic, and institutional, are important. Promotion of wood energy production requires a thorough knowledge of local socio-economic characteristics and a sound under-standing of local traditions regarding tree planting for different uses.

Almost everywhere there exists indigenous knowledge and methods of land management that incorporate trees into the farming system. However, increasing population, poverty and marginalization contribute to the degradation of natural resources and the acceleration of urbanization. This has exacerbated energy demand/supply problems. Although there is a growing tendency toward inter-fuel transformation in favour of “modern” energy sources (e.g., LPG, electricity, kerosine, etc.), in many urban areas, factors such as ease of availability, reliability and affordability directly affect consumers’ decisions. Available current information indicates that most poor people are not in a position to pay the extra cost required for accessories and appliances needed for conventional energy substitutes. Moreover, rural people have limited options to choose from. For them the only option available is biomass of some kind (i.e., woodfuel or residues). On the other hand, if they are forced to use more residues, this will affect the soil’s natural nutrient recycling processesl. This will in turn affect the productivity of farms and crop yields resulting in continued poverty. Other factors that affect energy transformation are concerned with the type of cooking practices and food habits of people.

With growing economic prosperity in the sub-region, woodfuel in many countries is being treated as a “dirty” and poor man's energy by most urban dwellers. However, due to increasing demand and localized scarcity it is emerging as a marketable product which, until not very long ago, was a non-traded commodity gathered free of charge from available sources by the users themselves. With the transformation towards commercial energy sources in most rural and sub-urban areas the potential for the economic production of woodfuel has become more feasible day by day. This, plus the renewability aspect of wood energy and the positive contributions it makes to the global environment, favours increasing use of woodfuel for numerous different purposes in the future. There is also the prospect of generating “modern energy” from woodfuel by using it as the source for primary energy- (i.e., methane, dendro-thermal, etc.). This possibility reinforces its continuing demand in the long-term and opens the prospect for further development in the future. All these positive aspects contribute favourably to the advancement of agroforestry practices in the sub-region. Therefore, RWEDP member countries in the sub-region may benefit positively by incorporating wood energy development as a strategy into their respective agroforestry extension programmes. It can also incorporate tree species that are acceptable to people for local or commercial purposes. It can introduce indigenous or exotic species either under short rotation, or long, to generate better economic returns or to increase the supply for domestic use in rural and urban areas. In addition to its benefits to farmers, agroforestry pro-grammes support sustainable land use and expand the area under forest cover. Moreover, it enhances the productivity of farms and helps generate income for rural farming families with limited opportunity for employment outside the lands they own. This new possibility may also create a favourable atmosphere for generating employment opportunities in the wood energy sector.

Other factors affecting the development of agroforestry are: land ownership and tenure; tree ownership and rights; national policy and legislation governing tree farming, woodfuel production (harvesting and conversion) and its flow in the market. All these issues directly affect the success of agroforestry programmes and could provide additional incentives for better land use and parti-cipatory management. If wood produced by farmers were allowed to be harvested, utilized and traded by the farmers themselves, there would be no problem for the promotion of agroforestry. Such schemes could be supported with cash incentives and funds from commercial lending institutions. A move in this direction calls for inclusion of these elements as topics for further research.

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Energy Contents

1 Ton wood = 15 GJ (airdry, 20% moisture; and 20 GJ at 0% moisture)
1 Ton Oil Equivalent (TOE) = 42 GJ (MTOE =i 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 (bbl) = 159 litre (liter = 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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B: Farm Household Decision Making and Extension

Framework for

Understanding Farm Household-level Decision Making

and Design of

Agroforestry Extension Strategies

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Introduction

A framework for the 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 socio-economic and biophysical conditions. Agroforestry technology and investment decisions are evaluated by farmers and agricultural entrepreneurs based on key external factors including:

- access to markets;
- access to support services;
- access to scientific and indigenous knowledge; and
- policies, rules and regulations.

The second half of the paper suggests alternative extension strategies based upon an understanding of the farm household. Emphasis is given to tailoring extension approaches to help move farmers from a subsistence orientation to a more entrepreneurial orientation where appropriate.

Framework For Farm Household–Level Decision Making

The Farm Household

The farm household is the level at which most resource allocation decisions are made. Division of roles and responsibilities among different family members occurs naturally among men, women, productive youth, and the elderly. Based on their respective duties, Farm Management Decisions are made (Part I). These may be broken down into: investment and marketing decisions; and production and conservation decisions. See Fig. 1.

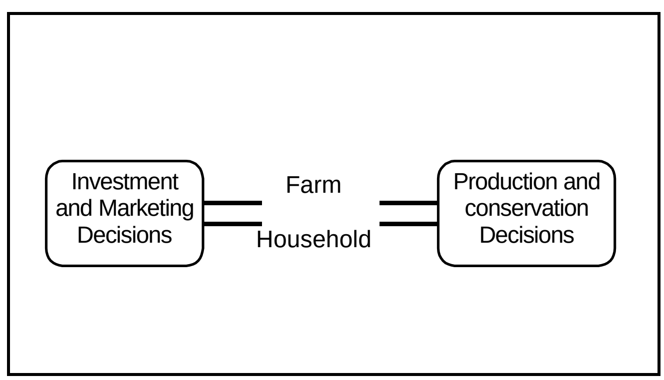

Fig. 1: Framework for Analysing Farm Household Decisions

These decisions are influenced by On–Farm Factors (Part II), and Off-Farm Factors (Part III). It should be pointed out that people do not use a linear decision making process. Rather, farmers consider many factors simultaneously. The framework is a tool to help understand these complex farm management decisions so that appropriate extension and development strategies can be developed.

Part I: Farm Management Decisions

Investment and marketing decisions

Box 1 summarizes some of the key resource allocation decisions faced by farm families. For example, if a need or market opportunity is identified for fuelwood, the family will have to choose what specific tree to plant, 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 marketed.

Box 1

Choice of agricultural enterprises
- Perennial crops
- Annual crops
- Livestock/fish
- Post-harvest processing

Allocation of labour
- Family labour
- Hired labour
- Off-farm employment

Allocation of land
$ By enterprise
- By responsibility

Allocation of capital
$ For production
- For consumption

Acquisition of inputs
$ Credit
- Supplies

Marketing
$ Products
- Market channels

Production and conservation decisions

Given the above investment and market decisions, farmers must also make choices regarding management of the production process. The best farmers will also try to identify means by which production can be sustained from year to year by minimizing damage to their resource base. Box 2 summarizes the sorts of choices they must make.

Decisions related to the management of perennial crops for fuelwood, may be related to stabilization of 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.

Conservation practices such as contour planting, vegetative erosion control and construction of drop structures all require additional labour 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.

Box 2

Management of agricultural enterprises
- Perennial crops
- Annual crops
- Livestock/fish
- Post-harvest processing

Conservation practices
- Crop management practices
- Erosion control practices

Off-farm employment
- Seasonal employment
- Regular employment

For example, processing of charcoal is an off-season enterprise that may attract farmers' attention away from longer-term conservation activities.

Part II: On–farm Factors

On–farm conditions affecting decision making are broadly divided into socioeconomic and biophysical factors. See Fig. 2.

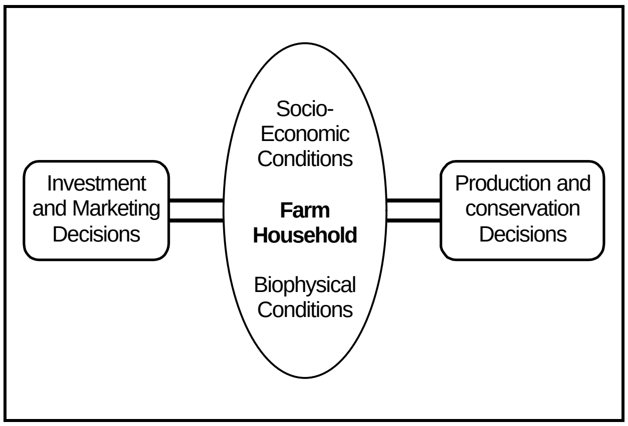

Fig. 2: On-farm Conditions Affecting Household Decision making.

<u>*Socioeconomic*</u>

A central factor affecting investment, production, and conservation decisions is the farmer's level of control over his land (see Box 3). 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.

Box 3

Assets
- Land stewardship
  - Tenure status
  - Areas and types (rainfed, irrigated, etc.)
- Livestock and crop rights
  - Ownership status
  - Profit sharing
- Buildings and farm implements
  - House, barns, etc.
  - Machinery, tools, etc.

Household members
- Composition (men, women, children, elderly)
- Age distribution
- Gender roles
- Health
- Education/skills

Cultural/individual attributes
- Attitudes
- Beliefs
- Aspirations for the future

Risk tolerance
- Availability of savings (cash, timber, etc.)
- 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
- Type(s) of off-farm activities

Household composition and allocation of responsibilities to different family members is also important in making farm management decisions. Division of family chores by gender partially determines how resource allocation decisions are made. It should be emphasized that “gender” refers to age and status as well as sex. For example, studies have shown 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. Likewise, children often play an important role in caring for livestock.

Subsistence farmers typically have different aspirations from market-oriented or commercial farmers. These ambitions are reflected in their beliefs, attitudes, and investment patterns. Different farmers also have varying risk tolerance levels based on savings and basic 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 it is associated with low risk. Also, farmers with heavy debts and obligations cannot afford to risk their family welfare with untested technologies.

Box 4

Moisture
- Rainfall level and distribution
- Irrigation

Soil
- Depth
- Stability
- Fertility
- Texture

Slope
- <7%
- 15-30%
- 30%

Altitude
- <300 m
- 300-900 m
- >900 m

Aspect
- North/South orientation
- Wind direction

Biological factors
- Pests
- Diseases

Biophysical

Biophysical factors are, for the most part, beyond the control of the farm family. These factors, as described in Box 4, have a direct influence on selection of a crop. There is, however, usually considerable variation in the microclimate of different parts of the farm. For example, the home garden is usually located near or around the household residence. It tends to get closer attention from women, receives more regular watering and fertilizing, and is more closely associated with subsistence than commercial objectives. Water, however, is nearly always the prime limiting factor. Soil, slope, temperature distribution and altitude are also influential for perennial crops. Finally, trees and some annual crops are sensitive to sun and wind exposure as well as biological factors. There are a number of tools available for matching species with biophysical factors but, as discussed earlier, the socioeconomic factors must be considered at the same time. Farmers do this intuitively and they almost always have good reasons for their decisions.

Part III: Off-Farm Factors

Off-farm factors have an influence on farm house-hold decision making as represented in figure 3:

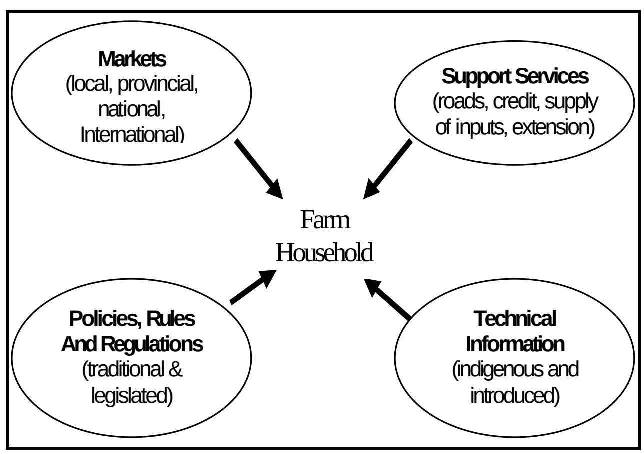

Fig. 3: Off–farm Factors Affecting Household Decisions

Markets and market channels

Farm families need outside 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 the farmer has.

Farmers seek market information from middlemen, producers associations, retailers, wholesalers, process ors, manufacturers and other farmers. A competitive market is, unfortunately, not always present. Having said this, there is usually gre.at opportunity to tap into domestic and international markets.

Box 5

Local
- middlemen
- producers associations
- local industry

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

International
- commodities exchanges
- multinational corporations

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.

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 enforced 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 farmers who are exploited by unscrupulous officials. These laws are, however, necessary to protect public forest resources.

Box 6

Traditional laws and common practices
- social norms
- customs

Written legislation
- national
- local

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.

Support Services

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

Box 7

- Roads
- Credit institutions
- Suppliers
- Subsidies
- Farmers associations
- Middlemen and brokers
- Market information services
- Extension services

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.

Technical Information

Issues covered under this heading include information on different aspects of growing crops such as propagation techniques, nutrient require-ments and harvesting technologies. Information can be provided from sources such as successful farmers, researchers, extension workers and private industry (see Box 8). An example of how technical technical information can influence a farmer's decision is mango planting. On poor soil with a pronounced dry season, mango seedlings die if appropriate technologies are not used for establishment. In Central Java farmers dig a hole of 1 x 1 x 1 meter, remove the poor soil and replace it with fertile red soil and organic manure. The next year, farmers dig 4 to 6 one-meter deep drills around the tree and add more organic manure. The purpose for this is to prevent mango roots from growing upwards seeking surface moisture and nutrients. Roots that are enriched with manure grow downwards seeking nutrients at deeper soil levels.

Box 8

- From other farmers (indigenous)
- From researchers and extension workers (introduced from research)
- From industry and brokers

To summarise

The interaction between all the of factors discussed above is presented in figure 4. This may also be used as a framework for the selection of extension strategies which is discussed below.

Extension And Development Strategies

The purpose of this section is to take a quick look at extension as it has evolved over the past several years. In light of the previous discussion on the farm household, emphasis is given to matching extension strategies with the decision making needs of the farm family..It is apparent that in many development programmes, traditional extension is not stimulating development to a significant extent and this is serious because extension services are expensive. Traditional government extension services are only suitable for a given period of development or under specific sets of conditions. This tends to be in the relatively early stages where government induced programmes are needed to meet national objectives such as food security

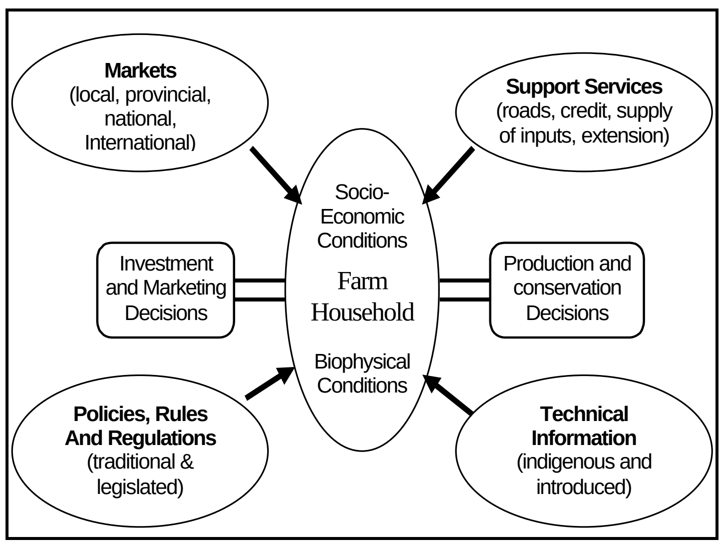

Fig. 4: Interaction Between All Factors Influencing Household Decisions

or import substitution. Once a reasonable proportion of the rural community has moved from subsistence agriculture to a market-driven economy, then governments can gradually invest less in traditional extension and the private sector plays a greater role.

Under these conditions, governments can encourage industrial investment in rural areas and act as stimulator to commercial organizations and farmer groups. There may also be a need to act as a watch-dog for the rights of small farmers to prevent undue exploitation by the powerful few.

Alternative extension approaches

The figure below represents a range of alternative extension approaches. Any one of these may be appropriate at certain points in time and under certain conditions. It is a mistake to try to force any one extension system upon diverse sets of conditions. Governments should encourage voluntary, commercial and farmer organizations to deliver needed services when these mechanisms have a comparative advantage in responding to the evolving needs of farmers. Depending on the status of the farm household and the environment, extension approaches may fall along the continuum illustrated in figure 5.

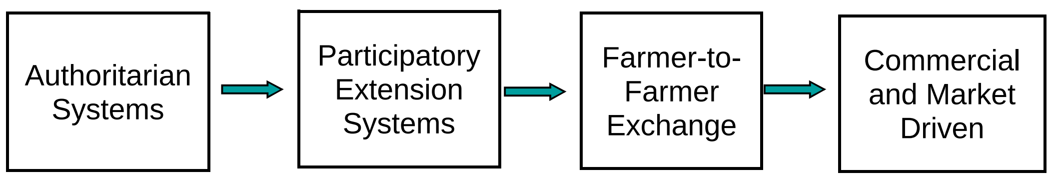

Fig. 5 Range of Extension Approaches

A detailed discussion of these broad approaches will not be attempted here. Rather, reference may be made to Table 1. This rough typology attempts to link on–farm decision making to alternative extension delivery strategies based on their relative strengths and weaknesses. Although it is tempting to advocate one strategy over another, all of these strategies have proven to be successful at different points in time and under different conditions. For example, if the “green revolution” had waited for development of farmer organizations, an opportunity would have been lost for rapid transfer of technology through coordinated government efforts.

Conclusion

In Southeast Asia investment in agroforestry has progressed extremely fast. To keep up with the industrial sector, farmers are becoming increasingly linked with the mainstream economy. This is an inevitable trend if farmers are to obtain a more equitable share of the benefits of rapid economic growth. Farmers must not remain on the sidelines because there is already a widening gap between urban and rural people. Fuelwood is one component in the production system of farm households. It will play an economic role that is directly commensurate with the value that it brings to the farm household. Extension efforts must, therefore, examine the value of this commodity in the light of competing enterprises. The old top–down technology–driven extension model will not work any longer. Let us all look at the farm family as we look at our own families and learn from their experience as we move forward together.

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C: IMPACTS OF SOIL AND WATER CONSERVATION IN WOODFUEL PRODUCTION:

THE MAG–UUGMAD EXPERIENCE

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Introduction

This paper contains stories and lessons drawn from the experiences of the Mag–uugmad Foundation, Inc. (MFI) or Mag–uugmad as it is popularly known. Mag–uugmad is an NGO formed in June 1988 by implementing staff and farmers' leaders. Its mission was to carry out the soil and water conservation programme initiated by World Neighbors in some watershed areas of Cebu in 1981.

The province of Cebu, the case study setting, is a mountainous island situated in the central part of the Philippine archipelago. The upland areas of Cebu, including its critical watersheds, are severely denuded. This situation was precipitated by the expansion of farming communities within the watershed areas, the encroachment of inappropriate lowland farming practices into ecologically fragile sites and the excessive extraction of resources from the remaining forest.

High dependence on woodfuel by the island's 2.7 million inhabitants, particularly households and businesses concentrated in the metropolis of Cebu City, is often cited as a major source of the province's environmental woes. The government tried to discourage and regulate the woodfuel trade hoping to improve the situation. But the problem was compounded by increased economic pressure on the impoverished upland community for livelihood opportunities. This led some people to look at the problem from another angle, namely that urban markets for woodfuels create incentives for rural and upland farmers to earn money by growing and selling trees. This argument has become a driving force in Mag-uugmad's soil and water conservation programme.

Mag–uugmad is working towards a farmer–centered and process–oriented development pathway. This new direction is anchored in the belief that rehabilitation and sustainable development of the uplands is the moral obligation of the people who depend on its resources for a living; the farmers themselves. The promotion of soil and water conservation (SWC) through farmer–based extension, a concrete expression of this belief, is the main thrust of this paper.

Participatory rural appraisal (PRA) was used to examine the impact of SWC and woodfuel production on a village within the watershed area. Field inquiries and farmers' workshops were conducted to evaluate the processes of the farmer-based extension system (FBES). The recently concluded strategic planning of Mag-uugmad compiled important experiences on the management aspect of the FBES.

This paper focuses on four major topics, namely: a) SWC programme, b) nature and processes of FBES, c) woodfuel impacts, and d) summary of lessons learned.

Soil And Water Conservation Programme

The general objectives of the SWC programme are to: a) reverse environmental degradation in the watershed area, b) develop farming technologies suitable to small farmers' resources, skills and management capability, c) demonstrate the ability of local farmers to teach their neighbors better ways of farming, d) improve farm productivity and increase income, e) contribute to the enhancement of the well-being of the family and the community.

SWC practices and farming systems

The SWC programme fostered by Mag-uugmad is a package of technology options aimed to control erosion, conserve water, restore soil fertility, improve crops and cropping systems and expand farm–based livelihood opportunities. Agroforestry lands are also a significant source of commercially–traded woodfuels in Cebu. Among the most common agroforestry approaches are sequential intercropping of coppiced *Gliricidia* and corn, the establishment of *Leucaena* hedgerows along slope contours, and the planting of a variety of species around field edges as property markers and live fencing.

Soil erosion control

Soil erosion in the watershed area is accelerated by open cultivation, tree felling and overgrazing. Mag-uugmad recommends a combination of structural and vegetative approaches to contain soil erosion. The structural approach includes such measures as bench terraces, contour bunds, contour and drainage canals, rockwalls, soil traps and gully checkdams. The vegetative approach is comprised of contour hedgerows, trees planted along farm boundaries, woodlots, and cover crops.

Water conservation

Soil erosion, soil compaction and vegetation loss gravely impair the capacity of the land to absorb and store water. To cope with water shortage, farmers established canal and storage systems on their farms. They constructed retention canals to increase water absorption and diversion canals to drain off excess rainwater. The water flows to a ground catchment where it is stored for farm use.

Soil fertility management

Soil nutrients are lost due to soil erosion, inappropriate cropping systems and improper disposal of crop residues. Nutrient loss is replenished through recycling of crop residues, organic matter built up from hedgerow prunings, composted manure in combination with inorganic fertilizers, and crop rotation using legumes.

Crops and cropping systems

The major crops grown are corn and vegetables. Corn is produced mainly for household consumption and is normally grown during the “panuig” or the first cropping season (April-August). If the crop yield falls short of a year’s food requirement, corn production is repeated in the “pangulilang” or the second cropping season (September-January). The farmers cultivate seasonal cash crops such as bell pepper, pole bean, mung bean, tomato, ginger, tobacco, cut flowers, cauliflower and other high value crops. Banana, taro and papaya are common perrenials grown. Farmers also grow such permanent crops as coconut, mango, jackfruit, coffee, cacao, and other multi–purpose trees. Farm productivity is optimized through relay cropping, crop rotation, and intercropping practices. Some farmers are starting to adopt alternative pest management techniques such as botanical pesticides. SWC technologies are adopted by farmers not only to stabilize openly cultivated farms but also to bring about favorable conditions for the establishment of agroforestry and to enrich existing coconut farms.

Farm-based livelihood

Sustained SWC adoption has expanded farm-based livelihood options among farmers. Farmers have derived additional income from the sale of seeds of hedgerow species. Pruned branches of fodder hedgerows and trees are processed into charcoal or fuelwood and sold. Livestock production (goats, swine, cattle) integrated into the farming system augments the income of farmers and contributes to the restoration of soil fertility.

The process of technology build–up

Any technology, however workable it appears to be, will always pass through the filter of a farmer's biases (immediate economic gains, low cost, little labor requirement, compatibility with skills and farm resources, etc.) before the farmer decides to adopt the technology. In the case of Mag–uugmad, the SWC technologies were adopted selectively and sequentially. The SWC programme evolved through the process of technology build–up where new technologies are built upon the gains of mature technologies.

In general, only a few technologies in the SWC package were adopted by farmers at the start. Preferred technologies then were simple structural barriers (contour bunds, canals, check dams, etc.) to control erosion and hedgerows for woodfuel and fodder production. This is the first stage of the technology build–up process. After the farms were relatively stabilized, farmers focused on soil fertility management technologies (composting, green manuring, recycling of crop residues, etc.). This is the second stage in the process.

As soil fertility was gradually restored, farmers started to experiment with high–value crops and woodfuels in the locality. During this stage, crop diversification and the search for a more productive cropping system were the main interests of farmers.

At present, research and extension deal more with specific concerns of productivity such as pest control, water management and long–term production systems.

Farmer–Based Extension System

The farmer–based extension system (FBES) is a development approach wherein farmers and extensionists share lessons with other farmers in SWC and farming systems drawn from their own experiences. Farmer extensionists assist fellow farmers in identifying key farm problems, implementing appropriate technologies and facilitating the formation of “alayon” or farmers' workgroups.

The FBES evolved from the early successes of the SWC programme. The SWC package was readily adopted by farmers because of their need for a steady supply of woodfuel and fodder. This was immediately addressed by such components as hedgerows and cover crops. The momentum of technology transfer was triggered by the remarkable success of the early adopters. World Neighbors (WN), the project initiator, saw the need to develop farmer extensionists to assist in the implementation of a rapidly expanding programme. These farmer extensionists, then called farmer instructors (FI), were selected by WN from among the outstanding farmer adapters in the community. However, during the early years of the project, the farmers served as mere “extension aides” of the implementing staff.

The SWC programme was eventually entrusted to Mag–uugmad in preparation for the World Neighbors' phase out. A formal management structure at the farmer level was created to consolidate the gains of extension and direct the pace of programme expansion. As a result, technology adoption advanced faster from farmer to farmer and from village to village. Presently, Mag–uugmad's effort is geared towards the complete turnover of FBES management to mature and capable people's organizations.

The transformation of farmers from adopters to farmer instructors is a long process: adopter–>outstanding adopter–> farmer instructor trainee–>farmer instructor on probation–> fully fledged farmer instructor.

The farmer instructor trainee (FIT) is selected from among the outstanding SWC adopters. Setting of the criteria for evaluation and selection of FITs are done by farmers themselves. The FIT undergoes one-year on–the–job training through an understudy scheme. After a year, the FIT's performance is evaluated by Mag–uugmad based on the criteria agreed.

Once the FIT passes the evaluation, he/she is considered an FI on probation (FIP) and will serve for another three months before being evaluated and enlisted as a fully fledged farmer instructor. This signals his/her entry into the formal structure of Mag–uugmad as a part–time staff member.

To be a farmer instructor the candidate must meet the following criteria: a) deep understanding of the principles and practices of SWC; b) technologies are applied and maintained well in one's own farm; c) willing and have the time to share ideas and experiences with other farmers; d) good communication skills; e) credible in the community; f)friendly, hard–working resourceful and helpful.

Farmer–based extension strategies

The farmer–based extension strategies proven to be effective include: model farm development; alayon formation; participatory farm planning; small scale experimentation; and trainings/cross visits. The inter–play of these strategies is the key to the success of farmer–based extension work.

Model farm development

The model farm displays various SWC technologies, cropping systems and land–use patterns appropriate to the locality. It differs from a demonstration plot in the sense that it is not just a showcase but a product of a long process of technology adaptation by the farmer. The model farm serves as a living example of the technologies promoted by the FI's, without which training and cross–visits would not be successful. It also reinforces the farmer's credibility as an extensionist by exemplifying consistency in words and deeds.

Alayon formation

The "alayon" is a traditional form of cooperation in the village, wherein farmers group themselves and work on each other's farm on a rotation basis. This mutual sharing of labor hastens the pace of technology adoption, especially the adoption of those that are labor intensive. The alayon also serves as a venue for group learning, problem solving and promotion of equitability among farmers.

Participatory farm planning

Participatory farm planning (PFP) is a process wherein alayon members or loose groups of farmers help each other in preparing their respective farm plans. The PFP process is a sequence of the following activities: assessment of the household economy (farm income vs. farm/household expenses) –> vision of the household economy (2–3 years) –> appraisal of current land use, crops and cropping system, market trends, technologies, etc –> analysis of key farm problems –> recommendations and options –> preparation of farm plan (activities, result indicators, sketches) –> critical examination (how to's) –> presentation of farm plan to the family for final review. What makes PFP genuinely participatory is the involvement of the family in the assessment of the household economy and in the review of the farm plan.

Small-scale experimentation

Farmer extensionists conduct their own experiments to ascertain the appropriateness of new technologies before these are disseminated to other farmers. Farmers learn of new technologies mostly from cross visits to successful farmers and technology resource centers but seldom do they adopt the technologies on a wide scale without testing them first. Experimental plots aid the farmer in extension work. Neighbors may take an interest in the experiment, keep track of its progress and readily adopt the technology if it turns out to be successful. The role of women in conducting trials is important as they are more keen on monitoring.

Training and cross visits

Training and cross-visits are especially helpful to farmers from distant villages where SWC model farms do not exist and the alayon is not practiced yet. Training methodologies that have proven to be effective are farm tours, farm practicums, sharing of experiences and other participatory techniques. Farmer–to–farmer training, because of its adaptability to farmers' natural learning pro-cesses, promotes understanding and motivates farmers to promptly apply the lessons learned.

Table 1: Reasons-cited by Fuelwood-Using Households for the Using this Fuel (Based on the survey of T. Bensel & E. Remedio)

Reason	Stated as one reason for use (%)	Stated as the most important reason for use (%)
Food cooked with wood tastes better	65.2	30.4
Fuelwood is inexpensive	47.8	15.9
Fuelwood is readily available	33.9	13.8
Household is able to obtain fuelwood for free	31.2	13.4
Fuelwood gives off high heat/ cooks food fast	16.3	9.1
Fuelwood used only for specific types of cooking	8.3	4.0
Fuelwood stoves are inexpensive	19.6	2.5
Others	43.5	10.9
Total		100.0

The process of FBES expansion

The alayon is the major vehicle for spreading the SWC programme and there are two modes of alayon formation: one is the “cell–division” type and the other is the “frog–leap” type.

The “cell–division” type is prompted by the expansion of the alayon from within. The alayon usually starts with a few early adopters of SWC techno-logies. But, as the farmers' work take shape (contours, crop arrangements, experimental plots), neighbors and passers-by are attracted and start to ask questions about the advantages and the implementation process of the new technologies. Farm developments and the owner's story motivate other farmers to adopt the technology and join the alayon. As more farmers enlist in the alayon, a problem arises. It now takes much longer to complete one cycle of the rotated schedules. Saddled with the problem of membership increase, the group decides to break up into smaller, more manageable alayons and the same process of growth and division starts all over again.

The second mode of expansion is the “leap–frog” type. Sustained participation in the alayon hones the social and technical skills of farmers. This prepares them for possible entry into the pool of farmer instructors where their main task is to facilitate formation of other alayons. The alayon that an FI is assisting may produce potential farmer extensionists who will, in turn, be assigned to the next village or farm and assist another alayon. It is through this wavelike progression from one alayon to another that the spread of SWC technologies in watershed areas is hastened.

Woodfuel Impacts

Planting, managing, and harvesting trees and shrubs varies considerably by land–use category. In Mag–uugmad sites, land–use is primarily for agroforestry and woodlots. The sites have a total annual rainfall of 1500 mm in a 9–month wet season from April to December. The slopes range from 15–70%, with some areas that are very steep. The average farm size is 0.75 hectare and it is intensively utilized. Most farmers own goats which are housed in a goat barn and fed using a “cut and carry system”.

For many years, commercial demand for fuelwood and charcoal in urban areas of Cebu Province has provided the necessary incentive for farmers to grow trees and shrubs around the agri-cultural landscape and thereby improve their land–use practices.

Demand

Fuelwood and charcoal are still significant sources of energy in both the residential and commercial sectors of Cebu City. Households meet a significant portion of their fuelwood demand by “freely” gathering a variety of woody and non–woody biomass fuels, with the rest coming mainly from urban wholesalers and retailers. The table below shows the different reasons for using fuelwood in households.

Commercial establishments obtain their fuelwood directly from rural traders, by–passing the urban trading network altogether. This sector is also somewhat less dependent on primary fuelwood than the residential sector, with certain commercial end–users, such as eateries, food vendors, poso makers, and various industrial establishments making intensive use of coconut fronds, bamboo and scrap wood. Table 2 shows the fuelwood consumption by different types of business establishment.

The two major industrial users of woodfuels in Cebu City are rattan furniture and fashion accessory manufacturers. These businesses have a combined annual consumption of approxi-mately 3,898 tons of fuelwood, or about 5.7% of total fuelwood consumption in Cebu City.

Three types of institutions were identified as potential woodfuel users: schools, hospitals and prisons. Overall, information on energy use was collected from 56 different institutions, indicating that this sector utilizes approximately 598 tons of fuelwood and 4 tons of charcoal annually. This translates into only 0.9% and 0.3% of the overall consumption of fuelwood and charcoal in the city, respectively.

Based on the findings of the household and commercial sector energy consumption surveys, fuelwood and charcoal will continue to be a significant source of energy in the economy of Cebu through to the year 2000.

Table 2: Fuelwood and Charcoal Use among Commercial, Industrial and Institutional Establishments in Cebu City, 1992 (Bensel, T. & A. Remedio survey)

End User	Charcoal (tons/yr)	Fuelwood (tons/yr)	% Primary fuelwood	% Coconut fronds	% Scrap wood	Bamboo
Bakeries	533	3,590	97.7	2.3		
Restaurants, Eateries, Food Vendors	1,327	1,566	41.4	54.5	2.6	1.5
Barbecue, Lechon Vendors	4,744	49	24.0	72.3	-	3.7
Poso Making	-	1,167	28.6	40.2	16.6	14.6
Commercial Food Processors	10	542	77.4	18.4	4.2	-
Snack Food Vendors	-	2,228	78.5	11.6	9.5	0.4
Industrial Users	-	3,898	25.7	-	74.3	-
Institutions	4	598	61.4	24.4	14.2	-
Total Commercial	6,618	25,638	50.8	33.1	14.7	1.4
Total Household	6,867	42,997	62.8	16.4	18.8	2.0
Overall Total	**13,485**	**68,635**	**58.3**	**22.6**	**17.3**	**1.8**

Supply

Cebuano farmers long ago recognized the demand for commercial woodfuel in urban areas and have responded with a number of innovative tree management schemes. Commercial trade in fuelwood and charcoal appears to be a long–established industry, dating back at least to 1920 in mountain baranggays of Metro Cebu. Initially, much of this trade centered around extraction of native shrub and secondary forest species such as *Vitex parviflora, Buchanania arborescens, Psidium guajava and Pithecellobium dulce.* Over time, however, these species have been largely replaced by exotic fast–growing leguminous tree species like *Gliricidia sepium, Leucaena leucocephala, and Cassia siamea.* In most of the Mag–uugmad sites, these species have been intentionally planted in small woodlots and plantations or as part of agroforestry schemes.

In Brgy. Guba, the main hedgerow species are *Calliandra calothyrsus, Flemingia macrophylla, Desmodium resondi, Demanthus virgatus, Gliricidia sepium, Leucaena leucocephala and Leucaena diversifolia.* In most instances a mixture of species is used in the hedgerow which provides diversity and complementarity. The farmers have been encouraged to view their hedgerow and structures, not only for soil conservation, but as a productive entity capable of providing saleable products. All hedgerow species can be used for fodder or fuelwood. The steeper portion of the farm has been planted with species such as *Gmelina arborea, Gliricidia,* Mahogany *(Sweetinia macrophylla)* or *Leucaena.* This is for fuelwood and timber production but is also important in helping to stabilize the catchment and act as a recharge zone for natural waterways in the area. The farmers are encouraged to plant and expand these woodlot areas.

Table 3: Species Composition of Commercially Traded Woodfuels in Cebu City, 1991-92 (Bensel, T. & Remedio, E.)

Local/Common Name	Scientific Name	Percent of Total	
		Fuelwood	Charcoal
Biateles/Giant Ipil-ipil	Leucaena leucocephala	32.60	29.30
Madre de cacao/Kakauati	Gliricidia sepium	17.10	27.90
Kabahero/Native Ipil-ipil	Leucaena glauca	7.00	12.00
Robles/Yellow cassia	Cassia siamea	1.30	1.70
Manga/Mango	Mangefira indica	7.40	5.10
Caimito/Star Apple	Chrysophyllum cainito	4.70	4.10
Lomboy/Java Plum	Eugenia cumini	2.20	0.30
Nangka/Jackfruit	Artocarpus integra	2.10	1.50
Sambag/Tamarind	Tamarindus indica	1.90	1.00
Santol	Sandoricum koetjape	0.80	0.40
Abocado/Avocado	Perseass americana	0.60	0.90
Other Fruit Trees		3.20	1.10
Anan/Balinghasai	Buchanania arborescens	4.10	-
Bayabas/Guava	Psidium guajava	2.20	0.90
Tugas/Molave	Vitex parviflora	-	6.30
Kamanchilis/Manila tamarind	Pithecellobium dulce	1.70	0.30
Bagalnga	Melia dubia	0.90	-
Manga-manga/Matalamban	Cyclostemon bordenii	0.80	0.40
Dita	Alstonia scholaris	0.50	-
Agoho	Casuarina rumphiana	0.30	-
Cha	Ehretia microphylla	-	0.50
Other Secondary Forest Species		5.60	3.30
Mahogany	Swietenia macrophylla	2.00	1.50
Gmelina/Yemane	Gmelina arborea	1.00	0.90
Total		100.00	100.00

In Brgy. Tabayag, Argao Cebu, hedgerow species are used to stabilize rock walls. These are perennial leguminous shrubs and trees such as *Calliandra calothyrsus, Gliricidia sepium, Leucaena leucocephala* and *Leucaena diversifolia.* The use of *L. diversifolia,* on the other hand, is expanded at this site. The high soil pH is ideally suited to *L. diversifolia* and farmers indicated that it was readily eaten by their goats. The productivity of *L. leucocephala* was limited by psyllid attack at this site and has been are replaced by *L. diversifolia.* The higher slopes are planted in woodlots.

Table 3 shows the woodfuel species commercially–traded in Cebu City

Trading

Widespread misperception in official circles about how woodfuel–producing trees are grown and harvested has led to the existing punitive regulations on woodfuel trade and calls for even stricter measures. Such an approach will undermine much of the reason for participating in tree-planting programmes, eliminate an affordable source of cooking fuel for the urban poor, and deny thousands of rural households the opportunity to earn income through planting and harvesting trees and shrubs on their own lands.

Woodfuel harvesting and transport in Cebu is regulated by the Department of Environment and Natural Resources (DENR). The most fundamental rule in force regarding woodfuel trade stems from DENR Administrative Order no. 86, series of 1988, which states:

> *No permit is required in the cutting of planted trees within titled lands or tax-declared alienable and disposable lands... provided that a certification (referred to as a certificate of origin or transport permit) of the Community Environment and Natural Resources Office concerned to the effect that the forest products came from a titled land or tax–declared alienable and disposale land is issued accompanying the shipment* (DENR 1991a, emphasis added).

In order to be able to harvest and sell "naturally growing" species found on titled lands, a special "cutting permit" is first required in addition to the transport permit even though, as recently as 1992, a temporary ban on the issuance of cutting permits was in effect. Technically speaking, a landowner interested in harvesting trees for sale as woodfuel or for other purposes must first approach the DENR, show land titles and/or tax declarations, and indicate to the DENR the potential volume of trees on their land, origin (planted or naturally–growing) and species, with the latter requirements to be accomplished through an initial inspection of the lands by an official of the DENR. In reality, the system only occasionally works this way and much of the trade goes unregulated by the DENR. This does not necessarily imply that much of the trade consists of banned species originating from public or government lands. In fact, most of the fuelwood and charcoal sold in Cebu does not come from planted species grown on titled lands. A problem lies with the regulatory system itself, suggesting a possible need for revisions in how woodfuel harvesting and transport is regulated.

The number of intermediaries involved in rural woodfuel trading and transport in Cebu varies greatly between locations. In some Mag-uugmad sites, woodfuel–cutters carry bundles of wood which they display along the roadside or sell to passing rural traders. On the other hand, charcoal traders in interior mountain baranggays can pass through as many as nine intermediaries before finally reaching the consumer. More common is to have a single rural trader purchasing supplies of fuelwood and charcoal from the uplands and sell these to urban wholesalers, retailers or large–scale consumers.

After years of sustained SWC implementation integrated with woodfuel production and FBES, there has been a positive impact on the lives of the people.

Productivity

SWC technology has made possible the optimum utilization of local resources. The “lagunas”, parcels of land left idle after years of overgrazing, were gradually rehabilitated through SWC technologies, thus expanding production areas. Before the project started, a large part of the village could only be farmed during the first cropping season and the average production was way below the food requirement of a family. After a decade of project implementation, most farmers are productive for two cropping cycles and some are already farming the whole year. This breakthrough in farm productivity is resulted from fuelwood production and food self-sufficiency and an increase in income derived from cash crops and other farm–based livelihoods.

The experience of Cirila P. Alcantara, a farmer in Sitio Catives, Guba, Cebu City, is one good example. Day Cirri, as she is fondly called, remembers how hard it was to look for fuelwood in the area before she became an adopter of the SWC programme. It had even become a source of conflict with neighbors when each one had to grab the remaining source of fuelwood. After 3 years of sustained technology adaptation, Day Cirri attained self–sufficiency in fuelwood supply, as well as food production. She was able to encourage most of her neighbors to adopt the technology. Now, they have a sustainable supply of fuelwood for their own consumption and for selling to urban consumers.

Resource Conservation

A decade ago, the farmed areas in Mag-uugmad sites were almost devoid of effective vegetative cover and the extractive livelihood activities (fuelwood, charcoal, lumber, fodder, etc.). were taking theeir toll on nearby forests (predominantly secondary growth). Presently, more farms are stabilized by soil conservation measures and are adequately covered by vegetation for most of the year. Increase in farm production and income has enabled farmers to undertake long-term but resource-conserving production systems (i.e. tree-based farming) and to break free from their dependence on the forest for survival.

The forest was finally given a much-needed rest to heal its wounds. In less than a decade, the people were beginning to enjoy the blessings of a regenerating forest: favorable microclimate, beneficial fauna and increased water yield. Development work, in this case, not only extricated the farmers from the poverty trap but also transformed them into effective partners for rehabilitation of the watershed.

Resiliency

SWC and improved cropping systems enhanced farmers' capacities to overcome economic and natural perturbances. Farmers absorb market fluctuations by growing different kinds of crops at the same time. Efficient water management reinforces the farmers' tolerance of erratic weather patterns. Boundary trees and farm hedgerows minimize damage caused by strong winds. Expanded livelihood opportunities improve the farmers' chances of overcoming natural calamities and crop failures.

The farmers' resiliency was put to a test when Typhoon Reming struck the village in 1987. Crop damage was almost total. The villagers did not seek relief assistance from outside sources. They simply herded their goats and cattle to the town's livestock yard and bought food supplies. In less than a week's time community life was back to normal.

Replicability

The replicability of SWC is evident in the spread of the technologies far beyond the boundaries of Mag–uugmad sites. The SWC programme started in 1981 with just 5 farmer participants. From then on, the technologies spread naturally from farmer to farmer in various villages within the watershed areas. The villages also served as one of the venues for Mag–uugmad's farmer–to–farmer training. It is estimated that no less than 1,500 farmers from 10 provinces have drawn lessons on SWC from local farmers.

Mature SWC technologies are easily replicated because their outcomes fit the criteria of farmers adopting new technologies, i.e. increase in yield, decrease in production costs, etc. SWC technologies are also readily adopted by farmers because they are simple, locally suited and adapted to indigenous knowledge and skills.

Equitability

The “alayon”, as mentioned earlier, served as a good venue for promotion of equitability among farmers. The mutual sharing of labor and resources, regardless of one's situation in life, benefited the poorer sector of the community. Accumulation of economic gains from farm productivity and the sustained practice of the alayon narrowed down income gaps among farmers.

Based on the recollection of farmers, the proportion of various income groups in the village in 1981 were as follows: 10% of households had an annual surplus, 20% had just enough, and 70% suffered chronic shortages. At present, the wealth distribution pattern is estimated to be 20, 60 and 20 percent, respectively.

Political Empowerment

The alayons formed by the farmer instructors became the building blocks of people's organizations (PO). The alayon dynamics fostered cohesiveness among members and provided the grounds for evolution of genuine leaders of the PO. As more farmers joined the alayons and eventually the PO, the political power of the pro–development sector in the community has grown correspondingly. This new–found power finally found its expression in the electoral process. Key PO leaders won the majority of seats in the baranggay council, the basic unit of local government. This political gain was translated into concrete developments for the village such as an access road, health center, linkage to government agencies for such services as livestock breeding, land tenure improvement, etc. These social structures and services accelerated gains in productivity, income, health, education, and others.

Mag–uugmad's approach to soil and water conservation looks at the direct and indirect potentials of increasing the production of woodfuel and other wood products. SWC technologies have provided farmers with a relatively easy way for trees to be established, maintained and harvested. It will continue to strengthen the capabilities of upland cultivators in community research and development and aim towards better natural, social and economic conditions. Finally, it will encourage multi–cropping and agroforestry systems intended to yield multiple products and increase productivity while simultaneously reducing soil erosion.

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D: AGROFORESTRY IN FUELWOOD PRODUCTION IN YUNNAN

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Background Information

Yunnan province is located in Southwestern China and shares borders with Vietnam, Laos and Myanmar. It covers an area of 390,000 square kilometers and has a population of 40 million which consists of 26 ethnic groups (minorities) including the Han.

As in other regions of the world, forest resources have been degraded in Yunnan. Although there are several reasons for degradation, fuelwood consumption has been blamed as the major one. Even today, with various alternative energies, fuelwood is still the principle energy source for rural people in most areas of the province. According to the Third Provincial Forest Survey which was conducted in 1987, 22 million cubic meters of timber were used annually as fuelwood, which accounted for 60% of the total amount of timber consumed.

Degradation of forest resources has caused serious problems, including fuelwood shortages, in rural areas. It has become more and more difficult for farmers to find fuelwood. Rural energy is now a key issue for rural development.

The fuelwood problem has attracted the attention of governmental agencies and research institutions as well as farmers. Fuelwood plantations have been enhanced, but it estimated that only 6.6 million cubic meters of fuelwood is produced in the province, accounting for only 28% of total demand.

On the other hand, studies on fuelwood plantations were listed as a priority in the 7th Five-Year Plan by the Yunnan Provincial Science and Technology Committee and research programmes on fuelwood production have been conducted. However, as the saying goes, "only the one who tied the bell on the tiger can take it off", thus, only farmers themselves can solve their problems. So, how can agroforestry, as it emphasizes farmers' participation, assist rural people in solving the fuelwood problem?

Some Indigenous Methods for Fuelwood Production

Fuelwood tree planting around houses

In Xishuangbanna, in southern Yunnan, Dai people have a tradition of planting *Tie-Dao-Mu* (*Cassia siamensis),* as a source of fuelwood. They grow trees around their houses or in upland areas as hedgerows. Three or 4 years after planting, farmers cut the tree to about 1.5 meters high. Then the stake sprouts vigorously and the branches are pruned every year for 20 to 40 years. Local people call the tree the "thousand knife tree" as it can be cut many times.

Taungya model in fuelwood production

In Southwestern Yunnan, *Alnus nepalensis* is planted with upland rice. In this system, the tree and rice are cultivated together for the first 2 to 3 years. Then the trees are managed as a fuelwood plantation. Around 8 to 10 years later, the tree is harvested as timber or fuelwood. Before the harvest, the tree can also provide fodder and fuelwood every year.

A similar system can be found in central Yunnan. In this case, *Pinus armandi* is seeded in lines. Annual crops, such as beans and corn, are cultivated between the lines in the first 2 to 3 years. Then the pines are managed as multipurpose trees.

Trees as hedgerows

Although it is not very common, in the uplands of central and northeastern Yunnan, *Tephrosia candida, Canjanus canjan* and *Leucaena leucocephala* are sometimes grown as hedgerows. In Dongchuan, northeast of Kunming, a farmer, who is also a retired teacher, grows *Paulownia fargesii* in parallel hedgerows on his 2 mu cultivated upland. In 1992 the 120 trees provided him with about 800 kilogram fuelwood. When harvested, they will serve as timber for furniture. More importantly, the trees reduce soil erosion. A forester and a leader working in the local forestry bureau learned of this system and ardently wrote a report which requested similar experiments and promotion of the system.

Constraints of Fuelwood Production

Tradition and knowledge

Although some indigenous technologies have been identified, generally speaking, farmers have not paid much attention to fuelwood production, and sometimes they ignore it completely. Farmers in most areas of Yunnan do not plant trees for fuelwood purposes since they can collect fuelwood in forests or elsewhere. They spend a great deal of time looking for fuelwood in distant forests rather than growing trees for fuelwood supply.

An example is the village of Shanjiao in Qiaojia County. The village is situated on the bank of Jingshanjiang River. Farmers do not grow trees on their barren hills which were once covered by trees and cut by farmers. Rather, they dredge up branches and timber from the river, which flows down from the upper reaches during the rainy season, although this is dangerous and sometimes illegal. In central Yunnan, farmers like cutting branches, twigs and cones from quercus and pine trees as fuelwood. However, they rarely grow these trees specifically for that purpose.

Ownership and forest policies

In China, all land is the property of the nation rather than individuals. Land, except those for natural reserves and collective purposes, are allocated to farmers according to the number of family members. Farmers do not want to make long term investments, like planting trees, on the limited land they are allocated because they are afraid that the allocation may be changed. In the early 1980s, when land was first allocated, farmers just cut standing trees and did not replant. As a consequence, many hills were denuded.

Logging is strictly controlled in China. However, this policy can cause problems if improperly carried out. For instance, in many areas, farmers must cut trees they have planted within their homesteads. In some cases, they even have to pay for the logging. This unclear crop ownership discourages farmers from growing trees. How can farmers plant trees under this kind of control?

Technological problems

Yunnan farmers have been successful in cultivating food crops to feed themselves. However, they are not good at managing their lands to get what they need, particularly under increasing population pressure and limited lands. Farmers are afraid that tree planting affects food production. They lack agroforestry technology for integrating trees with their agricultural activities.

Agroforestry Approaches in Solving Fuelwood Problems

To refresh on the knowledge and attitude of local people, governmental officers, practitioners and extension workers.

Agriculture and forestry are administrated separately in China. In rural areas there are both agricultural and forestry extension systems in which governmental officers, agronomists, foresters, and extension workers are involved. The objectives and working methods of the two disciplines are different and sometimes conflict with one another. Usually, agricultural agencies want more land for food and cash crops (not including trees), while the forestry sector wants to protect forests and return cultivated land to forested land. Agroforestry is an unknown concept and working method for them.

Moreover, the knowledge of these officers and practitioners concerns conventional agriculture and forestry. They need re-education to change their attitude and to acquire agroforestry technology. Continuing education can be established in agriculture or forestry institutions to introduce agroforestry techniques Training courses and workshops are also valuable. Then farmers' knowledge can be improved through the influence of agricultural and forestry extension systems.

To conduct agroforestry demonstrations in fuelwood production in typical areas.

It takes time to change farmers' traditions and attitudes. They tend to maintain things as they are and are reluctant to change. However, if they see by themselves that they will benefit from certain technologies, these will be accepted and practiced. Field demonstrations and on-site training are direct ways to extend agroforestry technology to farmers. This kind of demonstration requires cooperation among local government workers, farmers and researchers.

Networking among researchers, practitioners and farmers can facilitate the extension process. These networks can be organized on the basis of administrative prefectures or geographic features.

Research in fuelwood production

At the research level, attention should be given to integrating fuelwood production with farmers' agricultural activities on their sloping lands. Field trials on fuelwood species selection, the interaction of fuelwood species and annual crops, and the multi–purpose uses of trees should be conducted in project areas. While these things need to be done, native species and indigenous methods are more easily accepted and adopted.

The Fuelwood Plantation Study in Central Yunnan, in which the Southwest Forestry College played a major role, has been conducted since 1992. The research includes fuelwood species selection, silviculture and multipurpose management of fuelwood plantations.

Conclusion

China faces serious fuelwood shortages. Since 1982, fuelwood plantations have been included in national rural energy development programs. However, widespread planting of fuelwood trees is not taking place in Yunnan. The slow pace of tree planting originates from ideology, technology or from a combination of the two. Agroforestry extension, training and research should play a significant role in solving fuelwood problems in rural areas.

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E: Species Selection and Woodfuel Production in Agroforestry

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Selection of Suitable Woodfuel Species

What are the characteristics of good woodfuel species? The answer depends on the local situation including: climate; soils; production and management priorities and capabilities; size of landholding; interaction with other crops and wood properties sought. It is difficult to recommend specific species for universal application, but some general criteria for selection should be as follows:

- Adaptability to local environment (climate, soils, pests); Local species are usually better adapted than exotics.
- High wood productivity; preferably high branchwood productivity to allow for continuous pruning.
- Multipurpose, i.e. have other useful outputs.
- Produce thornless wood in small diameter size, easy to cut and transport.
- High pruning or coppicing tolerance.
- Compatibility with the other farm crops
- Good burning properties; low moisture, ash & sulphur content, high density, no sparks.

Agroforestry classification used in this paper

Agroforestry systems can be classified according to a number of different criteria depending on the objectives of categorization. The prevailing system used has been suggested by Nair (1985), and is based on four sets of criteria: System structure, system function, agro-ecological zone and socioeconomic level. These four classes are, of course, not totally independent. For the sake of simplicity, the classification used here does not use all these criteria. One system function common for all the systems included is that they all produce woodfuels, although it is not the major output in all cases. First, the systems have been categorized according to the nature and arrangement of their elements. This includes the following structural compositions.

Agrisiviculture (AS):	Composed of agricultural (annual) crops and woody perennials (trees, shrubs and vines)
Silvopastoral(SP):	Combinations of pasture and/or animals and tree. In this paper the practice of shrimp farming in mangrove forests (the falling leaves being the “pasture” for the shrimps), termed silvofishery, has been included in this category, although it is normally placed under “other systems”.
Agrisilvopastoral (ASP):	Agricultural crops, pasture and/or animals and trees.

For the purpose of this paper, the systems have been further divided into two rough climatic zones: humid tropical and subhumid tropical. Humid tropical is here defined as receiving more than 1500 mm of rain annually (MacDicken & Vergara, 1990) and subhumid as areas receiving less than this and having a pronounced seasonal distribution of rainfall. For a detailed account of agroforestry classification, which is outside the scope of this paper, the reader is recommended to consult Nair (1985, or 1993) or MacDicken and Vergara (1990)

- Easy propagation and management; high seed availability and farmer-“friendly” technology requirements.
- If intended for sale, the preferences of end users should be taken into account.
- Any other preferences expressed by farmers.

Calorific value is a difficult characteristic to use for species selection because of large variation, even within the same species, as well as variation in moisture content due to inadequate drying.

Although on–the–site tests to determine which species, systems and management practices are preferable, this requires considerable time and is rarely feasible. An alternative is to use existing productivity figures such as those presented in Attachments A & B and synthesized in Tables 1–4, to guide the initial selection of system type and/or species. The weakness of this approach is the low degree of relevance it may have to specific site conditions. The area or number of trees required to supply a given rural population with sufficient fuelwood, under different agroforestry systems in different agro-ecological zones can be approximated from Tables 1–4. These figures may be used to evaluate the supply situation or to guide proper allocation of land and choose the best agroforestry system for the specific situation. If an initial plan of intervention is based on these guidelines, expectations should be adjusted in accordance with local condition, like slope, soil type and the results of field trials.

Some productivity data for individual species may also aid species selection as presented in Attachment A, but the original sources provide no information on the growth conditions, type of agro–ecosystem or management applied. Another useful source of information is the ICRAF Multipurpose Tree Database, although its emphasis is on African tree species.

Woodfuel Supply

After selecting woodfuel species, what is the level of woodfuel production to be expected? Precise data on woodfuel production are surprisingly scarce, especially data related to traditional agroforestry systems. This situation is mainly caused by the fact that woodfuels are most often collected for home use and less often purchased or sold. When it is traded, it is usually only on a small scale and so does not enter official statistics.

Productivity of individual systems

In Attachment A the wood productivity reported from a number of agroforestry systems is presented. Most data are from experimental plots and should hence be viewed more as potential rather than general average productivity figures. As far as possible, both fuelwood and total wood production are presented in order to give a more reasonable basis for comparison of systems. Before interpreting the data in Tables 1–4 and the attachments, it should be stressed that most of these systems are not cultivated–only to provide wood, but also to supplying fodder, grains, tubers, vegetables, various animal products, etc. In many systems it is, therefore, likely that if more emphasis had been placed on woodfuel output higher woodfuel productivity could have been achieved. Similarly, where a farmer's preference is for fodder or other products, his management practices would be different and woodfuel productivity would be lower than indicated here.

Table 1: Average and range of wood productivity in agroforestry systems. Synthesized from Attachment A
(t/ha ± standard error of the mean)

Climate		System components		
		AS	SP	ASP
Humid	Average	14.1 ± 9.9 (n=11)	19.5 ± 11.8 (n=6)	12.9 ± 2.6 (n=3)
	Range	3.5-42.3	5.4-58.5	10.2-15.4
Subhumid	Average	7.8 ± 6.3 (n=29)	7.0 ± 8.4 (n=10)	2.9 ± 3.6 (n=3)
	Range	1.4-27.5	0.2-24.1	1.1-9.0

Even within the classification groupings already described, the systems reported still represent a wide range of situations. For instance, tree density ranges from alley cropping systems of 50,000 trees per hectare to scattered trees on pasture land. In some situations it may thus be more relevant to look at production per tree rather than per hectare.

It is unfortunate that productivity data from several countries like Nepal, Pakistan and Bhutan are not available, especially data from their mountainous regions, since such data are likely to differ significantly from lowland data. To draw conclusions regarding these areas is highly questionable given the limitations of the available data. As a rule of thumb, productivity figures should be expected to be lower than average in high mountain areas due to lower average temperatures and a shorter growing season, although higher rainfall may counterbalance this to some extent.

Wood productivity by agroforestry system class and ecozone

In the following section an attempt has been made to synthesize data of individual systems to determine if there are distinctive differences between system classes and ecozones. Based on the system classification described above, average productivity for each category of system has been calculated and is presented in Table 1. The wide variation covered by the averages is also presented. The difference between systems in the humid and subhumid zones is clear for all three kinds of systems, with productivity in humid areas being 2–4 times higher. Within each zone the differences are less pronounced but agrosilvopastoral systems seem to have a lower average wood productivity, especially in subhumid areas. This may simply be because resources are divided between more components in this type of system.

If productivity data from the three different systems in the humid zone are compared statistically to their correspondents in the subhumid zone, it can be seen that the calculated means are significantly different. Most of the figures at the maximum end of the reported ranges relate to systems using very fast growing trees like *Leucaena leucocephala* and *Calliandra calothyrsus* at very high densities of up to 40,000 trees per hectare. Other variation is due to numerous factors (soil conditions, irrigation and fertilizers) about which information was not available.

Land needs for woodfuel supply

By using figures for country–specific rural household woodfuel need the average minimum area of agroforestry land required to supply the household with sufficient woodfuels has been calculated. For countries where reported consumption is markedly lower than the assumed actual need, e.g. India and Bangladesh, the average consumption for the region as a whole has been used instead. These results are presented in Table 2.

In the humid zone the area needed is surprisingly similar for the three system categories, all requiring around 0.2 ha. In the subhumid zone the area needed is on average 3-5 times higher, with agrosilvopastoral systems having the largest average land requirements. These figures should be compared with the average land holding sizes for the countries in the region. Bearing in mind that these are average figures, it can be seen that, *in countries with a predominantly humid climate, the area of agroforestry required to meet fuelwood needs is roughly equal to 15 -30% of available agricultural land.* Since urban areas, which may often include homegardens, are usually not included in the category of agricultural land, the actual area required may be even lower.

In Bangladesh the required land area could be in short supply, especially in drier areas, although the generally high soil fertility in most of this country may produce higher than average yields. But because many farmers have less than average sized landholdings or none at all, they have to purchase fuel to meet their energy requirements. However, even farmers designated as landless in Bangladesh usually still have a homegarden (Abedin et al.,1990), which can supply part of their needs.

In India the area required would amount to about 50% of average agricultural landholdings (assuming that all household energy requirements are met by woodfuels and cowdung is used as fertilizer). Again, the distribution of landholding sizes means that some rural dwellers must supplement their woodfuel production with purchased wood.

Table 2: Minimum area of agroforestry systems needed to supply one household with woodfuel (ha).

Minimum area in ha		System components		
Climate		AS	SP	ASP
Humid	Average	0.21 (0.27)# (n=11)	0.20 (n=6)	0.20 (n=3)
	Range	0.06-0.8	0.05-0.49	0.15-0.26
Subhumid	Average	0.60 (n=29)	0.59	0.95
	Range	0.08-2.01	0.17-13.4 (1.31)*	0.39-2.56

Notes: # If the least favorable cutting regime that required 0.8 ha, reported from Costa Rica, is included the average instead becomes 0.27 ha.
* If data from Mali and Ethiopia is excluded

Source: Jensen (1995)

In the mountainous regions of Nepal and Bhutan, where productivity is lower, farmers may not be able to supply sufficient woodfuels from average and below average sized landholdings. In Nepal about 65% of the woodfuel is estimated to originate from forests. In Bhutan the figure is probably even larger, although is not precisely known (Ministry of Agriculture, Bhutan, 1991). When looking at the overall forest situation in Bhutan, this consumption does not pose any threat to forest resources at present but problems may exist at the local level. In Nepal considerable efforts are needed to ensure sustainability, like increasing wood productivity, diversifying energy sources, improving energy conservation, etc.

In Pakistan about 27% of woodfuel is estimated to originate from forests. Recently a biomass survey, including all woody vegetation, was carried out in Pakistan using satellite images, GIS and ground surveys (Archer, 1993). The biomass resources and productivity figures obtained were, however, subdivided by agro–ecological zones rather than specific vegetation types or management systems. It is, therefore, not immediately clear how large the wood resources are on farmlands.

For the remaining countries the data suggest that sustainable supply can be achieved through agroforestry practice on roughly 25–50% of agricultural lands.

Individual tree productivity in different agroforestry system classes

For agroforestry systems with lower tree densities, it may be more relevant to look at the productivity of individual trees. This kind of data is presented in Table 3 and, from those figures the minimum number of trees required to meet the woodfuel demands of one household has been calculated (Table 4). Systems with tree densities higher than 2000 per hectare have been excluded from these calculations. These high densities are only possible on very short rotations, before competition gets too pronounced, or with very heavy pruning applied as in alley cropping systems. Obviously there is great variation in the growth and biomass of individual trees. The present figures

Table 3: Annual woodfuel production in kg per tree.

Climate		System components		
		AS	SP	ASP
Humid	Average	26.9	n.d.	n.d.
	Range	12.5-54.3		
Subhumid	Average	12.9 # (n=14)	8.4 (18.7)*	14.8
	Range	2.65-25.0	0.2-17.2 (70)*	3.39-32.3

Notes # High density stands excluded (>2000 tree/ha)
* Including data on Acacia albida from Mali of 70 kg/tree
Source: Jensen (1995)

are based on the various agroforestry systems listed in Attachment A, consisting mainly of young trees, i.e. with high growth rate but low total biomass as compared to mature natural forest trees.

It has been reported that as little as 50–100 trees would be enough to supply, on a continuous basis, the necessary fuelwood for one household (FAO, 1991). Although this seems to be theoretically possible for some agroforestry systems in the humid region, the present data indicates that, on average, a higher number is needed, ranging from 140 trees in humid areas to almost 400 in subhumid areas. This, however, assumes that all individual trees supply some wood for fuel which may not be possible due to variations in specific properties, rendering some species either unwanted or unsuitable (see below). Thus, in general, a higher average number of trees will be required per household unless woodfuel production has a very high priority for the farmer.

Table 4: Minimum number of agroforestry trees required to supply one household with woodfuel.

Climate		System components		
		AS	SP	ASP
Humid	Average	137 (n=4)	n.d.	n.d.
	Range	52-226		
Subhumid	Average	283 (n=14)	365 (n=5)	309 (n=2)
	Range	60-853	41-819	88-489

Source: Jensen (1995)

Factors influencing woodfuel supply

Although conditions for tree growth may be favorable in a given area and production could be as high as the data above indicates, in most situations one or more factors will reduce the actual output to some degree. These factors include:

- Degraded environmental conditions
- Inappropriate species choice for the particular situation
- Farmers give low priority to woodfuel production
- Poor management out of ignorance or lack of interest
- Socio–economic factors limiting credit availability for investment in tree growing or limited resources forcing farmers to focus on immediate needs like food production or off–farm employment.
- Poor infrastructure and distribution network may limit trade flow of woodfuels.
- Policies and legislation related to land tenure or trade in woodfuels.

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Attachment A. Reported annual fuelwood supply of various agroforestry systems (other product outputs not shown)

Country	Type of AF-System					Continuous Supply		Minimum area to supply 1 household (ha)
	Class	Rain/Soil	Tree	Tree density no/ha	Crops	t/ha	kg/tree	
Indonesia	Hum-AS	n.d.	*Calliandra calothyrsus*	n.d.	n.d.	22.8-42.3		0.06-0.11
Indonesia	Hum-AS	n.d.	*Several spp. (Tegalan)*	n.d.	annual	8.4		0.28
Indonesia	Hum-AS	n.d.	*Several spp. (Tegalan)*	n.d.	annual	12.6		0.19
Indonesia	Hum-AS	1500-2500mm	*Acacia mearnsii*	n.d.	annual	7.8-19.4		0.16-0.40
Indonesia W. Java	Hum-AS		*Mixed tree garden (Kebun campuran)*	n.d.	fruit	15.2		0.16
Indonesia	Hum-AS	n.d. (West Java)	*Mixed tree garden (Kebun campuran)*	n.d.	fruit	18.9		0.13
Costa Rica	Hum-AS	n.d.	*Cordia alliodora*	n.d.	cacao	8.3*		0.33
Costa Rica	Hum-AS	2637 mm, Alluvial deposits, moderate fertile	*Erythrina poeppigiana (3 pruning regimes)*	280	coffee	3.5 7.9 15.2	12.5 28.2 54.3	0.8 0.35 0.18
Nigeria	Hum-AS	2200-4320 mm	*Gmelina arborea*	1510	yam, corn, cassava	19.2	12.7	0.15
Indonesia	Hum-SP	Soil pH 6, low sulphur	*Calliandra calothyrsus*	40 000	pasture	22.1	0.55	0.11
Indonesia	Hum-SP	as above	*Sesbania grandiflora*	30 000	pasture	7.1	0.23	0.35
Indonesia	Hum-SP	as above	*Leucaena leucocephala*	40 000	pasture	29.6	0.74	0.08
Indonesia	Hum-SP	as above	*Gliricidia sepium*	40 000	pasture	15.3	0.38	0.16
Asia	Hum-SP	Mangrove	*Avicennia/Rhizophora*	n.d.	aguafauna	13.5-58.5		0.05-0.21
Vietnam	Hum-SP	Mangrove Monsoon, saline soils	*Rhizophora/Avicennia/Bruguiera*	n.d.	shrimp	5.4-9		0.29-0.49
Vietnam	Hum-ASP	Temporarily flooded acid sulphate soils	*Melaleuca leucadendron*	20 000	rice, fish shrimp,	0.8 fuel* 10.2 tot*	0.04* 0.51*	3.51 0.26
Indonesia W. Java	Hum-ASP	Humid tropical	*homegarden*	n.d.	fruit, tubers, vegetables animals	13.1		0.18
Indonesia	Hum-ASP	n.d. (West Java)	*homegarden*	n.d.	as above	15.4		0.15
Thailand	Shum-AS	1000-1500 mm, acrisols	*Eucalyptus sp.*	625	n.d.	2.1	3.36	1.36
Thailand	Shum-AS	(1000-1500 mm)#	*Eucalyptus camaldulensis*	625	cassava	2.64	4.2	1.08
Thailand	Shum-AS	(1000-1500 mm)#	*Eucalyptus camaldulensis*	625	mung bean	4.90	7.8	0.58
Thailand	Shum-AS	(1000-1500 mm)#	*Leucaena leucocephala*	625	cassava	7.15	11.4	0.4
Thailand	Shum-AS	(1000-1500 mm)#	*Leucaena leucocephala*	625	mung bean	9.79	15.7	0.29
Thailand	Shum-AS	(1000-1500 mm)#	*Acacia auriculiformis*	625	cassava	8.73	14.0	0.32
Thailand	Shum-AS	(1000-1500 mm)#	*Acacia auriculiformis*	625	mung bean	14.35	23.0	0.2

India	Shum-AS	1000-1500 mm	*Leucaena leucocephala giant variety*	n.d.	papaya, lemon, turmeric, okra	4.91		0.17 (0.57)a
India	Shum-AS	1000-1500 mm	*Leucaena leucocephala*	10667	maize	5.09	0.47	0.16 (0.55)a
India	Shum-AS	1000-1500 mm	*Leucaena leucocephala*	10667	black gum	6.06	0.57	0.14 (0.46)a
India	Shum-AS	1000-1500 mm	*Leucaena leucocephala*	10667	clust bean	5.07	0.47	0.16 (0.56)a
India	Shum-AS	1660 mm Sub tropical	*Morus alba*	100	rice/wheat	1.78	18.0	0.47 (1.58)a
India	Shum-AS	1660 mm Sub tropical, seasonal	*Grewia optiva*	100	rice/wheat	1.40	14.0	0.60 (2.01)a
India	Shum-AS	1660 mm Sub tropical, seasonal	*Eucalyptus hybrid*	100	rice/wheat	2.6	26.0	0.32 (1.08)a
India	Shum-AS	Seasonal	*Leucaena latisiliqua*	n.d.	fruits	4.10		0.20 (0.69)a
India	Shum-AS	Seasonal	*Leucaena sp*	625	sorghum	6.70	10.72	0.12 (0.42)a
Banglades h	Shum-AS	Seasonal	*Artocarpus heterophyllus*	125	annuals	3.13	25.0	0.29 (0.90)a
Indonesia	Shum-AS	1500mm, seasonal	*Several spp. (Tegalan)*	n.d.	annuals	1.33 fuel 2.03 tot		1.79 1.17
Indonesia	Shum-AS	Seasonal	*Calliandra calothyrsus*	1667 833	maize, fruit	4.41 fuel	2.65	0.54
Indonesia	Shum-AS	Seasonal	*Eucalyptus sp.*	1667	maize	8.82	5.29	0.28
Indonesia	Shum-AS	Seasonal	*Acacia decurrens*	5000	maize	13.86	2.77	0.18
Nigeria	Shum-AS	1250 mm Ferric Luvisol	*Gliricidia sepium*	5000	maize	7.25	1.05*	0.38
Nigeria	Shum-AS	as above	*Flemingia congesta*	5000	maize	3.4	0.49*	0.83
Nigeria	Shum-AS	as above	*Cassia siamea*	5000	maize	14.35	2.03*	0.20
Nigeria	Shum-AS	1280mm Oxic Paleustalfs	*Leucaena leucocephala*	20 000	corn,cowpe	27.5	1.26*	0.08
Nigeria	Shum-AS	as above	*Gliricidia sepium*	20 000	corn,cowpe	10.15	0.63*	0.16
Nigeria	Shum-AS	as above	*Sesbania grandiflora*	20 000	corn,cowpe	7.8	0.49*	0.20
Kenya	Shum-AS	1300 mm Ferric Cambisol	*Leucaena leucocephala*	10 000	maize beans	12	1.2	0.23
Kenya	Shum-AS	1260mm Ferric Cambisol	*Leucaena leucocephala*	50 000	cassava	24.8	0.35*	0.16
India	Shum-SP	Seasonal	*Albizia lebbeck*	400	pasture	3.42 fuel 6.88 tot	8.55 17.20	0.12 (0.41)a
India	Shum-SP	Seasonal	*Albizzia procera*	400	pasture	2.79 fuel 6.68 tot	6.79 16.70	0.13 (0.42)a
India	Shum-SP	Seasonal	*Hardwickia binata*	625	pasture	2.78	4.46	0.30 (1.01)a
India	Shum-SP	Seasonal	*Albizzia amara*	625	pasture	2.15	3.44	0.39 (1.31)a
Kenya	Shum-SP	1260 mm Ferric Cambisol	*Leucaena leucocephala*	50 000	napiergras	24.1	0.35*	0.17

India	Shum-SP	Seasonal	*Albizia lebbeck*	400	pasture	3.42 fuel 6.88 tot	8.55 17.20	0.12 (0.41)a
Kenya	Shum-SP	as above	*Leucaena leucocephala*	50 000	banagrass	20.4	0.28*	0.20
Mali	Shum-SP	700 mm, Ferric Acrisol	*Shrubs*	924-2142	pasture	0.2-0.6	0.2-0.3	5-13.4
Ethiopia	Shum-SP	600-900 mm Regosols, Fluvisols, Litosols, Cambisols	*Acacia albida*	6 20 65	pasture	0.4 1.4 4.6	70*	7.0 2.0 0.6
Indonesia C. Java	Shum-ASP	Seasonal	*Homegarden*	1053	fruit, tubers, vegetables	5.1 fuel (7.6) tot	3.39* (5.05)	0.69 (0.46)
Indonesia C. Java	Shum-ASP	Seasonal	Homegarden	n.d.	fruit, tubers, vegetables	7-9		0.39-0.50

Attachment B. Reported woodfuel productivity of individual tree species (circumstances of production not reported)

Species	Yield (m^3/ha/yr)	Species	Yield (m^3/ha/yr)
Acacia auriculiformis	17-20	*E. tereticornis*	10-40
A. decurrens	6-16	*E. urophylla*	20-30
A. mangium	27-44	*Gliricidia sepium*	8-40
A. mearnsii	10-25	*Gmelina arborea*	20-35
A. saligna	1.5-10	*Grevilla robusta*	15
A. senegal	4-7	*Leucaena diversifolia*	8-42
A. tortilis	4.5	*L. leucocephala*	10-55
Albizia lebbeck	5-28	*Measopsis eminii*	8-30
A. procera	10	*Melaleuca quinquenervia*	10-16
Alnus acuminata	10-15	*Paraserianthes falcataria*	20-50
A. rubra	17-21	*Pinus caribae*	15-40
Anthocephalus chinensis	10-40	*P. halepensis*	3-12
Azadirachta indica	2.4-21	*P. kesiya*	<20
Cajanus cajan	2	*Prosopia alba*	7
Calliandra callothyrsus	5-20 (first year) 35-65 (2nd year onwards)	*P. cineraria*	3-21
Cassia siamea	5-30	*P. juliflora*	4-6
Casuarina equisetifolia	6-28	*P tamarugo*	2-4
Dalbergia sissoo	9-15	*Pterocarpus indicus*	25-40
Eucalyptus camaldulens.	5-30	*Robinia pseudoacacia*	7-24
E. citriodora	15	*Samanea saman (Albizia s.)*	15
E. cloeziana	13-18	*Sesbania bispinosa*	15
E. deglupta	20-40	*S. grandiflora*	5-25
E. fastiga	21-28	*S. sesban*	70
E. globolus maidenii	10-50	*Swietenia macrophylla*	15-20
E. gomphocephala	6-7 (difficult sites) 21-44 (irrigated)	*Tamarix aphylla*	3-5
E. grandis	17-45	*Terminalia catappa*	3.5-8
E. microtecha	5-10	*Trema orientalis*	28-40
E. occidentalis	3-8		
E. robusta	10-35		
E. saligna	19-50		

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F: WOODFUEL UTILIZATION IN INDONESIA

Tjutju Nurhayati, FPSERDC, Bogor, Indonesia

Background

Physical and chemical characteristics

When wood is used as woodfuel, humidity, specific gravity, and chemical composition determine the energy value. Wood with a high moisture content is difficult to ignite and will use part of its free energy to evaporate water content resulting in considerable fuel consumption. The humidity of air dried fuelwood depends on environmental conditions. Because of the high relative humidity in West Java, air dried wood still has a humidity of 15 to 25%. Since the water content of wood influences weight, most fuelwood is traded in volume measures.

Specific gravity is important when assessing the energy value of wood since this indicates the concentration of components which can be burnt per volume measure. Measurement is based on oven dried weight to exclude the influence of water.

Wood with a high resin content will have high calorific value. The resin content of hard wood is generally high. Also the lignin content of wood is an indicator of calorific value. The lignin content is species–specific, but is generally high in coniferous wood. Tables 1 and 2 give some indications. In terms of preference by users, a low ash content is also important while selecting fuelwood species. Normally fast growing species which have a self–regeneration potential are used as fuelwood.

Table 1. Physical and chemical characteristics of some tree species used as fuel.

Species	Moisture (%)	Specific gravity (g/cm^3)	Calorific value (cal/g)
Acacia auriculiformis	67.39	0.72-0.78	4,385
Acacia mangium	44.00	0.60-0.73	4,878
Calliandra sp.	40.31	0.59-0.61	4,237
Hevea brasiliensis	25.03	0.68-0.77	4,246
Leucaena leucocephala	74.0	0.72-0.76	4,399

Table 2. Chemical composition of wood in percentage.

Component	Softwood	Hardwood
Cellulose	41-44	40-45
Lignin	28-32	18-33
Penthosan	8-13	21-24
Extractives	5-7	3-4
Ash	0,9	0.2-6

The role of woodfuel in Indonesia

In Indonesia, biomass energy accounts for 43.25% of the total energy consumption. This high proportion of renewable energy reduces the potential emission of greenhouse gases were fossil energy sources to be used.

Materials Available for Woodfuel

According to a survey on fuelwood production in West Java, village lands contribute to 93.4% of the total production, while forest areas only contribute 6.6%. Most fuelwood production comes from mixed gardens.

Other sources of fuelwood are:

Waste from saw mill industries

In the production process of boards, the amount of waste such as slabs, trimmings and sawdust is higher than the actual end product (Table 3).

Waste from plywood industry

In the newly developed plywood industry in Indonesia, more than 50% of any log will become waste (Table 4).

Wood from forest exploitation

In forest exploitation, only valuable logs are extracted. The top of the tree, starting from its first branch, as well as surrounding damaged trees and felled trees for extraction roads are left on the forest land.

Table 3. Wastewood from sawmills.

	Percentage
Slabs	25.87
Trimmings	11.74
Sawdust	10.60
Total	48.21

Table 4. Waste wood from plywood production.

	Percentage
Log cutting	4.73
Sawdust	1.87
Plywood cutting	3.01
Thickness reduction	1.67
Veneer	19.44
Size reduction	2.96
Core	18.48
Total	52.16

Wood from thinning

Based on a study conducted in Pulau Laut, the amount of wood from thinning forest plantations could be as high as 58.79 m^3 per ha., most of it used as fuelwood.

Rubber plantation wood

For replanting of rubber plantations, 9,400 ha is felled yearly in Indonesia, yielding around 1.1 million m^3/year of rubber wood. Of this amount 71% is produced on Sumatra only. Java and Bali produced 19% between them and the other islands 10%.

Wood Conversion to Energy

Direct combustion

With a sufficient supply of oxygen, wood will burn in a stove at a temperature of around 1200°C. This is the most straightforward way to convert wood into energy, and is the most commonly used.

Pyrolysis

Conversion of fuelwood into charcoal is called *pyrolysis*, a process which takes place when the oxygen flow is controlled. In this process gasses (non calorific and calorific) and tar are released, leaving the main product, charcoal. While heating, decomposition begins with evaporation of water at a temperature of 100°C, followed by decomposition of acetic acid, hydrocarbons, phenols and others at temperatures of 150 to 250°C. The subsequent stage of decomposition which is an exothermic process occurs at a temperature above 250°C. At this stage charcoal is being produced. Table 5 shows the products of destructive distillation of 5 fuelwood species. Depending on the level of technology, temperatures for production can vary between 500 and 1,000°C. Charcoal produced at temperatures higher than 700°C is called white or active charcoal and is of higher commercial value. Most charcoal produced in rural areas is of lower value and is called black charcoal.

Table 5. Charcoal production efficiency and calorific value of different tree species.

species	Charcoal production efficiency (%)	Caloriffic value of charcoal (cal/g)
Acacia aurculiformis	33.31	7,121
Acacia mangium	30.69	7,250
Caliandra sp.	33.68	7,120
Hevea brasiliensis	30.50	7,0948
Leucena Leucocephala	32,82	7,138

Gasification

Wood which is burnt in a reactor with a controlled supply of air will produce various combustible gasses like methane, hydrogen, carbonmonoxide and others. After cooling and purification, the obtained combustible gasses can be used for power generation with a combustion motor or for direct burning.

Biogas

After mixing saw dust with a substrate containing methane producing bacteria, biogass can be produced. In an experiment held at the Forest Products and Socio-economic Research and Development Centre, it was found that formation of biogas at thermophilic temperature in an anaerobic reactor was faster than when produced at other temperature levels.

Use of Woodfuel

Household

Fuelwood is mainly used in households and small scale industries in rural areas. Based on a survey, fuelwood consumption in rural areas is 0.75 m^3/capita/year, while in urban areas only 0.03 m^3/capita/year is consumed. A study on the production of fuelwood for consumption in one household of 5 persons revealed that growth of fuelwood was far behind the rate of consumption. Therefore, efficient use of fuelwood by utilizing energy efficient stoves is very important. For the purpose of energy conservation, a competition was held in Indonesia for the best energy efficient stove. The SAE model from Yogyakarta was chosen as winner. This is a portable pottery stove with a burning efficiency of 17%. To install it permanently, a mantle of clay and sand at a ratio of 1 : 1 can be constructed around it. In this way the efficiency can reach 25 to 30%.

Rural industry

Rural industries are high users of fuelwood since other energy sources are more expensive than traditional production methods. Consumption of fuelwood per unit of product is shown in Table 6.

Table 6. Woodfuel consumption of rural industries.

Industry	Energy consumption in m^3
Brick making	0.45/1,000 pcs
Roof-tile making	0.53/1,000 pcs
Lime indusry	1.08/1,000 kg
Soya sauce	9.08/1,000 ltr
Palm sugar	12.0/1,000 kg

Wood industry

In the wood industry a lot of the waste wood is used by the industry itself, mostly for wood drying. Fuelwood consumption for the same commodity differs between mills. This can be explained by the differences in the stoves that are used.

Drying for plantation products

Cacao and coffee beans, rubber, and tea leaves are typical plantation products which are dried using fuelwood. One type of stove is the heat gasification combuster for cacao bean drying. The consumption of air dried wood is 0.27 kg per kg wet cacao bean. The stove decreases moisture content from 136.6% to 7.2% of the dry weight of cacao beans.

Converting pig–iron

Charcoal can be used as a reductor and energy source in pig-iron smelting. Charcoal used for this purpose must have the following specifications: 70% fixed carbon, 4% ash, 10% maximum volatile matter, and calorific value of 7,000 cal/g. The ratio of charcoal consumed to pig–iron raw materials should be 1 : 1. Assuming a recovery of 25% in the charcoal production process, this results in a use of 4 kg fuelwood/kg pig-iron.

Blacksmiths

Blacksmiths use charcoal as a reductor and energy source in producing various iron tools. To produce a chopping-knife of 500g, 1,300g of charcoal is required to be burnt in a conventional stove.

Conclusions

1. Use of fuelwood plays an important role in conserving other fuels, particularly commercials fuels.

2. Demand for fuelwood is higher than amount produced.

3. Diversification in using fuelwood and wood energy is needed.

4. Fuelwood stoves should be highly efficient in consuming fuel.

5. For continued use of fuelwood, replanting of selected fast growing tree species should be recommended especially in forest areas and mixed gardens.

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G: The Cookstove Component

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Why Energy Planning -- ARECOP'S Point of View

During the early years of improved cookstove (ICS) programmes, in the 1970's and 80's, the use of biomass fuel efficient stoves was expected to stem worldwide deforestation, particularly in countries where biomass was the primary form of fuel for the majority of the population. Because fuelwood users were seen as a major contributor to deforestation, improved cookstoves were linked almost exclusively with the forestry sector.

While the use of biomass resources for fuel naturally does have an impact on the sustainability of the biomass user's immediate environment, more recent data indicate that the largest contributors to deforestation are clearing of land for agricultural purposes and under–regulation of the growing logging industries. Thus, this link to deforestation can no longer be the only rationale for improved cookstove programmes.

In addition, statistics on national fuelwood consumption should be applied with care as considerable data reflect that those categorized as ‘fuelwood users’ often actually rely most heavily on non–wood biomass. Indeed, in many regions, the use of fuelwood is becoming, more and more, a luxury. While many community forestry programmes have included improved cookstove components, in fact, biomass fuel users in most Asian communities rely on agricultural land and home gardens for their fuel needs not forests as is commonly believed.

It has been estimated that less than 50% of fuelwood is collected from forests, with the remainder coming from agricultural land and other sources[2]. Other estimates on national woodfuel procurement suggest that this is quite a conservative estimate. In Thailand, for example, it is estimated that 56% of woodfuel is collected from “around the homes and neighboring land” while 37% is collected from public lands and 7% is purchased[3]. In Bangladesh, “out of the total household energy consumption, fuelwood use varies” from 3.9% to 22%. Cow dung is a major fuel for landless and marginal farmers[4].

With dramatic changes in environmental conditions for marginal farmers in rural Asia, exacerbated by high population growth rates, there is a need for greater agricultural output from an increasingly overburdened land. What may have been viable a few years ago may no longer be adequate for the lives of biomass users. To effectively plan and manage wood energy, we must stop basing our programmes on the assumption that forests are the major source of fuel and assess the use of biomass and it's role in the lives of users at the micro level. The basic need for energy has a seemingly endless chain of implications[5].

Scattered data indicate that many biomass users are forced to be self-sufficient in terms of their fuel needs due to a lack of access to forests. Thus, biomass fuel supply and consumption have fundamental roles in the user's social and economic welfare in relation to their *immediate environment*. Because securing biomass for fuel is largely the domain of women, fuelwood scarcity has implications for the *working roles of women* in rural communities who, with increasingly degraded natural environments, find the time and energy necessary for collection of fuel and water to be significantly increased while soil fertility decreases due to land erosion. Heavier burdens are placed on the land and as woodfuel becomes increasingly scarce, people begin to use agricultural residues as fuel instead of returning it to the soil as natural fertilizer.

From the side of commercially–oriented supply of biomass, there is little regulation of the activities of this *informal sector* that collects fuelwood and, in some cases, produces low–grade charcoal from peri–urban and rural resources. For urban fuelwood users, the rising costs of wood sold by the informal sector consumes large chunks of household incomes.

The implications of biomass scarcity are multiplied further for *small scale industries* that rely on biomass fuel resources. Small scale industries, such as rural food processing enterprises which are frequently managed by women at the household level, often represent the backbone of rural economies and a source of *local employment*. Food processing serves as supplementary source of income for farmers during off seasons and has the added benefit of diversifying the output of agricultural activities. Thus, it contributes not only to household income but to community nutrition as well. The inability to maintain these industries feeds the growing urban migration.

In both households and small scale industries, the use of fuelwood and other biomass for cooking and heating has undeniable *health* consequences. The combination of inefficient cooking technology, increasing use of low grade biomass fuel due to fuelwood scarcity, and the presence of products of incomplete combustion (PIC) in poorly ventilated kitchens has a direct impact on the health of women and children who spend large portions of the day in the kitchen. Implications on health are reflected in the high rate of Acute Respiratory Infection (ARI), which remains the number one cause of infant mortality in developing communities. Further, low birth weight as well as lung and eye disease among women can be linked, in part, to overexposure to excessive smoke and heat on a regular basis[6].

As a comparison, “Health for Millions”, a journal of the Health Association of India, reports that pollution consisting of respirable suspended particles in the average rural Indian kitchen is 100 times higher than the WHO recommended level of 210/mg/person/year and several times higher than outdoor air pollution at a major traffic intersection in Ahmedabad[7]. While studies and available data on the impacts of indoor air pollution, such as those in the numerous publications of Dr. Kirk Smith of the East–West Center, are quite conclusive in linking inefficient use of biomass with poor health. Indoor air pollution, however, remains low on the priority list of research and intervention among medical establishments.

Essentially, the interaction between biomass users and their environment in their quest for energy gives rise to a whole series of chain reactions. These chains can be so long and convoluted that their source, the use of biomass energy, becomes difficult to trace. In spite of growing recognition of the multiple issues raised when addressing biomass fuel needs, ICS technology has yet to be successfully and comprehensively integrated on a large scale into other development programmes with complementary objectives.

While significant progress has been made in the development and application of biomass alternatives, such as solar and photovoltaic energy, micro–hydro energy and biogas, such technology is not yet widely available for current users of biomass fuel.

Meanwhile, wood energy has yet to be fully integrated into national energy planning. The lack of accurate data and awareness of the potentially sustainable use of wood energy among governments in the region means non–renewables are expected to fuel the process of “modernization”. Growing demand for non–renewable energy sources increases dependence on imported fossil fuels and, in countries like Nepal, sets the stage for future “debt traps”[8].

In Indonesia, as populations shift from the use of biomass to kerosene, a common energy switch, the total government expenditure for subsidy of imported kerosene naturally increases. In terms of more immediate benefits for current biomass users, improved biomass cookstove technology must be a priority in national energy planning.

The task before us to make biomass fuel:

- Non–detrimental for users and their environment; and
- A recognizably modern, manageable and viable form of energy in the eyes of energy planners.

Ensuring Fuelwood Supply While Using It Well

To fulfill these two tasks, agroforestry for fuelwood production, in combination with technology for efficient consumption of fuelwood, can act as a fundamental strategy for environmental, social and economic development. Biomass fuel should not be detrimental to the health and livelihoods of biomass users while ensuring it's role in long term energy planning.

Heightening the role of ICS technology and the improved use of biomass is related to the need for improved land management, underemployment, debt cycles and health considerations from urban locations to rural and isolated developing communities[9].

Small scale industries

For farmers who make active use of diverse forest resources or agricultural by–products, small scale food processing is the most common means of generating income. For many farmers, such processing activity is considered to be side income because they identify themselves primarily as farmers. In fact, the income from small industry often represents their primary source of income and thus contributes more to household income than farming.

However, rural small scale industries face growing competition from large scale industries which are generally favored by governments and provided with political and financial support in the interest of national economic development and foreign currency. Small scale industries that utilize traditional technology are, in many cases, entirely left out of this development process. They are often beset with cycles of debt due to systemized dependency on traders and middlemen who transport and sell their goods. Small scale industries represent an overlooked sector of community livelihood. A study on small scale forest enterprises in India reports, the importance of this sector is corroborated by the finding that, if small forest enterprises were considered in calculating the contribution of the forest sector to the national economy, it would be five times higher than is presently estimated[10].

For example, purchase of fuelwood is the highest production cost for palm sugar processors. Also those that collect fuel for cooking experience increasing scarcity of fuelwood resources with low productivity of their land due to degradation of natural resources. This situation is particularly difficult because both raw materials for processing and fuelwood supply are affected by declining productivity of land.

The lack of technological input for effective use and renewal of resources and the poor bargaining position of small scale producers gives rise to an environment of social breakdown, unsustainable livelihoods and inappropriate use of natural resources. Patterns of urban migration and unending cycles of debt, are not uncommon[11].

In 1993, ARECOP carried out a study that focused on the technology, market status and socio-economic conditions of small scale palm sugar processors in India, Indonesia, Sri Lanka and Myanmar. The workshop that followed the completion of these studies concluded that small scale palm sugar processing is a viable source of livelihood that can be sustained with appropriate intervention and technology, including technology for more efficient use of biomass resources. The studies and the workshop participants concluded that the potential contribution of palm sugar to local and national economic development is significant but remains largely unrecognized

Thus, intervention programmes should be broad in terms of the issues to be addressed and the benefits to small scale palm sugar processors should be emphasized. Approached from the viewpoint of woodfuel production and land management, the use of improved cookstoves can conserve agricultural by–products for crop production while actively renewing their woodfuel supply needs. Thus, with the application of improved ICS technology, an opportunity is created for small scale palm sugar processors to maintain their livelihood by utilizing existing resources more effectively.

Alternatively, from the viewpoint of fuelwood consumption, while ICS technology is a vital component, ICS is not be expected to stand alone but serve as a link in a set of intertwined benefits. ICS technology must be integrated into diverse programme objectives.

For example, poor hygiene and inefficient food–processing technology generally go hand in hand. The introduction of improved cookstoves can be implemented as a means to improve hygiene and improve market potential while making more efficient use of available biomass resources. Use of improved cookstoves also has a direct impact on the working conditions of processors. A reduction in the amount of heat that escapes and removal of smoke will positively affect the health of processors.

Biomass upgrading (charcoal and waste briquettes)

As populations shift income levels, or as kerosene and gas fuel become more widely available, those that utilize biomass will tend to take advantage of other forms of fuel. To minimize dependency on fossil–based fuels and encourage populations to stop using biomass fuel, governments such as those of Indonesia and Vietnam, have chosen to introduce coal briquettes as an alternative. The use of coal briquettes on a large scale can have a number of disadvantages, including dangerous indoor and outdoor air pollution.

While research and development on solar and microhydro technology continues, more efficient use of biomass–based energy resources, such as high quality charcoal and bio–waste briquettes, remain under–explored. The development of such technology could have greater acceptance among users, due to greater similarities with their traditional cooking fuels. They also may have more meaningful impact on the environment.

For example, in regions where logging and plywood are major industries, sawdust waste disposal is often unregulated and contributes to environmental pollution. In fact, sawdust has vast economic potential if manufactured into briquettes. It could also eliminate pollution of rivers where it is most often dumped.

The same is true of charcoal. Charcoal has wide popularity among urban populations in Asia. Yet the use of natural resources for charcoal production is unregulated and production techniques are often inefficient resulting in low grade charcoal. In Nepal, for example, it is illegal to produce charcoal and yet Kathmandu has a thriving black market for charcoal, which is produced secretly outside the city using inefficient production techniques. It is then transported by the illegal producers. There are even a number of charcoal stoves on the market in Kathmandu.

Development of charcoal and waste briquette production have high potential for income generation, national economic development, employment and multiple social benefits including entrepreneurship among developing communities. As populations shift up the "energy ladder", coal, kerosene or gas do not have to be the only alternatives.

The potential for enhancing women's roles in community welfare development

The rising frequency of "Women in Development" oriented programmes reflects the felt need among development organizations to actively incorporate women in programme goals, objectives and participatory implementation processes. The development of WID programmes rose partially out of the experience that male community members were most vocal during interactions between extension workers and the community, regardless of who was intended to benefit from the programmes. Women's voices were most often excluded from the process of defining programme direction.

While few can deny that women are the primary caretakers of family welfare within the home, environmental conditions outside the home have the dominant impact on their ability to do so. While women may make a large contribution to household income through home industry (such as food processing) and may rely on local forest resources for this activity, these activities are considered to be secondary and women's role is largely unrecognized particularly in terms of natural resources management .

In fact, the Indian study on small scale forest enterprises quoted earlier also found that the employment generation potential of small scale industries is twice as much as that of larger scale enterprises. Half of the employment generated is by women, as compared to only one tenth in large scale forest enterprises. In addition, in terms of employment, it was found that in India bamboo and cane collection and processing are the most important (400 million womandays), followed by collection of other forest produce (280 million womandays), with fuelwood collection, trade and charcoal making being the third most important with 200 million womandays (excluding the gathering of fuelwood for own use.)[9]

A common factor in the above mentioned approaches to integration of fuelwood supply and consumption is stimulation of local economic development. This is a side benefit that has an indirect, but crucial, relationship to improvement of environmental conditions. The greatest impact is experienced by women. In addition, while economic benefits can be derived from the production and marketing of woodfuel, this places a burden on only one form of income generation. However, an inter–linked set of alternatives for economic benefit can diversify the source of income and the natural resources that are used in its generation.

If successfully managed, this will lead to sustainability of the programme due to continued interest of programme participants. While farmers may agree that it is a good idea to take care of their environment, there must be economic benefits if the changes are to be maintained. Among programmes that have introduced improved cookstoves, it is the extended set of benefits that make this initiative successful and worthwhile.

Maximizing The Cookstove Component

For effective incorporation of improved cookstoves (ICS) into agroforestry extension, work an understanding of how to maximize the benefits of ICS is essential. In addition, while small industry and biomass upgrading provide a link between improved cookstoves and forestry, cookstoves themselves have a further extended chain of benefits which need to be tapped to ensure successful adoption of the stove by biomass users.

The status quo of improved cookstove programmes

The past two decades of improved cookstove programmes have given rise to a number of practical cookstove designs that are adaptable to specific conditions and needs according to users' habits and customs. However, experience indicates that further development is needed.

Common obstacles facing improved cookstove programmes include:

- Technical expertise is highly centralized among a few experts.
- Programme structures de–emphasize the needs of users and are counter-productive.
- Expectations that stove programmes should stand on their own.
- A lack of awareness and understanding on the multiple benefits of improved cookstove technology.
- An absence of multi–sectoral support for stove dissemination efforts.
- A general lack of cooperation among governmental, non-governmental and private institutions.
- While strong in terms of technology, the dissemination of improved cookstoves evolved slowly. The early focus on technical aspects of stove design gave way to greater attention to socio–cultural elements of ICS application in users' homes. It became clear that, even the most technically sound stoves would not be acceptable, if they did not suit the users' cooking habits and customs.

Because dissemination of ICS was expected to make a dent in growing deforestation, programmes have developed a rather top–down, largely subsidized approach to dissemination.

Such programmes represent the “status quo” of ICPs and have common patterns of inception and implementation. These can help us determine what dissemination strategies can be counter–productive in reaching stated programme objectives.

Often programmes in Asia have begun with governmental initiatives to disseminate ICS with programme goals translated into quotas for dissemination. Each agency that participates, whether governmental or non-governmental, thus has an obligation to fulfill it's share of the quota. To ensure that quotas are met, field workers and village cadres are often given monetary incentives for each stove adopted. This emphasis on quotas and the attraction of incentives means that users' needs and their understanding of the stoves is de–emphasized. While the stove may be installed in kitchens, it may never even be used.

Many programmes, whether part of a national initiative or not, place heavy subsidies on the stoves themselves so that users pay only a minimal amount for the stove (usually between 0–50%of market value). While the use of subsidies can be useful to raise awareness during the early stages of improved cookstove promotion, permanent subsidy can give rise to a number of ill effects, such as:

- Because the stove is practically free, it is uncommon for a biomass user to turn down the offer of the stove. Thus, there is a lack of emphasis on the user's needs and awareness.
- The concept that a stove is, and should be, free.
- Unwillingness on behalf of the user to pay for a stove in the future.

Another characteristic of the “status quo” programmes is that technical skills among field staff or trained village cadres is often limited to only the one stove design that has been selected for dissemination. This limits the ability of the ICS disseminators to tailor stoves to the needs of users. This decreases the probability that the stove will actually be used.

Lastly, because an emphasis is placed on fulfillment of adoption quotas, improved cookstove dissemination often becomes a programme in itself and little effort is made to link the benefits of stove improvement with other development objectives. The three benefits most often cited to appeal to potential users are: saves fuel, saves time, and reduces smoke. Quite often improved cookstove programmes are expected to stand alone based only on these three superficial functional benefits.

Although these are the most prominent benefits of improved cookstove technology, these reasons may not be sufficient persuasion for a woman to adopt an improved cookstove in her home. In fact, she may have a number of reasons *not* to adopt the stove. For example:

- What would she do with the extra time she would save
- She doesn't need to save fuel because during the harvesting season she can use agricultural residues
- Smoke is not a problem because she's used to it and, anyway, her mother and grandmother cooked this way, why shouldn't she?

All too often the disappointing stove adoption rates among biomass users can be explained by the lack of dialogue concerning the goals of the programme and the methods to achieve these objectives. While significant effort has gone into ICS, there has been minimum priority placed on investments in improved cookstove technology to ensure future sustainability and as a means for ongoing dissemination.

In the meantime, however, many of those that have supported the dissemination of improved cookstoves, such as international funding agencies and NGOs, have quietly pulled away their support.

Beyond The Status Quo

Fortunately, there are means to overcome the status quo. In cooperation with our partners in the region, we aim to overcome existing obstacles through two inter–linked strategic themes:

- Improved cookstove dissemination that sustains itself through supply and demand, and
- Development of programmes that incorporate multiple benefits for biomass users.

As described above, the technology for cookstove development has largely been in the hands of the implementing agency. The role of biomass users in adaptation of improved cookstove technology has been, for the most part, a passive one. Thus, the supply of both the technology and the actual cookstove has been dependent on the funds of the implementing agency and the energy of its field staff.

The tendency for implementing agencies is to appeal to only the most obvious benefits of ICS. There is a focus on fulfilling quotas determined at the macro level, as well as provision of subsidies that make up the programme structure. There is little, or only superficial emphasis on understanding the needs of the biomass user.

Thus, stimulation of supply and demand for cookstove dissemination requires two things:

- The basic technology must be in circulation in the environment and within the economies of the biomass users
- The users must be conscious of the potential benefits of the technology as applied in their environment.

The stimulation of supply and demand for improved cookstoves

The technology must be in circulation in the environment and within the economies of the biomass users. We refer to this shift in dissemination strategy as commercialization; that is, the process of moving cookstoves into the market arena with commercially–motivated production and dissemination.

Fortunately, there are successful programmes for commercialization to refer to, implemented in Pakistan, Indonesia, Sri Lanka and Kenya. The trial–and–error processes that these programmes have undergone have much to teach us. The basic method used is:

- Stimulate decentralized production and dissemination of stoves by training traditional artisans (potters or metal workers) in the production of stove designs that are suitable for mass production.
- Engage existing marketing channels to transport the stoves to marketplaces (rural, semi-urban and urban).
- Engage in a promotion and awareness campaign for biomass users on the benefits of improved cookstoves.

The role of the implementing agency as a commercially–oriented programme is quite unique. The implementors must take on very different roles and, in some cases, learn different skills[12]. Essentially, the implementor acts as a facilitator to stimulate the commercialization process such that, eventually, the dissemination of ICS sustains itself through a function of supply and demand.

This pattern is not always suitable for remote areas such as the mountainous regions of Nepal due to an absence of local marketing centers. Some improved cookstove programmes in these areas have adopted the concept of commercializing by training local individuals to build stoves in users home for a fee.

Whether it is the stove itself or the service that is being disseminated, the underlying theme supporting the dissemination is *popularization*. To achieve widespread and successful dissemination of ICS, improved cookstoves and related technologies must be popularized and accessible in existing marketplaces. By introducing socially, economically and environmentally beneficial technology into the mainstream market, users can gain familiarity with the device and its benefits. The inclusion of such technology into the commercial mainstream also means employment for manufacturers, traders and retailers, thus contributing to entrepreneurship and local economic development.

Multiple benefit programmes for biomass users

Past efforts to incorporate improved cookstoves in forestry programmes sometimes surfaced due to the need to include women in such programmes. The introduction of ICS was seen as a means to do so. The success of this strategy varies from programme to programme but it seems that ICS has been regarded as a prop for inclusion of women as opposed to a justifiable programme component. The limitations of programmes in the past have led us to re-examine the actual benefits of improved cookstoves.

Through an understanding of the various impacts of biomass fuel use on the environment, socio–economic conditions and health, and by addressing the implications of biomass use *as experienced by the biomass fuel users*, we can better formulate the means through which improved cookstove technology is applied in integrated programmes. Ganesh Shrestha, of the Center for Rural Technology (Nepal) claims, “For the vast majority of people, forests are part of their life and their livelihood. Forest protection disrupts the age–old human–forest relationship. Therefore, the solution lies in effective management of forest resources and expansion of forest-based enterprises along with other renewable energy options.”[7]

For example, small scale industries can thrive with reliable woodfuel supplies. The opposite is also true. The participants of a programme for woodfuel production can directly benefit from conservation of the resources they are cultivating for household or small scale industry energy needs. The use of improved cookstoves as a mean of conservation provides an opportunity for links with local food processing industries, improved land management to ensure sustainable supply, and improving the healthiness of the processing environment. Such a programme has the added benefit of attracting and cultivating multi-sectoral support and input.

Thus, improved cookstoves are not expected to stand alone but, rather, be absorbed in the context of various programmes such as agroforestry extension. The most important feature of such programmes is that *the benefits of such linkages are understood and actually experienced by the biomass users themselves*, *not just by programme planners, evaluators and funding agencies*.

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