MULTI-STORIED TREE CROPPING SYSTEMS:
A SUSTAINABLE LAND USE SYSTEM

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Abstract

Because of limited land and high population densities, Bangladeshi farmers have developed highly sophisticated multi-storied tree cropping systems. The majority of rural people in Bangladesh rely on their homesteads, rather than on natural forests for a range of products and services. This situation presents an interesting contrast for forestry professionals as they are seen as providing technical advice to maximize yield and better market income generating tree species, rather than enforcing strict policies on extraction and management of forest products. This paper presents how the Bangladesh Agriculture University developed a range of multi-storied systems for different regions of Bangladesh to improve yields of marketable species.

Introduction

In Bangladesh, the need for maintaining the population-food-nutrition balance can hardly be overemphasized. The country, which has only 8.16 million ha of arable land, has to feed about 120 million people. The population has doubled in the last 30 years with a density of 806 people per/km². An important implication of the rapidly expanding population is that the availability of per capita land has declined from 0.19 ha in 1961 to 0.101 ha in 1992. This has put heavy pressure on the land.

Most of the native fruits, vegetables, fuelwood and timber come from homesteads and marginal lands. It has been estimated that 30,000 ha of land provides 80 percent of the country's fruit and 85 percent of the fuelwood and timber (Rahim 1994). Obviously, this situation creates a shortage of food and other forest products. There is little possibility of gaining more land for forestry and agriculture, though through the mixed cultivation of trees and agricultural crops in multi-storied systems increased yields can be obtained. In Bangladesh, multi-layer tree gardens and multi-storied cropping systems are practiced in and around most homesteads. Because of this, farmers have learned through the centuries to maximize the small amount of land they have for the efficient cultivation of a range of products.

These systems, are crucial to Bangladesh because of space constraints in most small farms. A multi-storied technique can provide greater economic return per unit area. Land cultivated in this way can maintain an ecological balance and provide for efficient use of all natural resources. This type of situation, where most wood and tree products come from private farmland, offers an interesting contrast to other areas in Asia where rural people derive most of their forest products from natural or degraded forestland. In Bangladesh, the main focus is not on regulating how farmers manage their farming system, but on how professional foresters and researchers can better understand farmer preferences to maximize yields and generate income through the species that grow within their homesteads.

This paper discusses a multi-storied, agroforestry system studied in a demonstration plot at the Bangladesh Agricultural University (BAU) from 1991 to 1997 with the financial assistance from the Village and Farm Forestry Program (VFFP) of Swiss Development Cooperation (SDC). In order to increase the efficiency of these systems where limited land is available, BAU experimented with various types of tree and plant combinations to maximize yields and income. The experimental plots attempted to focus on certain conditions specific to the different regions of Bangladesh. The study incorporated market preferences and a mix of tree and plant species that could grow well in the multi-storied system.

The Multi-Cropping System

Multi-layer cropping systems are found in tropical and subtropical regions (a majority in the lowland, humid
zones). Population density is generally high in areas of intense, homestead gardening. Equally high are the contents of agroforestry systems which contain food crops and fruit trees. Generally, there are several secondary outputs from the systems. Some of the main advantages for using the multi-cropping system include:

- Increased utilization of scarce natural resources.
- Intercropping of seasonal fruits species with annual crops provides farmers with a continuous source of income during non-bearing years and optimizes land-use.
- Increased biodiversity which reduces pest and disease pressure.

Currently (1998) in Bangladesh, there are 19.7 million homesteads where multi-storied systems could be applied. There are many areas where integration of a multi-cropping system could improve production and yield, including:

- The northwest where fruit trees, such as mango and litchi orchards, could benefit from this system to provide cash during non-bearing years.
- In Madhupur and Gazipur, where jackfruit orchards could be used for a variety of uses.
- In the forest plantations of Chittagong Hill Tracts where banana, pineapple, aroids and cassava could be grown easily.

Issues and Achievements

Structure of the Multi-Layer Home Garden

Generally home gardens consist of a herbaceous layer near the ground, a tree layer at the upper level and an intermediate layer between the two (see Figure 1). The bottom area can be split in two with the lowest section being less than one meter in height and dominated by different vegetables and medicinal plants. The second layer is from one to three meters in height and composed of food plants (such as cassava and banana). The upper section can also be divided in two, consisting of fully-grown timber and fruit trees in the uppermost layer (over 25 meters) and below it, medium-sized fruit and timber trees between 10-20 meters. This type of model can provide an array of products for consumption and sale. The woody and herbaceous species that are most commonly found in these types of systems are also indicated in the figure. In just this small area, a plethora of species can be found which provide a variety of uses and purposes.

Various multi-storied systems developed at BAG

The experimental plots at the horticulture farm of BAU produced a variety of different systems which can be
used in the different regions of the country. The first is a multi-storied cropping system in a three-layer canopy configuration. The first layer consists of aroids (Colocasia) ginger or pineapple, the second and third layers are for coconut. Table 1 shows that this system is economically viable.

Table 1: income from multi-storied cropping system in coconut orchard

<table>
<thead>
<tr>
<th>Multi-storied system</th>
<th>Income (US$ per Ha)</th>
<th>Total per Ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coconut/Banana/Taro</td>
<td>420 + 1,530 + 250</td>
<td>2,200</td>
</tr>
<tr>
<td>Coconut/Banana/Ginger</td>
<td>420 + 1,530 + 2,040</td>
<td>3,990</td>
</tr>
<tr>
<td>Coconut/Banana/Pineapple</td>
<td>420 + 1,530 + 1,260</td>
<td>3,210</td>
</tr>
<tr>
<td>Coconut/Banana</td>
<td>420 + 1,990</td>
<td>2,410</td>
</tr>
<tr>
<td>Monocrop system (Coconut)</td>
<td>540</td>
<td>540</td>
</tr>
<tr>
<td>Coconut/Pasture</td>
<td>540 + 105</td>
<td>645</td>
</tr>
</tbody>
</table>

Another configuration developed consists of papaya and pineapple which flourishes when grown in conjunction with mango. Under the same conditions, another system consisting of mango and pineapple has been successfully tested. These two and three-storied systems have produced high financial returns per unit area (Table 2).

Table 2: Income from multi-storied cropping system in mango orchard

<table>
<thead>
<tr>
<th>Multi-storied systems</th>
<th>Income (US$ per ha)</th>
<th>Total per ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mango (on year)/Pineapple</td>
<td>1,650 + 1,260</td>
<td>2,910</td>
</tr>
<tr>
<td>Mango (off year)/Pineapple</td>
<td>105 + 1,290</td>
<td>1,395</td>
</tr>
<tr>
<td>Mango (on year)/Papaya/Pineapple</td>
<td>1,450 + 605 + 1,120</td>
<td>3,175</td>
</tr>
<tr>
<td>Mango (off year)/Papaya/Pineapple</td>
<td>150 + 1,020 + 1,260</td>
<td>2,430</td>
</tr>
<tr>
<td>Mango/Pasture</td>
<td>1,450 + 60</td>
<td>1,510</td>
</tr>
</tbody>
</table>

Plant and Crop Selection

Careful Species selection is important in multi-storied cropping systems. Shade-tolerant plants and crops are essential, as is the proper maintenance for the system's continuous production. The combination of crops with different production cycles should be synchronized to facilitate an uninterrupted supply of food. Depending on the climate and other environmental factors, there may be peak and lag seasons for harvesting, but in general there needs to be consumable products year round. Though most production is for home consumption, the marketable surplus can be a safeguard against crop failure. A relatively small amount of time is required to maintain the system.

Practices and Management

The management of crops (especially trees) in multi-layered gardens is important for maximizing fruit and biomass production, and for intensifying plant populations (Hossain 1991; Farooque and Rahim 1991; Haque 1991). From planting to harvesting, appropriate horticultural practices should be followed in order to utilize land efficiently, and facilitate production from trees and their associates (Farooque and Rahim 1991). Adequate pruning and training techniques ensure that the proper number of trees per unit area can be cultivated (Rahim 1997), and also allows for healthy growth. The compatibility of fruit and forest trees, as well as other annual crops, should be determined to provide for high productivity yields.
Conclusion

In high density population areas, a multi cropping system is imperative to provide households with enough food for consumption as well as income for other essential goods. Farmers in Bangladesh have practiced a highly sophisticated form of multi-storied cropping for generations and have great experience in maximizing yields within the small amount of land they have.

Literature Cited


Rahim, M.A. 1997. Fruit Tree Management. Frameworking of fruit trees, training, pruning and beating habits of fruit trees. SDC Publication.