# Fuelwood production in traditional farming systems

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**LAND-USE PATTERN IN BANGLADESH *those who actually grow food know the importance of trees***

**An examination of time-tested local systems that combine food and wood production for the needs of farmers.**

The history of fuelwood in the developing world illustrates the dependence of rural communities on forests and trees. Over time there has been a build-up of fuelwood shortages, with new problems continually arising for rural people in meeting their daily fuelwood requirements. At the same time, environments, under conditions of scarcity, have deteriorated. Should these trends continue, in certain parts of the world the very survival of populations will be in jeopardy.

The reasons for the existence of this situation are well documented. Growing population pressure has usually been recognized as the most important single factor. But whatever the relationship between the trend in human population and increasing fuelwood shortages and environmental deterioration, it must be noted that the relationships among rural forestry, traditional farming activity and the role and potential of rural forestry have for a long time been neglected or ignored. Not only could forestry provide sufficient fuel and other goods and services essential to rural populations, but it could also contribute to stabilizing the foundations of food production systems and to stopping or reversing the impoverishment of the rural environment as a whole.

## Traditional farming

Across the world there are fuelwood shortages in precisely those areas that are under the most agricultural pressure. These include all the arid and semi-arid regions under tropical, subtropical and Mediterranean climates, as well as some wetter zones with high population density. The most important features of these areas are the vulnerability of the wood resources and the risk involved in exploiting them because of soil fragility and climatic fluctuations. For both economic and social reasons, the only available energy source for the rural, and part of the urban, populations is organic material, especially wood and charcoal.

Traditional farming systems have often succeeded in integrating useful trees into agricultural activities and in providing a reliable and sustained supply of wood for local needs. A brief description of some of the traditional farming systems illustrates the potential efficiency of rural forestry in a wide range of environments, ranging from the humid to the arid regions.

**Traditional home gardens**

Throughout Southeast Asia (Malaysia, Indonesia, Sri Lanka! Viet Nam, Thailand), on fertile lowlands with high rainfall, traditional home gardens are of fundamental importance in feeding whole populations. In this system, the multi-storeyed vegetation of the tropics is formed of trees useful to man in providing year-round fruit, food, fodder and fuelwood. The upper storey is usually composed of such trees as coconut palms, *Durio* spp., mango trees, star-apple trees *(Chrysophyllum cainito),* and jack-fruit trees. The middle storey has various species of *Eugenia* (the most popular of which is the Java plum, *Eugenia jambolana), Psidium guava, Nephelium lappaceum* and various species of Anonaceae. The under-storey may consist of *Carica papaya* (pawpaw), orange trees and useful plants of the families of Marantaceae, i.e., *Maranta arundinacea,* and of Zingiberaceae *(Zingiber* spp. and *Curcuma* spp.). Here and there *Sesbania grandifolia* is planted at

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| **Using various tree-planting patterns, 2 to 5 percent of farm land can grow trees for fuel and other purposes without any loss in agricultural production, random to provide poles for light-structured buildings, bark for medicinal purposes, and flowers used as mulch to improve soil fertility. On the edge of the gardens, clumps of bamboo are planted.** |

Fuelwood is obtained from pruning, from bamboo and *Sesbania* wood, and from coconut leaves and shells. For a family of five persons, fuelwood requirements can be met by six coconut palms more than five years old. The traditional home gardens have helped to maintain soil fertility and to provide a reliable source of fuelwood. It has been reported that in east Java 63 percent of all fuelwood was obtained from farmyards; and that in central Java 49 to 81 percent of all fuelwood came from home gardens, where quick-growing species such as *Albizia falcataria* were introduced. The production in one watershed in central Java was estimated at between 7 and 9 $m^3$/ha/year.

**The Combretum-rice system**

In Southeast Asia, in areas with an annual rainfall varying from 1500 to 2 000 mm over five to six months, the Combretum-rice system is common. Farming activities consist mainly of rice cropping, which is done in the rainy season, but trees have always been planted in conjunction with rice production. Rice fields are demarcated in the form of squares of I hectare each by small dikes which are planted with two rows of *Combretum quadrangulare* at 1.5 x 1.5 m between and within the rows. Sometimes *Calophyllum insophyllum is* planted on large dikes to produce seeds from which oil is extracted and used for lighting. *Combretum is* managed under a coppice system with a rotation of five to six years. This means that each year farmers cut between one fifth and one sixth of-the total length of their dikes. Fuelwood production from the first cutting is estimated at between 0.6 and 1.0 $m^3$ per 400 linear metres per year. In the second and third rotations, this production may double.

**Bush-fallow systems**

These are adaptations of the shifting cultivation which occurs extensively in Africa, Asia and Latin America among subsistence farmers to reconstitute soil fertility and to supply rural people with fuelwood, fodder and minor forest products. A number of bush-fallow systems are of particular interest.

The gum arabic tree-fallow system has long been used in regenerating soil fertility over large areas, particularly in Kordofan and Darfur provinces and parts of the Blue Nile and Kanala provinces in the Sudan. In this system, crops are grown and gum is produced in a well-defined rotation. A typical cycle begins with the clearing of *Acacia senegal* while leaving important trees *(Balanites egyptiaca)* and cropping with *Pennisetum typhoideum* and *Sorghum vulgare* for four to ten years until the soil becomes exhausted and infested with *Striga hermonthica,* a root parasite of these cereals. In a second stage, *Acacia senegal is* planted or regenerated; in three years these trees reach about I m in height. In a third phase, lasting six to ten years, *Acacia* trees dominate, and they are tapped for gum and used for fodder and fuelwood. Finally, when as a result of heavy tapping the trees begin to die and are cut, the cycle is repeated.

In Kurdistan and in the Zagros mountains of Iran the local people use a system very close to the *Acacia senegal* fallow system, but because the cycle is too short there is a risk of soil deterioration. The system involves the exploitation of natural scrub and bush for fuel. After exploitation, the land is ploughed and cultivated with barley. Then, after only one crop is harvested, it is left fallow for three to five years to allow the natural vegetation to re-establish itself. Total fuelwood production from the vegetated part may be estimated at 15 to 25 $m^3$ for the fallow period of about five years.

In southern Iran, farmers practicing irrigated agriculture deliberately plant crops of *Tamarix* spp. around their fields to protect vegetable crops. When the land is abandoned after the well water becomes salty, they plant tamarisk trees to reduce soil salinity before moving to another piece of land. This, in addition to fuelwood, produces sticks for their vegetable crops. After three to four years the trees are dug up and both roots and aerial parts are used for fuelwood. On the basis of 200 trees/ha, between 4.7 and 6.5 $m^3$ of fuelwood could be collected after four years, in addition to between 0.8 and 1.2 $m^3$ of roots.

Another type of bush-fallow system which has been adopted as a management method for regeneration and enrichment of the dry forest is the "rab-cum-Kumri" system in India. This is a form of the taungya system whereby the dry fuel species are regenerated in patches or strips after one or two years of food crop cultivation. Coppicing of the stools or replacement can be ensured by sowing or planting in case of coppicing failures. This system does not involve the replacement of the natural forest by a more homogeneous tree crop as in classical taungya. Nevertheless, it provides farmers with some fuelwood for domestic use.

**Legume-tree food crops**

This system has been used over a considerable area in semi-arid ecosystems where soil fertility and moisture availability are limiting factors to food crops. Two legume trees are generally used, namely *Acacia albida* and *Prosopis* spp. *Acacia albida is* suited to the savannas or semi-arid zones where rainfall ranges from 300 to 900 mm annually. Dwellers in these zones encourage the regeneration and growing of the tree to maintain soil fertility and to produce fodder and fuelwood. In western Senegal, *Acacia albida* was used to improve millet production and to increase soil fertility. Each tree affects 100 to 300 $m^2$, which means that 100 trees per hectare are enough to maintain indefinitely the nutrient requirements of the cropland. The high population density (80-100 per $km^2$) supported in this region is possible because of successful maintenance of soil fertility.

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| **Traditional home gardens in the tropics help to maintain soil fertility and provide reliable fuelwood supplies. In Java they provide up to 81 percent of fuelwood.** |

*Prosopis* spp., like *Acacia* spp.. have also traditionally been used in agriculture to improve soil fertility in many arid zones. In the Rajasthan desert of India, the dominating tree on agricultural land is *Prosopis cineraria.* As with *Acacia albida.* the farmers carefully nurse young seedlings. After 15 to 20 years, *Prosopis cineraria is* lopped every year for fodder. Average forage yields from leaves are 3 kg/tree/year in addition to 80 kg of branches and small pieces of fuelwood.

### Shade-tree industrial crops

Use of shade trees for industrial crops (coffee, cacao, pepper and tea) is well documented. In Sri Lanka, *Glyricida* spp. provide live support stakes for pepper vines or shade trees for tea plantations. An appropriate pruning operation can yield a limited amount of fuelwood each year. Although this yield may be small on a hectare basis, the potential contribution is large in view of the total area devoted to combination tea and pepper plantations in the tropics.

In Costa Rica, the combination of coffee, laurel and *Erythrina* functions as an effective system. Laurel *(Cordia alliordia)* is kept at a density of 100120 plants/ha and *Erythrina* at 140150 plants/ha. *Erythrina,* being a legume, fixes nitrogen; laurel, through its root system, mobilizes the mineral nutrients in the soil and brings them to the leaf and litter apparatus. A timely pruning of *Erythrina* after the hot season favours the process of flowering and fruiting and at the same time provides a quantity of green leaves which can be buried in the soil. During the hot season, *Erythrina* is not pruned, so it can offer shade and evapotranspiration. Exploitation of laurel on a 10- to 15-year rotation will provide timber and firewood.

Trees planted in shelterbelts and windbreaks to improve local microclimates and to enhance the quantity and quality of crop yields are used in the agriculture of many countries as environmentally effective hedges. Apart from its effect on crop production, the system also provides cash crops and a substantial amount of fuelwood. In many countries of the Near East, local varieties of poplar *(Populus nigra, Populus alba)* have for a long time been planted by farmers along field boundaries and irrigation channels for the dual purpose of producing wood and protecting crops. In Democratic Yemen, for example, a windbreak consisting of two rows of *Canocarpus lancifolius,* established in alluvial soil under irrigation, can produce about 350 $m^3$/km of fuelwood after 20 years, or an average of 17 $m^3$/km/year.

Other examples of rural forestry could also be cited. All show a variety of forestry practices and successful adaptations to meet fuelwood requirements. There are, however, a number of features which distinguish them from classical plantation forestry. First, fuelwood products in farming communities are from a variety of ligneous material and come from a wide range of woody species. Farmers will often plant not one but several species, often multi-purpose species, to cover a variety of specific economic and ecological needs. Another important characteristic in fuelwood production is the selection and planting *of* only those species that provide food, fodder or income directly, or assist in the production and sustenance of these items by maintaining and improving soil fertility. In the subsistence economies, fuelwood was often regarded in the past as a by-product of the efforts to produce enough food for the family.

### Matching the trees to the appropriate systems of agriculture - some examples

| Species | System wherein the species is found | Fuelwood | Timber | Light farm wood | Other uses | Method of propagation | Annual rainfall and climatic/soils conditions |
|---|---|---|---|---|---|---|---|
| *1. Acacia arabica* | Windbreaks<br>Shade trees<br>Bush-fallow | XX | | X | Pods as fodder | Direct seeding on mounds, strip or line | Alluvial or loamy soil; moist conditions |
| *2. Albizzia falcataria* | Shade trees<br>Regular planting in farm forestry | XX | XX | X | | Direct seeding or seedlings raised in nursery | Wide range of soils but prefer loamy soil and good rainfall |
| *3. Bamboo* (several spp.) | Live fencing<br>Regular plantations in farm forestry | X | X | XX | Raw material for cottage | Rarely from seeds<br>Shoot cuttings | Loamy or clayey soil; moderate to high rainfall |

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| | Around houses | | | | industries<br>Shoots for food | | |
| *4. Calophyllum inophyllum* | Shade trees for amenity (roadsides, around houses, public gardens) | | XX | | Burning oil | Seedlings to be raised in nursery | Loamy/clayey soil; moderate to very moist conditions |
| 5. *Cassia siamea* | Shade trees in plantations | XX | X | | | Direct sowing of seed in lines | Heavy rainfall (poor growth in dry climate) |
| *6. Casuarina equisetifolia* | Agri-forestry systems<br>Windbreaks | XX | XX | X | Tannin bark | Seedlings raised in nursery. Planting (1.5- to 2-m spacing) or if too close, early thinning needed | Sandy soil; stand rainfall between 800 and 5 000 mm |
| *7. Combretum quadrangulare* | Rice field dikes | XX | | X | Medicine | Seedlings raised in nurseries. Direct seeding possible | Loamy soil; slower growth on sandy soil; average rainfall 1500 2 000 mm over 5/6 months |
| *8. Cordia alliodora* | Agri-forestry systems<br>Shade trees in coffee plantations | | XX | X | | Direct seeding (mixed success) Seedlings from nursery - wide spacing (unless early thinning) Natural regeneration good | Moist, well-drained sites; rainfall 1500-2000 mm |
| *9. Glyricidia* spp. | Shade trees in plantations or as living stakes | X | | X | | Direct seeding or stumps | Alluvial or clayey soil; high rainfall or moist conditions |
| *10. Grevillea robusta* | Shade trees in tea and coffee plantations<br>Roadside trees | | XX | | | Seedlings from nursery | Sandy soils; 700 to 1 500-mm summer rainfall |
| *11. Leucaena glauca* | Windbreaks<br>Shade trees<br>Planting around houses | XX | | X | Fodder<br>Green manure<br>Nitrogen fixing | Direct seeding or cuttings | Neutral or alkaline soils, poor growth on acidic houses soil; rainfall 600-1 700 mm |
| *12. Morus indica (M. alba)* | Regular plantations for silkworm raising<br>Irrigated roadside or canal planting | X | X | | Fruit leaves for silkworm raising | Direct seeding or branch cuttings | Light sandy soil. Moderate to high rainfall (18002 500 mm) or canal planting |
| *13. Pithecellobium saman* | Shade/amenity trees | XX | X | | Fodder<br>Medicine | Direct seeding or seedlings from nursery | Clayey or loamy soil; high rainfall; moist |

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| | | | | | | | conditions |
| *14. Prosopis* spp. | Plantations for fuelwood<br>Bush-fallow | XX | | X | Fodder | Direct seeding (if irrigated) or stump planting | Dry soil, not excessive moisture; grows on rocky and saline soils |

A third feature of farming communities is their relatively low consumption of fuelwood. Subsistence farmers have traditionally kept their fuelwood requirements in harmony with their actual needs. The practices described above suggest that under such conditions, where land is not scarce and where peasant communities are able to produce their own food and to integrate trees into their land-use systems, immediate and long-term requirements for fuelwood can be ensured, For a number of decades, however, this system has been under increasing pressure from a number of separate and related causes originating not so much in technical factors as in the land-use system itself. Early attempts to improve subsistence agricultural systems emphasized annual cash crops. The extensive cultivation required by such crops reduced the tree cover and exhausted soil fertility. Trees no longer improved soil fertility through nutrient recycling and humus supply, so commercial fertilizers had to be used. Although they were partly successful, they increased farmer dependence. Another factor was the intensification of livestock grazing without due regard to fodder production, which led to greater pressure on available woody resources and to the shrinkage of woody grazing grounds.

With the advance of large rural settlements and the expansion of cities, fuelwood, which used to be a free commodity, entered the market and was traded not only for cooking and heating purposes but also for a variety of artisanal and industrial uses such as brick and lime making, tanning, ceramics and pottery, brewing and food additives. This resulted in a rapid decline of fuelwood resources. Peasant communities found themselves with rising shortages which forced them to search farther and farther afield in order to meet their needs.

**Potential and limits of rural forestry**

The previous discussion strongly implies that rural forestry is the most natural solution to the problem of fuel in the rural areas, and that trees and forest vegetation can be integrated in the traditional land-use system in a variety of ways. Finally, it clearly demonstrates that such integration is not mere coincidence but the result of well-thought-out systems designed to improve subsistence food-production and to control land degradation.

These conclusions have important policy implications in relation to fuelwood production. They suggest a need to re-examine past plantation models, which have been based essentially on intervention in the forest domain and in the so-called wastelands. A concept of forestry is required which will spread across the whole spectrum of land management.

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| In subsistence economies traditional farming does not have exaggerated fuelwood needs. As long as there is enough land, the farmers can integrate trees into their land use so as to cover both immediate and long-term fuel needs. |

The agricultural sector, for instance, ought to include forest trees. Here their role would be to support agricultural production, diversify income and control land degradation.

Between 2 and 5 percent of agricultural land can be opened up for tree plantations according to various tree-planting patterns without any loss to agricultural production. This could have a great impact on the basic problems of food and land amelioration while providing the necessary fuelwood in the rural sector.

The implementation of this policy will require a programme to improve and/or introduce traditional forestry in agricultural communities. It will require the development of a number of technical solutions associated with the integration of tree growing and farming. It will also require that forestry that is now largely production oriented must become oriented as well to agricultural improvement. Fuelwood and fodder production would then become the two most important products. This would require a much more intimate knowledge of the tree species best adapted to the region and the people, but it would not eliminate the need for developing, through genetic selection, fast-growing strains of local and exotic species which are relatively unaffected by local pests, diseases and biotic factors. Nor would it eliminate the need for developing silvicultural systems adapted to different levels of rural production systems.

### The socio-economic framework

Before we can expect any success in the implementation of such a programme, the previous socio-economic framework, which has brought about the over-exploitation of trees on agricultural lands, will need to be fully understood. What will readily work in one region, for example, will not work in another. In some areas, trees and shrubs could be introduced without upsetting the local economy because of large holdings or because of the existence of intensive agriculture. In other areas this would not be possible because land holdings are too small and people are dependent on them for food. In uplands with small farming communities, trees could not be introduced without assistance to those now dependent on plant cover for part, if not all, of their livelihood.

If traditional forestry practices are to become an integral part of rural planning, farmers will have to be the object of special information campaigns and will have to be trained in tree planting and management. This can be done either individually or collectively. First of all, the political authorities will have to recognize that this integration of forestry and agriculture is becoming more urgent all the time because of the combination of increasing population and shortage of wood for man's most basic needs, especially fuel.

- Sponsorship of activities and observances, such as:

- Seminars and debates on the causes of hunger and proposed solutions.
- Analytic and informative newspaper supplements, radio and TV programmes.
- Market displays and harvest festivals; awards for farmers.
- Essay competitions for schoolchildren.
- Special religious services and meetings.
- Stamps, coins and medals issued by governments.