



Alley cropping systems: key objectives

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In an alley cropping system, trees are multi-functional: the aim is to provide a range of ecosystem services alongside wood and fruits. These include shelter for crops, host beneficial organisms, increase soil fertility and carbon storage, mitigate climate change, and provide protection against soil erosion.

Alley cropping systems seek to increase the productivity and profitability of the farming system and help create resilient landscapes.

Developing alley cropping systems needs careful thought in terms of motivations and constraints for adoption and thinking carefully about the goals and information needed to achieve success.

Introducing trees into arable systems results in long term land use change (generally between 20-80 years). Care should be taken to ensure that the initial diagnostics and technical planning are appropriate to ensure success.



Planting the right tree at the right place



A planting density of 50-100 trees per hectare is often recommended when talking about timber trees (*Arbre et paysage 32*)

How to combine trees and crops?

Alley cropping systems are a way of combining crop and tree production on the same plot, with both an economic and environmental objective. Generally they consist of:

- Tree rows (usually a mix of valuable hardwood species) established on cropland.
- Interstitial space between the trees is cropped with a range of species: cereals (for example, wheat, corn, barley), oilseed/protein crops (rapeseed, soya, faba beans, lupin, vetch, peas, sunflower), vegetables or vines.
- This type of system maintains the agricultural potential whilst generating new incomes, which makes it an appropriate option even on high-value agricultural lands.
- Tree rows are arranged in wide spaced parallel lines (28 to 40 m) in order to limit competition for light with agricultural crops and to allow mechanization of farm operations. Trees are established on grass strips of at least 2 m width, which allows cultivation up to 1 m from the trunk on both sides.
- With only 5 % of the area occupied by the rows (tree density changes from 50-250/ha initially to 30-50/ha in mature systems) the loss of crop productivity is low and the production of quality timber can provide substantial extra income over time.
- The large spacing between trees accelerates their radial growth. They develop larger crowns but, due to low density, they do not compete with each other (the average distance between two trees is 6 to 8 m).

In order to produce high quality timber on an alley cropping system, it is necessary to 1) plant the right tree stock, 2) protect each tree from game, 3) mulch the trees and 4) carry out planned pruning operations.

Why plant trees?

Trees protect soil against erosion and improve soil fertility. Intercropped trees develop deeper root systems and, as such, are more resistant to drought and strong winds. Trees also preserve groundwater quality by limiting the water-pollution caused by nitrate leaching and help decrease water runoff by improving water infiltration in soil. Trees store carbon in their wood and in the soil.



A great cultivated plain without trees... Land desertification on the way? (*Arbre et Paysage 32*)



Autumn rains on bare ground: water degrades the soil... and the soil degrades the water (*Arbre et Paysage 32*)



Trees can generate income for farmers



The buffer strip established on the planting line is a refuge for the crop beneficial organisms and a biodiversity tank

Trees diversify landscapes and stimulate biodiversity, especially when associated to a grass strip: usually present mainly on field boundaries, bird populations and beneficial insects are brought closer to the crops, at the centre of the field. The diversification of habitats also improves the game potential.

Maintain farm income

An agroforestry system generates continued income unlike forest plantations. This allows diversification of farm activities that maintain or increase its capital value without significantly decreasing the current income. High value crops can be intercropped until tree harvest if the final tree density is maintained between 40 and 80 trees/ha and if tree line spacing is at least equal to 2 times the adult trees height.

Strengths of the system

Profitable: researchers use the Land Equivalent Ratio (LER) to evaluate the productivity of alley cropping systems; essentially exploring the efficiency of the tree-crop association in different systems. The ratio compares the areas of monocrop systems with those that integrate trees to produce equal yields of biomass.

An LER above 1 means that the productivity of the agroforestry system is higher than the separate crop and tree systems. A large number of studies show LERs of between 1.2 and 1.6 for alley cropping systems. More concretely, an LER of 1.3 means that a 100 ha agroforestry farm will produce as much wood and grains as a 130 ha farm growing trees and crops separately.

Suitable for tenant farming: agroforestry plots are considered agricultural plots. The owner has the right to plant and let the farmer use the land. If the tenant wants to plant during the lease period, he/she must obtain a signed agreement from the owner. A contract specifies the responsibilities of each party and can include a way of eventually sharing between them the value added to the land.

Encouraged by public authorities: alley cropping systems are, under the right conditions, eligible to the support payments under the Common Agricultural Policy (CAP). Additional support mechanisms for agroforestry are available to farmers in several European regions. Under Measure 8.2 from the Rural Development Programme 2015-2020 it is possible to finance the costs of tree establishment and, in some cases, to tree monitoring over the first few years. The trees species must be largely forest species and planted at a maximum density of 250 trees/ha.

Adaptable and reversible: trees on farms have to be considered an additional crop, and managed in such a way that the whole system can evolve and adapt to its changing environment. After the main objectives of the agroforestry project have been defined, trees can be planted regularly over a 10-15 years period.

Monitoring strategy and harvest cycles will be determined according to the farmer's constraints and opportunities. After harvesting trees for timber, the stumps can be easily grubbed out using a shovel crawler or crushing jaws mounted on an excavator.



Planting trees in row arrangements makes field operations easier



Correct pruning ensures high-quality timber production – see the large and regular tree rings and absence of knots



Pollards can produce between 1 and 4 m³ of fuelwood per harvest

Making money with trees

Well selected agroforestry trees grow faster and more regularly than forest trees when selected carefully and planted in the appropriate location and managed well. A diversity of tree species are available such as wild cherry, maples, ashes, walnuts, oaks, service tree, apple, pear, etc.). Agroforestry trees are stimulated by crops and co-benefit from fertilisers and irrigation.



Training days are a powerful way of finding about the benefits of agroforestry systems

Think before acting

Short- and medium-term objectives

An analysis of the project has to be done before planting. The farmer should prioritize the possible roles played by the trees in the system and the expected productions in various types of system:

- **Sustainable ecological farming:** the main aim is for the trees to provide regulating benefits. The trees protect the soil against the erosion, improve water quality by intercepting pesticides, moderate local climate and for improving biodiversity.
- **Crop diversification:** trees provide products (hardwood, fuelwood, fruits, honey, cork) that increase the farm profitability while diversifying its activities and outcome sources.
- **Heritage and capital creation:** the trees will generate an additional income for the next generation or during retirement. If possible farmers should include the next generation into the planning process to ensure the continuity of tree management.
- **Tourism and societal-related value:** trees have a positive impact on landscapes, which enhance the value of the rural countryside and the attractiveness of the farm.

Human constraints

Appropriate training is important to get the most out of the different types of agroforestry system. It is essential to anticipate the time required and the level of monitoring required.

The human and financial investments are not limited to establishment. Tree management continues over the 10-15 years after planting and these need to be incorporated carefully into the management plans.

Environmental constraints

Land preparation is important before establishment. The previous crop can affect the development of the young trees. Unlike unmanaged land cultivated plots are generally easy to plant.

An environmental analysis (considering both climatic conditions and soil) is critical and should be conducted with an agroforestry expert. The ground has to be prepared by subsoiling to a depth of more than 30 cm, especially if a plough pan is present. Additionally, any game pressure has to be evaluated and steps taken to mitigate any potential damage.



Poplar is a fast growing specie providing income within 20 years

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