AGROFORESTERIE
association française

Agroforestry in 12 principles

Agroforestry refers to all agricultural practices that integrate trees into cropping or livestock production systems and are inspired, in agronomic terms, by the numerous species and vegetation levels of a forest.

1. Diversity and complementarity

Like natural ecosystems, agricultural systems need a certain minimum biodiversity to optimize production and ensure problems including diseases, invasive species, and physiological stresses are controlled. This fact is all the more relevant in context of the increasing frequency of weather extremes connected with climate change. Agroforestry, by multiplying plant strata, increases diversity in terms of species, habitats, ecological functions and use of space to improve the capture, fixation and recycling of resources.

2. Understanding the functioning of the forest

Natural ecosystems show great resilience to disturbances and it is urgent to draw inspiration from their functioning to benefit modern agroecosystems. In fact, forests spontaneously create more humus and add fertility to the soil. Contrast that to agriculture, which so often leads to degradation of the environment in which it takes place.

A necessarily simplified overview of the functioning of forests is as follows :

- Its inputs are limited almost exclusively to photosynthesized carbon, atmospheric nitrogen fixed by soil bacteria, and soil minerals resulting from the weathering of bedrock by bacteria and tree roots.
- The production of biomass is important: on average 10 tonnes of primary production per hectare per year (dry matter).
- The soil is always covered by a system operating at multiple scales, both spatial (strata) and temporal (development rates, species lifetimes, decomposition rates…) that maximizes the capture of resources (light, water, nutrients); limits leakage (erosion, leaching); and feeds the life of the soil (exudates, degradation of rootlets, leaf fall, death plants).
- The forest soil is never tilled, except by bioturbation, including by earthworms (in the temperate zone) or termites (in hotter climates) that contribute to structural stability and the production of humus.
- A spontaneous forest is never mono-specific. It's genetic and species diversity offers greater disease resistance and allows the forest to adapt to changes through time.

3. The Art of Transposition

Agroforestry aims to apply principles derived from the functioning of forests to agriculture. To be more precise, it aims to mimic the processes found in natural perennial-herbaceous systems such as savannas.

A savanna is a semi-open environment that maximizes the capture of light energy through complementary herbaceous, shrub and tree strata. These are common in drylands, and are shaped by grazing (and occasional fires) which prevent it from evolving towards forests (assuming enough water is present. In these environments, grazing is essential to the health of the entire system; indeed, savanna plant species (both herbaceous and perennial) coevolved with grazers. It is the terrestrial biome with the strongest productivity (plant and animal) per hectare. Human management mimicking savannas' key characteristics – an open upper strata over a lower strata of shrubs and herbaceous plants – leads to agricultural practices that maximise the permanent soil cover. This is achieved by integrating trees into crop fields, a practice known as agroforestry. Using these approaches makes it possible to get close to such high biomass productivity.

Doing so successful means first understanding these natural ecosystems, then imitating them, while making choices of trees, crops and management that fully exploit potential interactions between trees, crops and animals while rationalizing production operations.

4. Maximize photosynthesis

Imitating forests and savannas means using the organic carbon molecules resulting from photosynthesis as the major input of the system. It is this carbon which returns to the soil throughout the life cycle of the plants, and after their death, it is this carbon which nourishes the soil microbiome and thus creates or regenerates soil fertility.

But current agricultural practices favour bare soils after harvest and leave too little dead vegetation in the fields. Cereal straw, for example is often exported along with the grain. Bare soils freeze in winter, dry up quickly on sunny days, become waterlogged on rainy ones, and heat up in the summer. This creates havoc with the soil microbiome. Its inhabitants, used to the homeostatic environments of permanently covered soils, wither and die in this dangerously heterostatic environment. Soil degrades, compacts and erodes, forcing farmers to spend more on diesel and inputs to compensate for this declining productivity. Agroforestry turns this logic on its head. Its primary objective is to maximize the production of biomass across spatial and temporal scales in order to nourish the life of the soil, the only long-term guarantor of the kind of fertility suitable for long-term fertile production.

5. Lignin, stable anchor of humus

Dead wood returning to the soil contains lignin and other polyphenols that stabilize the humic acids and feed soil fungi. These are essential to proper soil functioning, since they decompose dead plant matter making it available for soil microorganisms and new plants and aggregate soil particles, thus making soil more resistant against erosion and leaching. A soil devoid of fungi loses its structure; it erodes easily through wind and water. Lignin is also key to a number of essential trophic cascades in the soil: the more it contains slowly decomposing matter, the more it can nourish people.

6. Buffer trees

Trees are climatic shock absorbers. By tapping and evapo-transpiring water from deep soil layers, trees refresh the atmosphere in summer. Their presence slows down the winds that result in major water losses through accelerated evaporation. And yet, the thought that forms most farmers' attitude to tree and water is that these big thirsty plants steal water from crops. Water competition between trees and annual crops does of course exist. But it is not hard to manage. For example, just think of a grove or woody windbreak bordering a field. Unlike crops, these perennial features hardly ever lack water, even in droughts, despite their higher water consumption. This is of course partly explained by the deeper roots, able to find moisture deep in the ground. But paradoxically, this is minor. The main source of their water is linked to the fact that the useful water reserves of soils are mostly biological, rather than physical. Above or below given temperatures, soil microorganisms are not active. The hot or frozen soils characteristic of bare ground are, in effect, sterilized. They cannot hold enough water. Similar phenomena affect the above-ground fauna, too: livestock need more energy to maintain their body temperature in open environments and seek shade on sunny days. Adding trees to our farming landscapes means benefiting from their beneficial effects over many years.

7. An agronomic vision above all

The reintroduction of trees in agricultural landscapes is the culmination of a global agroecological reflection. It is not an isolated solution. It makes no sense, for example, to start planting trees in soils that have been excessively tilled. Trees draw their strength from the mycorrhizal fungi with which they coevolved. These increase the trees' access to water and mineral resources. Tillage damages this major ecological function by destroying mycelial filaments; restructuring soil layers and damaging its aggregate texture. It is therefore necessary to think of trees as elements of a broader reflection to modify land management to favour the vegetative cover of soils.

8. In agroforestry, there is no model

While agroforestry is based on universal principles valid for most contexts and production systems (market gardening, viticulture, field crops, livestock farming etc.), it is not and cannot be a one-size-fits-all model. Farmers must test and adapt these principles to develop practices adapted to their needs and constraints.

What is crucial is to remember that agroforestry trees propose two important qualities: they are multi-functional (agroforestry trees have several functions and several uses) and multi-temporal (they provide services and resources at all time scales). In agroforestry, things like the return on timber sales are merely one variable among others, never the sole focus. That is why even soils that do not allow the production of timber will benefit from the presence of trees and shrubs.

9. Size is not a crime

To fulfil the many functions expected of them, agroforestry trees are always pruned, whether for lumber, fuelwood, fruits, fodder or more. Trees on farms have always been shaped by farmers. This, too, mimics a natural process: forest trees lose branches every day via a process of self-pruning fuelled by competition with neighbouring trees. Trees pruned to suit the needs of farmers regenerate their roots more quickly; let through the light needed by annual crops or pastures, produce more biomass and live longer. For that reason, many of the oldest trees across the world's temperate zone have been pollards.

10. Establishing agroforestry trees: don't overdo it

The agroforestry tree does not behave like a forest tree. It must be protected and managed. It is not a "natural" subject growing in its usual biotope. Under these conditions, it must be provided with well-prepared soils, tree shelters, good mulching and so on. Not overdoing it means not inadvertently producing "lazy" trees. They should thus never be tutored or irrigated (except in cases of exceptional drought), and it is essential to maintain a permanent cover in their proximity to oblige them to spread their roots in deeper soil horizons. This guarantees trees that will grow to be resistant to winds, storms and droughts – and protect and nourish the soil.

11. Ensuring the right connections

It is essential for the proper functioning of an agroforestry system to connect habitats in space and time. It is therefore necessary to link landscape units and phenology to ensure the continuity of food resources for biodiversity and wildlife throughout the year. Old, dead, hollow or even diseased trees are not be eliminated: they constitute a resource, a refuge and a repository of information for the resilience of the system.

12. Do one thing at a time

As one starts in agroforestry, one must establish and respect priorities. First, manage existing features like hedges, groves, and stream buffers; then protect naturally regenerating vegetation; then planting. It is because planting is expensive that available woody features need to be valued and managed.

This being said, there are never too many trees in agroforestry in that one can decide at any time to remove a surplus. There is usually more risk involved in not planting than in planting too much.

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