



## Agroforestry systems: A primer

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**Classical forestry's failure to win the support of rural communities poses a serious economic and environmental threat. Napoleon T. Vergara proposes a classification of the various subsystems of agroforestry as a step toward a new kind of community forestry.**

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Among Third World countries, there is a rising tide of concern that the practice of classical forestry - i.e., the raising and management of long-term forestry crops on a massive scale to produce large-dimension timber for commercial or industrial purposes - only increases the disparity in the distribution of wealth. Classical forestry, it is believed, makes a few wealthy individuals richer and the great number of rural poor worse off than ever before.

There is likewise increasing evidence to show that despite the long-term nature of these forestry activities, there is minimal beneficial socio-economic impact upon the rural populations in terms of economic opportunities and community stability; and that very little of the wealth extracted from the forests filters down to and remains in the rural communities. It is no wonder, therefore, that rural inhabitants find very little motivation to support government forestry conservation and restoration programmes.

Their lukewarm attitude toward forestry means that, given a range of prospective uses of upland or hilly land, farmers relegate forestry use to the lowest priority and elevate intensive cropping with annual food crops to the highest. The consequences of this land-use decision upon fragile uplands are well known: general site degradation through soil and nutrient loss, and serious downstream impacts in the form of sedimentation, water pollution, adversely altered hydrologic character, and overall reduction in productivity and sustainability.

Many observers believe that it is both necessary and possible to alter the nature of forestry practice in developing countries in the following ways: (1) make forestry smaller in scale (village rather than industrial); (2) make forest resources (land and vegetation) accessible for use by rural populations rather than keeping them as the monopolistic domains of industrial firms; and (3) integrate forestry more closely with farm operations in order to involve the farmers more intimately and enable their food crops to benefit from the supportive role of inter-cropped trees. In short, forestry practice should be converted from industrial forestry to village or community forestry.

Besides down-scaling, the other important result of conversion from classical to community forestry would be a widened range of cropping systems. No longer would forestry remain pure forest cropping; it could range from pure forestry at one extreme to the integration of tree

crops and annual food crops and livestock at the other. This means the inclusion of agroforestry, a land-use technique that falls under the umbrella of community forestry.

Agroforestry systems Agroforestry has been loosely defined as "trees plus any other crop", or as "combining trees with food crops", but the most objective and comprehensive definition advanced so far is as follows:

Agroforestry is a system of land use where woody perennials are deliberately used on the same land-management unit as annual agricultural crops and/or animals either sequentially or simultaneously, with the aim of obtaining greater outputs on a sustained basis. (ICRAF, 1983)

This definition has generated some degree of disagreement. Central to the debate is the nature of the perennial crop component of this system. "Perennial woody crops" could embrace fruit trees as well as timber-bearing or forest trees, and using this general term rather than specifying "forest crops", as implied in the name "agroforestry", has caused foresters to fear that the system may be used as a devious way of converting forests into orchards. Those with the opposite view argue, however, that this cannot happen over all forest lands, that such physical factors as soil quality, topography, elevation and accessibility, acting in concert with socio-economic factors, will serve to limit the conversion of forest lands to other uses.

### [INTERPLANTING ON A CHINESE COMMUNE \*Cunninghamia\* \(Chinese fir\) and vegetables](#)

## Classification

Some confusion about what agroforestry really is has arisen because of the profusion of names and terms contrived and used by various researchers in different regions (Combe and Budowski, 1979). To be sure, many of these terms are not interchangeable, and the confusion becomes more serious when users, unaware of the slight shades of variation in meaning and coverage, use them indiscriminately. It is necessary to bring some order through classification and appropriate nomenclature.

The first task is to find major systems of agroforestry under which the various types or subsystems could be grouped. The above definition of agroforestry shows that the component crops are arranged either temporally or spatially; thus, these two crop arrangements can serve as principal categories, as follows:

Crop rotation system (based on temporal arrangement of crops). As the name implies, this system includes all agroforestry types in which the annual food or cash crops are alternated with tree crops over time. There are in this category two types of crop rotation (see Fig. 1):

- *Swidden or shifting cultivation* is the oldest known agroforestry practice, dating back to the beginnings of the human transition from the hunting and gathering phase to the plant domestication and cultivation system of livelihood (Myers, 1980). The forest is cut, dried and burnt to clear the land for planting and to return the nutrients trapped in the forest biomass to the soil to be used by the food crops. Cropping lasts for about two to three years, after which the land is left over a longer period (eight to ten years) to forest fallow in order to rejuvenate the soil (Fig. 1a) and to prepare it for the next cycle of burning and cropping (Sanga, 1978).
- *Taungya*, which had its origins in Burma in the mid-1880s, was the first "modern" (as opposed to "traditional", as in swiddening) agroforestry practice, it was designed as a low-cost governmental approach to the reforestation of open

lands. Farmers are temporarily allotted government lands and contracted to plant desired tree species. While the trees are young and before the canopies close (one to three years, depending on the initial spacing and the inherent crown structure of the tree species), the farmers are allowed to plant food crops whose yields become theirs entirely and are regarded as their compensation for planting the trees. When food cropping is no longer possible, because of shading, the farmers are transferred to another open area where they repeat the process. Meanwhile, the "abandoned" area is by then a well-established forest and will not be cultivated for annual food crops again until the planted trees reach maturity and are harvested.

The rotation between trees and annuals under the taungya system is slightly different from that in swiddening in the sense that there is a temporal overlap between the crops (Figs. 1b and 1c). Another difference is that the tree crop during the fallow consists of systematically spaced and selected tree species rather than those that are randomly capable of natural regenerating or sprouting in an abandoned swidden.

### **Figure 1: Agroforestry crop rotation system**

*Intercropping system* (based on the spatial arrangement of crops). Under this system, the annual and perennial crop components are simultaneously present on site but are spaced in such a manner that they become mutually supportive rather than competing. Under such circumstances, they may jointly yield higher outputs per hectare per year. Four subsystems are found under this type (see Fig. 2):

- *Border tree planting* (Fig. 2a) is often found where farmers use lines of trees specifically as boundary markers, live fences, wind-breaks or fire-breaks. These functions complement their services in protecting or stabilizing the site, in producing green manure as organic fertilizer, in producing fodder for farm animals and in producing fuelwood.
- *Alternate rows* (Fig. 2b) and *alternate strips* (Fig. 2c) are referred to in the literature as "alley", "avenue", "corridor", "zonal", or "hedgerow" cropping (a "strip" differs from a row in that it is composed of two or more rows). When positioned across the slopes or along the contours, they are found most effective for erosion control and slope stabilization.
- *Random mix* (Fig. 2d) is a subsystem that displays no specific or orderly placement of the component crops. While the arrangement appears chaotic, the plants actually occupy their own special ecological niches and are able to coexist very well. Many of the home gardens of Indonesia and the Philippines are of this type (Christianty *et al.*, 1982).

### **Figure 2a: Intercropping system**



Figure 2b: Intercropping system

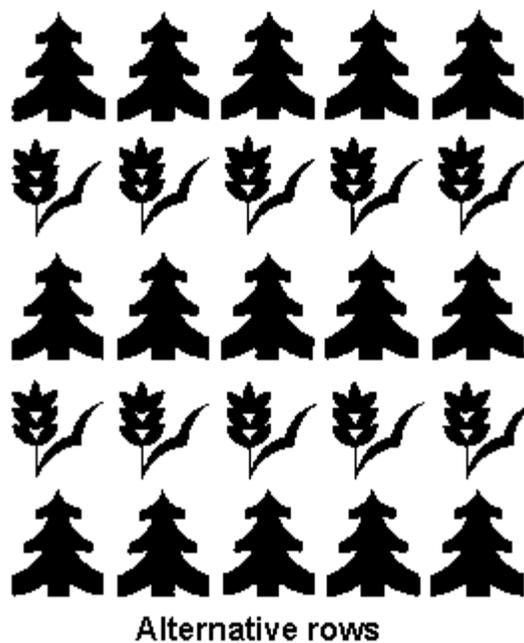
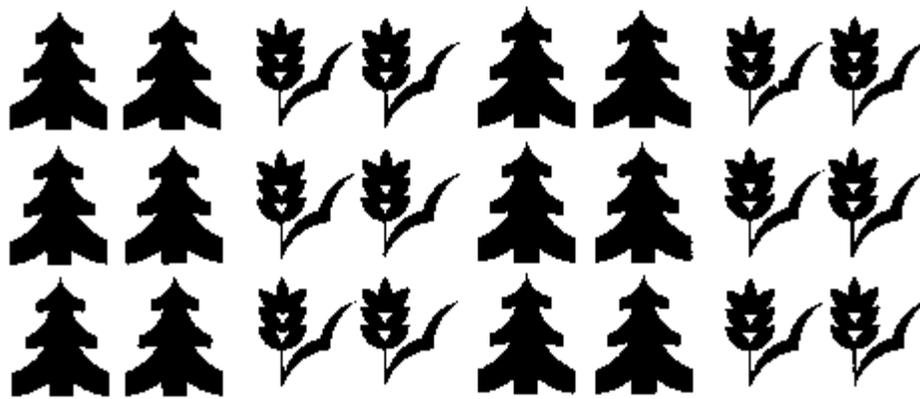
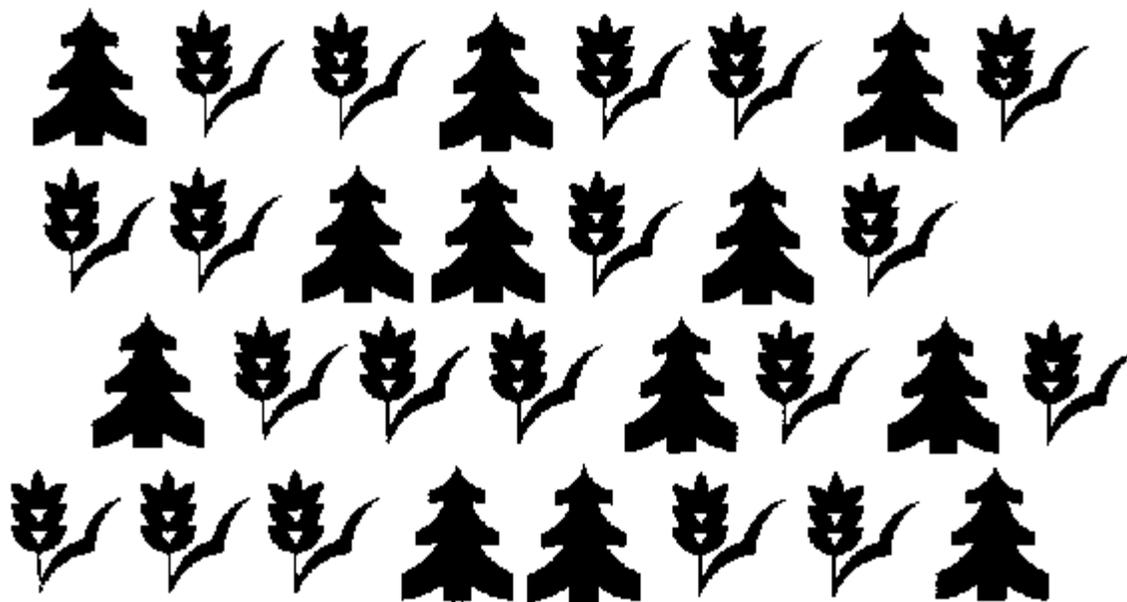


Figure 2c: Intercropping system



Alternative strips

Figure 2d: Intercropping system



Random mix

There is still another group of names that need to be classified. The term "agrosilviculture", for instance, is often seen in many publications and has come to be regarded mainly as a synonym for the broad term "agroforestry". However, in reality, it has a different and more precise meaning than similar compound-word terms such as "silvi-agriculture", "silvipastoral" and "agrosilvipastoral". A closer scrutiny of these terms reveals that the hierarchical order of the component crops in the compound names indicates an order of dominance among those crops. For instance, "agrosilviculture" implies that agricultural crops dominate over forest trees, while "silvi-agriculture" indicates that forest crops dominate. This order of dominance is illustrated in a graph (Fig. 3), where cropping systems are shown as a continuum over which appears a range of varying crop combinations.

Because of the competition for space between the major crops, forestry and agriculture, an increase in area allocated to one of them automatically results in a reduction of the area allocated to the other - provided, of course, that the entire area is always the sum of the two allocations. In Fig. 3, for instance, point A, at the extreme left, shows that 100 percent of the area is allocated to agriculture. Similarly, on the right (point E), the area is wholly assigned to forestry. At any point between these two extremes will be found agroforestry systems with varying ratios of land allocation. At point B, for example, agriculture dominates, so the system is "agrosilviculture". At point D, on the other hand, forestry is the dominant crop, so the system

may be properly termed "silvi-agriculture". A situation can arise, as shown in point C, where the crops get an equal share of the land. In that case, either of the two terms could be used.

### **Figure 3: Allocation of crop components in agroforestry**

The problem with the use of this graph, which attempts to show the integration of the component crops, is that it is only two-dimensional. It is thus difficult to use in multi-component agroforestry, such as when the livestock element is added. To remedy that weakness, another graphical presentation can be used (Fig. 4). While this new graph is able to show more than two elements or components, it is incapable of showing the degree of dominance of the elements involved. The choice of either Fig. 3 or Fig. 4 as a means for classification would depend on what the user wants to illustrate or emphasize.

### **Figure 4: Three types of agroforestry**

## **Current tropical agroforestry systems**

Swiddening as a form of crop-rotation agroforestry is, as indicated earlier, the oldest of the agroforestry systems. In the recent past, when population pressures were low, its practice was tolerated, since the fallow periods between food cropping are sufficiently long to enable the sites to regain their productive capacities, thus making the system sustainable. As pressures mounted, displaced lowland farmers brought and used lowland techniques on hilly lands and drastically shortened or even eliminated forest fallows. The sustainable nature of swiddening was thus lost, with the result that ecological degradation has accelerated both on-site and downstream. Swiddening has thus become a problem of immense magnitude. Almost all tropical countries are now united in condemning and campaigning against environmentally destructive forms of shifting agriculture. Forest policies and enabling legislations and regulations are directed against the forest farmer. Despite these regulations, however, the farmers persist in practicing swiddening, for want of a more suitable and more acceptable alternative for survival, so the problem has remained.

Taungya, which originated in Asia, achieved some degree of success at the start and was adopted by governments of other countries in equatorial Africa and Latin America. Of late, however, farmers have grown wary of the system because it grants no guarantees of tenure over land, and participants usually have to shift from one location to another every three years. Thus, there has been a decline in the number of participant farmers. The irony is that the more successful the cooperating farmers are in establishing the tree crop, the sooner they will be transferred by the government to another open site. Consequently, some of them are motivated to "fail", and they deliberately cause failures by killing young trees.

Another reason for the decline of *taungya* is the growing realization among farmers that their "compensation", solely in terms of the yields of their food crops, is less than those of other reforestation workers under normal wage arrangements. Consequently, government projects now have to supplement the "wage in kind" with cash wages. The only exception to this is in places where population pressures are great: here, *taungya* rights are frequently auctioned.

**One important result of conversion from classical to community forestry would be a widened range of cropping systems.**

**Under *taungya* systems, the irony is that the more successful farmers are, the sooner they are transferred to another site.**

Border tree-planting On good, level lands, where farmers are not beset by extreme problems of site degradation through erosion and runoff and therefore do not require the protective role of trees, the motivation to intercrop with perennials is low, and the desire to use every square

metre of good land for food crops is great. Thus, it is normal to find vast areas of level crop-lands almost treeless.

However, border tree-planting as a form of agroforestry on lowland areas is gaining adherents for several reasons. With the rising prices of energy, including biomass energy, farmers are increasingly producing fuelwood for their own use and for sale instead of being dependent on kerosene or other non-wood fuels. Fast-growing, multipurpose trees are planted along property borders; they are lopped off periodically for fuelwood and their leaves are also harvested and used as fodder or as green manure. In addition, normal litter-fall serves as added green fertilizer for the food crops.

Another frequent reason for border planting is the need for permanent fence posts around the farms or home gardens. Live trees used as posts do not require frequent replacements like the untreated cut poles that decay rapidly under humid tropical conditions. And if prices of wire fences that need to be strung between posts become prohibitive, farmers can plan closely spaced trees that themselves serve as a fence or hedgerow.

Alternate rows and alternate strips Because most areas occupied by migrant farmers and earmarked for government agroforestry programmes are "problem" areas in the sense that they are on sloping, degradation-prone lands which need either conservation or rehabilitation, the most favoured agroforestry systems have become the alternate-rows or alternate-strips systems, otherwise known as "alley cropping". The reason is that, as indicated earlier, rows or strips of trees planted close together to form contour hedgerows are the most effective vegetative means to stabilize and conserve soils on slopes. This is almost as effective as terracing, and yet it is much easier and less laborious to undertake. Moreover, if the trees selected are capable of fixing nitrogen and are able to regenerate by coppicing, they could serve as a steady source of organic fertilizer to rehabilitate a degraded site.

Random mix remains to this day the mainstay of the traditional smallholder polyculture systems in much of Asia, particularly in the case of the well-known Javanese home gardens and the coconut-based Philippine polyculture. The multi-tiered crowns of the integrated plants, ranging from root crops through grain crops and small fruit trees (cacao, Lansium) to the dominant coconuts, are close replicas of a multi-level tropical rain forest and represent highly efficient utilization of soil surface, vertical space, nutrients, moisture and solar energy. It is probably for this reason that the system has persisted and remained sustainable in these countries over many decades.

On small landholdings that have not been severely degraded, the random mix system could be introduced and maintained, as in the example of the Javanese home gardens, where farmer plots are often just a fraction of a hectare.

However, for rehabilitating and maintaining wide areas of badly eroded and depleted lands, random mix may not be as effective as, say, contour hedging or alley cropping.

## **Prospects for a sustainable agroforestry**

Both scientific and empirical sources of information have advanced the reasons for the greater stability and higher level of productivity of agroforestry in comparison with monocrops. Using these same scientific bases, modified and improved agroforestry systems can be designed and disseminated among traditional farmers for possible adoption. For instance, random mix home gardens can be modified into contour hedges or alternate rows or alley cropping for better site protection and, eventually, for greater and more steady productivity. Provided that farmers are enabled to participate actively in the conceptualization, planning and development of the agroforestry projects and programmes, they will become more readily inclined to adopt the system and thus move closer toward achievement of ecological stabilization and sustained

yields in agroforestry.

### [WIND-BREAK ON AFGHANISTAN FARM trees bring benefits - but also birds](#)

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