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Interplanting of Tamarindus indica L. in Teak Plantations

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INTRODUCTION

Teak (Tectona grandis L.) is a valuable timber tree, whose natural range extends through northern Thailand. In native deciduous forests of that region, it frequently is a dominant species (Gajaseni 1988).

Teak has been a traditional export of Thailand, and has made an important contribution to the economic development of Thailand. In recent years however, there has been a dramatic decline in teak harvest. Total yield from throughout Thailand dropped from about 300 x 10^3 m^3 in 1961 to 39 x 10^3 m^3 in 1985 (Royal Forest Dept. 1985). Harvest has been declining because of lower availability of merchantable logs, due to both legal and illegal overharvesting of the native teak forests (Gajaseni and Jordan, In Press).

In an effort to reverse the decline of available teak, and to insure its future importance in the Thai economy, the Forest Industry Organization of Thailand has organized a system of social forestry built around teak plantations. While this system has had partial success since its inception 22 years ago, there have been ecologic problems due to monocultural plantings, and economic problems caused by the long rotation period for teak. In this paper, we report on an experiment in which tamarind (Tamarindus indica L.), a fast growing legume that yields an important economic fruit, has been incorporated into the system in an attempt to overcome these problems.

THE FOREST VILLAGE SYSTEM

The Forest Industry Organization (FIO) of Thailand has set up approximately 30 'Forest Villages' in the Northern region of Thailand. The primary purpose of the villages is to supply labor for establishment and maintenance of teak plantations. Villagers are mainly landless peasants who volunteer to participate in the program. FIO offers subsidized housing, electricity, schools, and other amenities for families, and a small wage to workers. To further encourage families to join the cooperative system, they are allowed to interplant crops, mainly upland rice and corn, between the teak for the first two years of the teak rotation. The crops can be used by the peasants for subsistence, or to sell in the market.

The practice of interplanting crops during early years of teak
plantation has been called "Taungya" agriculture or forestry. A benefit to the FIO of taungya is that the cultivation of crops reduces weed competition with the teak seedlings. The peasants pull weeds as part of their corn and rice cultivation.

PROBLEMS WITH THE FOREST VILLAGE SYSTEM

Families have the privilege to work a plot of land for only two years. Then they must move their subsistence and economic cropping to another plot. This is demoralizing for the peasants, who would like longer-term control over the land. Peasants sometimes leave the village system in search of greater economic reward or land security. Peasants need a greater interval during which they can harvest subsistence crops, due to the decreasing amount of land for new plantations.

Weeding is another problem with the present system. The farmers pull weeds a part of their corn and rice cultivation, but when crops are abandoned after the second year, weeds invade aggressively, and the FIO must then hire crews to weed the plantations.

Thinning of the teak stand also is an expense for the FIO. Teak is planted at 4 x 4 meter intervals. At that density, shade from one tree will be enough to kill the branches and leaves of the adjacent tree, and ensure a cylindrical, clean bole. However, planting at this close interval results in competition for light, nutrients, and water. Effects are first noticeable before the plantation is 10 years old, and by the time it is 15, it must be thinned, or growth will stagnate. Trees removed by thinning are too small to have much value.

A third problem that may arise as pure teak plantations mature is deleterious effects on the soil, due to nutrient depletion. Some foresters of the region predict that pure teak can be grown on a site for only two rotations. Following that, a fallow with another species may be required.

TEAK FORESTS AND PLANTATIONS

Teak forests of Northern Thailand are heavily dominated by teak. Near Lampang in the Mae Moh valley, teak biomass constitutes 76 percent of total standing forest biomass in 10-year-old stands. Based on measurements of stumps in these forests, the standing crop of teak in these forests before logging was estimated to be 400 t/ha, and to represent 89 percent of total forest biomass (Gajaseni and Jordan In Press).
It is not clear why teak is so dominant. It may be due in part to the fire resistance of this species. Northern Thailand has a highly distinct 4 1/2 month dry season (Gajaseni 1988). During this season, fires can spread rapidly through native forests, and fire-resistance may favor teak in a competition with other native species. The strong dry season and associated fires also may inhibit pests and parasites of teak. Teak near Lampang appears relatively free of insects and disease when compared to plantations in regions where there is no strong dry season, such as Eastern Puerto Rico (Jordan, Personal Observation). There is also the possibility that teak may have an allelopathic affect against some of the other native plant species.

Although the deciduous forests of northern Thailand are heavily dominated by teak, when dominance is calculated as percent biomass, other species are common in the mature native forest (Table 1).

Table 1. Species composition in a mature mixed deciduous forest with teak, Lampang, Northern Thailand.

<table>
<thead>
<tr>
<th>Species</th>
<th>Density (no./ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tectona grandis L.</td>
<td>303</td>
</tr>
<tr>
<td>Xylic kerri C.&amp; H.</td>
<td>44</td>
</tr>
<tr>
<td>Careya arborea Roxb.</td>
<td>22</td>
</tr>
<tr>
<td>Diospyros mollis Griff.</td>
<td>16</td>
</tr>
<tr>
<td>Nauclea orientalis L.</td>
<td>16</td>
</tr>
<tr>
<td>Terminalia belerica Roxb.</td>
<td>16</td>
</tr>
<tr>
<td>Lagerstroemia sp</td>
<td>11</td>
</tr>
<tr>
<td>Schleichera oleosa Merr.</td>
<td>5</td>
</tr>
</tbody>
</table>

DIFFERENCES BETWEEN NATIVE TEAK FORESTS AND PLANTATIONS

An important difference between teak in the native forests, and teak in plantations is that in plantations, the trees are all of the same age, while in native forests, they are of mixed age. This difference is important for efficiency of resource utilization. When trees are all of the same age and have been planted at intervals of 4 meters, competition develops during the first decade. The crowns of the trees are all at the same height, and leaves of one tree interfere with light interception by leaves of another tree at that level. Yet considerable light reaches the floor untilized, and provides a resource for weed competition. In even-aged plantations, roots too, are competing for the same nutrients and water since root systems probably are more or less equally developed.

In contrast, in native forests where trees are of different sizes and ages, there appears to be more efficient utilization of resources. Leaves form different strata, and light that filters through the canopy is utilized by trees at intermediate and lower strata. The larger trees presumably
have deeper root systems, and can utilize nutrient and water resources at lower levels. When a large old tree dies and falls over, there are usually many younger trees already established nearby, that are able to utilize the resources released due to the death of the larger tree.

MULTIPLE CROPPING SYSTEMS

To reduce the economic and ecologic problems of the taungya plantations, we are modifying the system into a type of multiple cropping system. Multiple-cropping agricultural systems are often more efficient, both ecologically and economically, than monocultural systems (Francis 1988), especially where large scale, capital and energy intensive systems are not practical.

Multiple-cropping systems may be ecologically efficient for various reasons. In the lowland tropics, where soils frequently are of low fertility (Sanchez 1976) and fertilizers may be prohibitively expensive, the use of multiple cropping systems may be important. Different species usually require different relative amounts of each nutrient, and multiple-cropping will utilize more completely the complete stocks of all nutrients which become available in the soil. Resistance to pests also may be greater in multiple-cropping systems, because the variety of plant species may make it more difficult for insect predators to locate desirable host individuals. Weed species, too, may be more easily controlled in multiple-cropping systems, because the soil has a more continuous or complete coverage with a variety of crop species than with a single species.

Multiple cropping systems may be more economically efficient, in the sense that a variety of crops will increase stability of income throughout the year. It can buffer the farmer against disaster due to the poor performance or failure of one particular crop. It can also buffer the farmer against vagaries of price changes offered for various crops. When multiple cropping systems include a subsistence component, this can further protect the farmer against unfavorable economic conditions.

A multiple cropping system may have advantages over monoculture plantations, as well as over even-aged plantations. In an experiment to exploit the advantages of a multiple cropping system over a monoculture plantation, we are working together with the Forest Industry Organization of Thailand to interplant tamarind (Tamarindus indica) with teak.
THE MODIFIED TAUNGYA SYSTEM

In our experimental system, teak is planted at intervals of 12 meters. Tamarinds are planted at 4 meter intervals between the teak trees. Then between the trees, upland rice and corn are cultivated for two years, just as in the taungya system.

The advantage of the modified system begins after several years. Tamarind can begin yielding a harvest after several years. These fruits have a high economic value in the Thai marketplace. The tamarind can supply an economic income to the peasants for perhaps 15 or more years. This would alleviate part of the peasant farmer's problems with the taungya system by allowing them a long-term commitment to a parcel of land.

There are advantages of this system to the FIO also. To ensure good production of the tamarind, the peasants need to weed the plot for many years, thereby decreasing the labor needed to weed the teak. Regarding the problem of ensuring proper form for the teak trees, the tamarinds will shade out the side branches of teak, and ensure good cylindrical growth of the trunk.

Eventually, perhaps after 15-20 years, the teak will overtop and shade out the tamarind. This is another advantage, because in contrast to the pure teak plantation, thinning will not be necessary. The differential structure of teak and tamarind will ensure self-thinning. This should save the FIO additional labor expenses.

Tamarind also may counteract a trend the for the teak to deplete the soil nutrients. We do not know yet if tamarind in this region fixes nitrogen, but we are planning studies to determine this.

TRAINING CAPABILITIES

The experimental modified taungya system will serve as a training and extension center. The project will be a focus for thesis research for Master degree students in the Biology Dept. at Chulalongkorn University. As the program develops a Doctoral degree, the site will be an opportunity for dissertation research.

The research site also provides an opportunity for extension. In March 1989, the project sponsored a workshop for the leaders of the 30 forest villages in Northern Thailand, to explain to them our new system. A major emphasis of the meeting was a series of lectures focusing on ecological principles applied to forest management.
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**PROGRESS**

The research site was selected in 1988, and about 10 hectares were prepared for planting between Jan. and March 1989. The planting took place during May of 1989. In one small section of the plantation, the peasant workers substituted Jack fruit (*Artocarpus heterophyllus* Lam.) for one of the two tamarinds in the interval between teak. As of October 1989, the entire plantation had been successfully established.

**IMPLICATIONS**

The problems encountered in the teak plantations, such as competition, need for thinning and weeding, and the long time interval until economic income are common problems in monoculture plantations throughout the world. The idea of interplanting fast-growing legumes that yield economically valuable fruit between longer-lived trees planted for timber could be tried in many regions throughout the world, and with a variety of species combinations. It might be anticipated that such combinations might be both ecologically and economically superior to uniform monocultures.

**CONCLUSION**

In general, native forests appear to utilize light, water, and nutrients more efficiently than plantation forests, due to the diverse sizes and resource requirements of the many species in the native forests. For this reason, we anticipate that the mixed species plantation described here will be more productive at a lower cost than a pure monoculture stand of teak.

**REFERENCES**


**ACKNOWLEDGEMENT**

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