Agroforestry - Agroforestry Systems

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From an agroecological perspective, agroforestry systems (AFS) or agroforests are forms of land use that combine the production of agricultural crops and/or animals with forest species, simultaneously or in sequence, in the same area. These systems seek to reconcile increased productivity and economic profitability with environmental protection and improved quality of life for rural populations. Each crop or species is planted according to its ecological requirements, thus enabling its normal development, meeting the need for nutrients, water, light, and space (height, diameter, and type of canopy), all of which are carefully combined.

This practice is very interesting for peasant family farming because it combines economic and environmental advantages. The sustainable use of natural resources combined with less dependence on external inputs results in greater food and economic security not only for farmers but also for consumers.

We see agroforestry systems not only as a silvicultural technique or a natural resource management approach but also as an agroecological practice for conserving biodiversity, soil, and water in tropical areas. This is because it promotes sustainable agricultural development objectives for farmers with scarce resources, such as family farmers, providing socio-environmental and economic benefits that counteract the impacts of monocultures.

In addition, SAFs play an important role in conserving biological diversity in devastated and fragmented landscapes, establishing habitat and resources for animal and plant species, maintaining the connectedness of the landscape, reducing the adverse effects and pressure on remaining forest fragments; and providing buffer areas around protected areas.

In this way, agroforestry practices should be considered in efforts and public policies for broad landscape conservation that protects the remaining fragments and promotes the maintenance of tree cover in agricultural production areas, both around protected areas and in the areas where fragments connect. This strategy has been used in some conservation projects

with communities around protected areas and in watershed management in different regions of Brazil, where agroforestry systems have been developed in a participatory way with communities as an economic alternative that enables the conservation of natural resources.

An agroforestry system uses the local ecosystem as a reference for its design and management, observing the structure, function, and dynamics of local species, seeking to establish a system that is analogous to what occurs in the region in the sense of imitating nature. In this way, we can associate agriculture and forestry with the principles of natural succession, taking into account the temporal arrangement of the system, the ecological characteristics of the species involved in the system, both arboreal and herbaceous, and their ecological and economic purposes.

With light as the primary force that produces life, natural succession is the process by which plants organise themselves in space (tree height, canopy size) and time (life cycle, production, accumulation of organic matter) to optimise the sharing of resources and the use of solar radiation. In this way, groups of hardier species, known as pioneers, such as the embaúba (Cecropia spp.), facilitate conditions for groups of more demanding species, such as the juçara. In this way, the system will be able to recover more quickly from disturbances and return to its original state without too much damage.

To make it possible for all these complex succession dynamics to take place in the best possible way, constant management is needed to lead to the evolution of the system. To do this, we must be inspired by the renewing beings that manage natural succession in natural forests. These elements can range from lightning bolts that open up clearings and allow new life to pulsate to sawyer beetles that carry out meticulous pruning in forests all the time. Inspired by the natural agents that drive the dynamics of succession, the manager should always seek to accelerate processes that would occur naturally but much more slowly. In view of this, three fundamental management deserve to be emphasised: ground cover, selective weeding, and pruning.

Ground cover

It is essential that the soil, both in the beds and between the rows, is always covered with a good layer of organic matter. On the beds, a layer of fine straw is

usually used to facilitate planting, and between the rows, it is best to place wooden logs and coarser material for slow decomposition. This management:

- benefits the maintenance of moisture in the soil;
- benefits plant nutrition;
- prevents soil compaction;
- increases the amount of life in the soil, including mycorrhizae;
- reduces the appearance of spontaneous plants.

Selective weeding

It consists of selecting the species that appear spontaneously in the system, weeding them with a hoe, and incorporating them into the soil when they are unwanted. It is important at this point to interpret why these species have appeared in the system so that these spontaneous plants are no longer problems but indicators. Guanxuma (Sida rhombifolia), for example, often indicates points of soil compaction.

Pruning

It allows for fundamental adjustments in tree growth and the accumulation of pruned organic matter in the soil; it dynamises the system, renewing old plants and boosting growing plants. Pruning can be done to adjust the appropriate stratum of each individual, or to improve fruit production, or to incorporate organic matter into the soil. It also opens up light to lower strata and reduces competition for water in times of drought.

Agroforestry is an attempt to harmonise agricultural activities with the natural life processes that exist in each place where we operate and represents great potential for tropical regions, which are naturally rich in biodiversity, by protecting the soil from intense rainfall and direct sunlight. The great diversity of products, food security, environmental sustainability, increased soil fertility, and gradual reduction in production costs make agroforestry an excellent option as a productive practice for inclusion in family farming in Brazil.

In addition to the successional agroforestry mentioned above, there are various other ways of reintroducing trees into agricultural landscapes where forests have been completely removed. These include strips of trees, such as living fences and windbreaks, around crops and pastures, forming a small microclimate that helps to maintain water on the site and establishing a network of life processes that promote ecological and economic services for the family and the community. We can have increased production from crops and trees, and economic returns such as wood and fruit. Living fences, in addition to their immediate purpose, can act as shelters for birds and have beneficial effects on the biological control of insects. Dense living fences can reduce the harmful effects of wind and prevent animals and people from passing through. An example of this widely used on farms is dense living fences made up of sansão-do-campo or sabiá (Mimosa caesalpiniaefolia). Wind is an important variable that affects crop productivity by increasing water loss through evaporation and transpiration (evapotranspiration).

It is also a factor in the spread of pathological vectors. In the case of the coffee tree, which is a plant with a low tolerance to winds, productivity begins to fall with low winds. With faster winds, mechanical damage appears on the leaves, which are a gateway for fungi and bacteria, and the same happens with banana trees. Windbreaks should be aligned perpendicular to the prevailing winds in the area and not form a barrier that is too closed or too dense. To be functional, a good windbreak must be "permeable," meaning that part of the wind should pass through the trees.

In this way, tree belts bring great physiological comfort, with more water in the soil and air, a balance between transpiration and photosynthesis of the associated crops, thus improving the health of the plants and their production and avoiding irrigation and pesticide costs.

In addition to the systems and proposals that have been systematised and have emerged more recently, we can also mention traditional ways in which farmers, in various social and ecological contexts, have sought to introduce and maintain trees in their production systems, obtaining environmental goods and services. One example is in the south of Bahia, where we have forests that have been managed by humans for a long time and where there are traditionally shaded cacao plantations called the cacao-cabruca system. Cabruca consists of thinning out the native forest or forestation (including

removing hardwoods), eliminating the smaller vegetation and, maintaining the predominance of large trees, and introducing cocoa plants. This system preserves the layer of organic matter on the soil, maintaining the forest's natural nutrient cycling, maintaining a healthy environment, and good physiological comfort for the cacao, thus eliminating the large use of external inputs. In the past, this system occupied extensive areas of Atlantic Forest in the state of Bahia; however, as a result of the modernisation of agriculture, which began there in the 1960s, diseases such as witches' broom appeared, and production became very difficult.

In addition, successive crises due to the fall in the price of cocoa on the international market led many owners of cocoa forests to systematically exploit commercial timber, and there was a dramatic reduction in the areas occupied by this system. Today, in the remaining cabruca areas, farmers have tried to make this system more dynamic, practising fertiliser pruning and increasing the diversification of its composition. On the other hand, cocoa is also cultivated in the form of agroforests, whether they have low levels of biodiversity or a large number of components that are managed dynamically. The system is implemented in a capoeira, or by planting cocoa and service species such as fertilisers and banana trees in a roça, for shading and mulching purposes.

Another traditional agroforestry system practised in southern Brazil is called *faxinal*. This is a communal family economy system based on a native forest environment, with the Paraná pine as the dominant species, and where domestic animals are raised loose on communal pastures (collective farms with horses, pigs, goats, poultry, and rarely cattle). Most of the yerba mate harvest is concentrated in these collective farms as a source of supplementary income. On the same properties, the planting areas (almost exclusively short-cycle crops) are individual and separated from the collective farms by ditches and/or fences.

The traditional *faxinal* system preserves local biodiversity, becoming more evolved and permanent with less animal overload. Unfortunately, this system, which is based on a rare form of peasant organisation, suffered a gradual process of destruction from the 1960s onwards as a result of the "modernisation" of agriculture, as mentioned for the cabruca in Bahia. In Paraná, over the last 15 years, the number of *faxinais* has fallen sharply, but

there has been a gradual revival of interest in the system, both on the part of family farming communities and on the part of governmental and non-governmental organisations and research institutions. Some projects have sought to improve the family income of *faxinalenses*, based on the very dynamics and management of *faxinais*. By boosting what is already practised, various proposals have been contemplated, such as increasing the quantity and quality of yerba mate by enriching it with seedlings of good origin and improving management practices, diversifying and adding value to other products from the *faxinais*, such as pine nuts, medicinal herbs, native fruit trees, ornamental plants, aquaculture, seeds, as well as community-based ecological rural tourism, based on the beauty of the landscapes and the historical and cultural value that characterise some of the regions with the highest concentrations of *faxinais*.

The development of the theme of biodiversity conservation through SAFs should be seen in an integrated context with land-use planning, considering that the rural landscape tends to be a matrix of remnant forest patches, agricultural and agroforestry systems, hedges, windbreaks, and isolated trees inserted into the regional landscape. This mosaic of agroforestry landscapes should be seen as a potential reserve of biodiversity in itself, conservation of the soil's productive capacity and production of water in quantity and quality in a sustainable way, with the consequent well-being of people in the countryside and the city.

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