5

CO-DESIGN AND ESTABLISHMENT OF AGROFORESTRY SYSTEMS

Farmers have been designing agroforestry systems for thousands of years. They are the users and stewards of the land, and they often have a deep knowledge of the local plants, animals, the soil, weather, and the interactions between them. We use the term 'co-design' to describe the process of bringing scientific and technical expertise together with this local knowledge. It is an important step in creating agroforestry land-use systems that deliver optimal outcomes. The role of outside experts is to listen and learn from the farmer; to share their specialist knowledge, including experience they have gained from working in other regions or countries; and to facilitate the overall design process.

In this chapter, we provide guidance on:

- the kinds of information or knowledge needed to co-design agroforestry systems; and
- how to gather and use this information.

If both these components of co-design are done well, then the systems we design will reflect the principles of farmer-centrality, aptness and synergy.

What kind of knowledge is needed for co-design of agroforestry systems?

In co-designing agroforestry systems, the most important types of knowledge needed are the following:

- knowledge about the needs, aspirations and capacities of farmers and their families
- knowledge about the profitability of different agroforestry products
- knowledge about the local conditions that might affect the profitability or feasibility of such products
- knowledge about the different agroforestry systems in which selected products can be grown.

In most cases, no one person or group is the holder of all these types of knowledge. For example:

- Individual farmers know best about their own needs and aspirations.
- The local community will know about any customary limitations on land use.
- Marketing specialists may have information on current and future demand for products.
- Agroforestry specialists will know how much labour is required to manage different systems.

The information needed for agroforestry design will be different in each case. However, many of the same questions come up often. Table 2 lists the most common ones, and the most relevant knowledge holder(s) in each case. Additional specific questions to be addressed will vary from place to place.

Table 2. Core questions for agroforestry design

Question	Knowledge holders
What does the farming family want to produce on the farm, and how can trees contribute to that?	Farming family
How important is the farm for the farming family, compared to other tasks and any other work that require time away from the farm?	Farming family
Are the farmer and family members interested in planting more trees on the farm? If so, then why? (e.g., to provide better growing conditions for crops, increase fodder production, sell timber)	Farming family
What adult labour is available for maintaining any new trees that are planted on the farm?	Farming family
What previous experience does the farmer have in managing agroforestry systems?	Farmer
What is the farmer's level of technical understanding, and how willing are they to master a new system?	Farmer
What is the soil like in the parts of the farm where the farmer plans to plant more trees?	Farmer
Who is the owner of the farm? If it is not the farmer, what rights do they assert or have over the land? (Trees are a long-term investment and may be incompatible with short-term or insecure land tenure)	Farmer, technical experts
What are the main features of the climate of the area, particularly the mean annual rainfall and the length and timing of any dry season(s)?	Community, technical experts
What risks are associated with farming in the area, including pests and diseases?	Community, technical experts

Table 2. Core questions for agroforestry design *cont...*

Which farming systems and practices are used in the area?	Community, technical experts
Which crop species and varieties, livestock types and breeds, and tree species grow well in the area?	Community
Which tree species with the desired characteristics are available locally?	Farmers
Which crop species and varieties, livestock types and breeds, and tree species can be grown together?	Farmers, agroforesters
What are the most profitable agricultural products in the area?	Community
Can value chains be made to work better for farmers and other actors? (Farmers need to be connected with buyers and producers in order to sell their agroforestry products)	Community, technical experts
Does poor transport infrastructure (e.g., poor roads or absence of roads) make it difficult to get products to market?	Community, technical experts
What laws and government policies regulate production, harvesting and transport of livestock, tree and crop products?	Community, technical experts
Which species characteristics, such as biological traits, income-earning potential, and food value, would allow farmers to best address their objectives? (Several techniques are available to help participants rank their preferences for tree characteristics. It is also important to explore which characteristics are not valued)	Farmers, agroforesters
What are the main agroforestry options suitable for the area?	Farmers, community, agroforesters
What are the labour requirements of different agroforestry options, and how do they fit with households' other time and work obligations, considering the interests of families?	Community, agroforesters
How easy is it to make the transition to agroforestry? (A given agroforestry system may seem to offer what farmers are looking for, but it may be that the challenges of conversion from current land uses are too great for the system to truly be apt to people and place)	Farmers, community, agroforesters

Design process

Finding the optimal agroforestry system for a community or farmer(s) is a journey rather than a straight-line, one-way process from knowledge, through analysis, to formulation of interventions. In a participatory procedure, such a regimented approach would be problematic. The role of those facilitating the journey is to ensure that knowledge and views are sought, obtained and shared; those views are well informed; and that decisions are consensual, even when that means 'agreeing to differ'. Facilitators or extension service providers who work with farmers to develop agroforestry systems need to be:

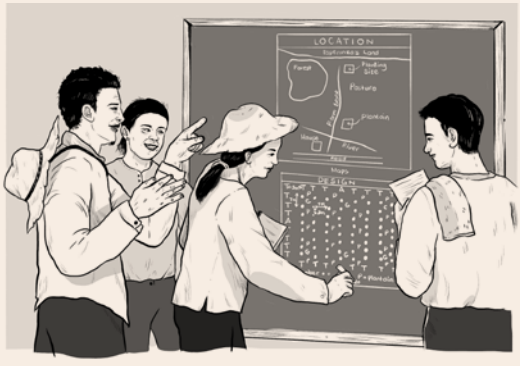
- well versed in local conditions;
- equipped with approaches to elicit information from other knowledge holders;
- receptive to local views;
- able to facilitate the sharing of information between stakeholders.

Box 2. Participatory techniques for gathering village- and household-level information of relevance to agroforestry design

Participatory mapping involves drawing maps with community members, and can help to develop common understanding. Community representatives could add to a map of their village drawn with markers on a large sheet of paper, or scratched into the earth with sticks, to show the distribution of land and social relationships, including common resources and any land-use conflicts.

Transects, also called **group walks**, can help get a sense of how people interact with their production systems and environment. A walk across the farm, combined with group discussions, can help outsiders gain valuable insights and information about the interplay between social and environmental factors.

Role-playing games: a landscape or farm can be represented simply as a board game in which participants are asked to make decisions about management. They can test out different courses of action and their potential consequences; exchange experiences, knowledge and perspectives; and build understanding about why others make particular choices. Subsequent discussion about how well the game represented reality provides further information about how players make decisions in real life.[6]



[6] A lot of useful information on participatory approaches can be found from many sources on the internet. A useful reference for this sort of game playing is Speelman EN, Rodela R, Doddema M, Ligtenberg A. 2019. Serious gaming as a tool to facilitate inclusive business: A review of untapped potential. *Current Opinion in Environmental Sustainability* 41: 31–37. https://doi.org/10.1016/j.cosust.2019.09.010.

Various approaches to participatory procedures of this sort exist (see Box 2 for examples). They need to consider local culture and society, including gendered interests and needs, as well as levels of literacy and broader education. A formal Participatory Learning and Action approach can be appropriate, but supporting agencies should select approaches they are familiar with and that they have capacity to implement.

The time needed for different approaches depends on the depth of knowledge required and the farmers' capacity. Some processes are completed in a day, while others require deep trust and involve long-term relationships between the external agents and community.

Independently of the specific methodology used, facilitators and interviewers should take care to avoid common pitfalls by adhering to the following guidelines:

- Keep in mind that a truly participatory process is not designed to deliver a particular technique to a farmer, but is rather a series of activities in which the expert and farmer learn from each other and develop interventions together.

- Be aware that interviewing farmers is not a participatory approach in itself. In a question-and-answer interview, often used in farmer surveys, many participants will give answers that they think the questioner wants – or indeed will say anything just to get rid of them!

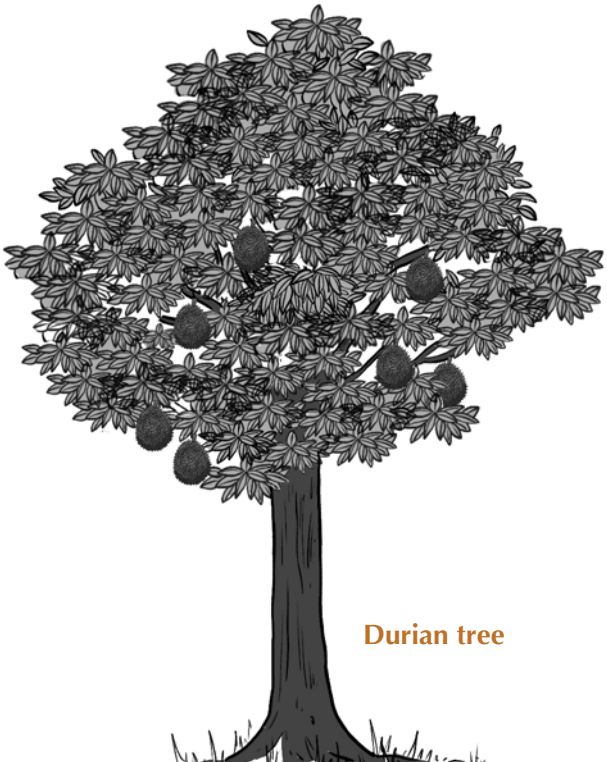
- Consider that farmers are usually not used to discussing their land-use decisions or livelihood aspirations with other people.

- Ensure engagement with those who carry out the physical tasks of farming and those who make decisions – whether these are women or men. Other community members should also be involved: in particular, youth should be included, as they may one day manage the systems.

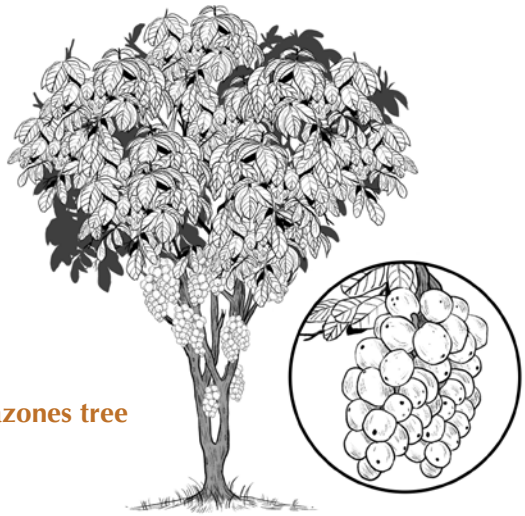
Species selection

Species selection is a particularly important part of agroforestry design because the species choice determines which goods and services will be produced by the system. The design principles of aptness and synergy are particularly important in species selection. Species should be at least compatible with each other, and preferably capable of mutually beneficial interaction, and their products should have high market potential or other uses important to the farmer.

In some cases, specific methodologies or criteria may be used in species selection – for example, the fruit tree portfolio approach (Box 3), or use of native species (Box 4).



Durian tree



Lazones tree

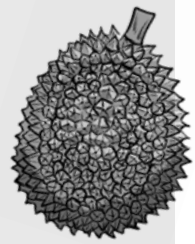
Box 3. Fruit tree portfolios: A targeted approach to species selection

In places where diets are heavily based on starchy staple crops, farming families – and especially women and children – are prone to debilitating nutrient deficiency diseases. The fruit tree portfolio approach to species selection responds to this problem by enabling the year-round production of fruits that are rich in vital nutrients and vitamins. It does so by taking advantage of the varying harvest times of tree fruits.

1 **The first step** in building a fruit tree portfolio is to determine whether a given community experiences food insecurity and serious nutrient gaps. For example, in many parts of the world, farming households experience 'lean seasons' before the main harvest, when stored household food supplies are running short.

2 **The second step** is to identify additional fruit tree species that can compensate for food and nutrition gaps, especially during the gap periods identified in the first step. Indigenous and underutilized tree species have an important role to play in local farm systems because they are often well adapted to the local soil and climatic conditions, and less vulnerable to variation in rainfall.

Both steps are highly participatory processes. This ensures that the portfolio responds to real needs, and that the species selected are locally available and acceptable to farming families. The portfolios can be further adapted to include other food trees – those that provide nuts, leafy vegetables, seeds and oils – and other crops such as vegetables, pulses and staples.[7]



[7] The fruit tree portfolio approach can be used with virtually any agroforestry system. It can be applied at the individual farm or community level. More details on the approach can be found in McMullin S, Njogu K, Wekesa B, Gachuiri A, Ngethe E, Stadlmayr B, Jamnadass R, Kehlenbeck K. 2019. Developing fruit tree portfolios that link agriculture more effectively with nutrition and health: A new approach for providing year-round micronutrients to smallholder farmers. *Food Security* 11: 1355–1372. https://doi.org/10.1007/s12571-019-00970-7.

Box 4. Trees and biodiversity conservation

Trees-on-farms contribute directly to the conservation of biodiversity by:

- increasing agrobiodiversity – the variety and spatial variability of animals, plants and microorganisms in an agricultural landscape
- conserving indigenous, rare or threatened tree species (in situ conservation)
- providing foraging or breeding opportunities for wild or farmland-adapted animals.

Almost all agroforestry systems lead to an increase in agrobiodiversity (the planted species and livestock), but they do not necessarily contribute to the conservation of naturally occurring species or habitat connectivity. To do so, more native trees and species – those that occur naturally in the planting zone – need to be included in the system. However, from the farmer's viewpoint, native species often have both opportunities and challenges:

Opportunities

- Native tree species are well adapted to the local soil, water and climatic conditions.
- Farmers and local markets are often familiar with the species and their products.

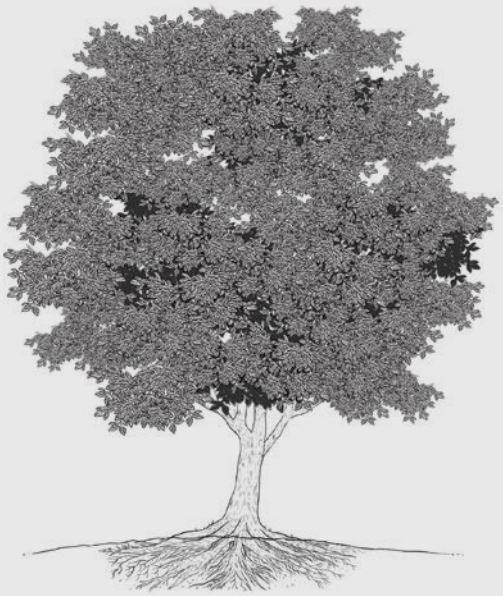
Challenges

- It may be difficult to obtain seed or plants of native species, particularly if they are rare or threatened.
- Many countries control the harvesting and transport of native tree species. These regulations, designed to protect natural forest from overexploitation, often apply (counterproductively) to planted trees on private land. The administrative procedure of applying for felling and transport licences can be complicated.

Box 4. Trees and biodiversity conservation *cont...*

- Farmers often prefer widely available exotic species due to their rapid growth and – in many cases – high demand for their products (poles, timber, fruits, etc.).
- The native species of highest biodiversity value may provide no direct benefit at all to the farmer.

If the challenges to farmers growing native species outweigh the opportunities, then governments or others interested in biodiversity conservation will need to provide appropriate incentives and remove disincentives (see **Incentives** in Chapter 5). Farmers or landowners should be considered as private sector partners in conservation, who will need to be compensated for allocating land, resources and labour. Such compensation should cover not only the planting of the tree, but also its subsequent management and protection.



From design to action: The planting plan and its implementation

Importance of the planting plan

The final stage of design is to draw up a planting plan. The planting plan is important for three reasons:

1. Its preparation provides an opportunity to document the results of the design process. This ensures that everyone involved is 'on the same page' and avoids misunderstandings.

2. The planting of agroforestry systems requires more care than the planting of conventional agricultural, horticultural or forestry plantings, because the layout – the planting locations of trees and crop plants – is more complicated than in a plantation with just one species. A plan is needed to ensure that everything goes smoothly.

3. It helps ensure that the implementation – and not just the design – takes account of the agroforestry design principles.

What needs to be in the planting plan?

The planting plan needs to cover the 'where, what, when and who' of the process. It should be a short document that everyone involved can easily understand. It may be useful to draw up a simple template. Figure 5 is an example of a planting plan prepared in this way. Whatever form the plan takes, site visits are essential, because the plan must be based on specific local conditions of soil, vegetation, aspect, and so on.

For **sequential systems**, it is important to map out the life cycle and productive lives of the different species, so that planting can be timed to avoid productivity gaps and resulting cash flow problems. These can occur between the end of one component's lifespan and the beginning of the next one's productive period.

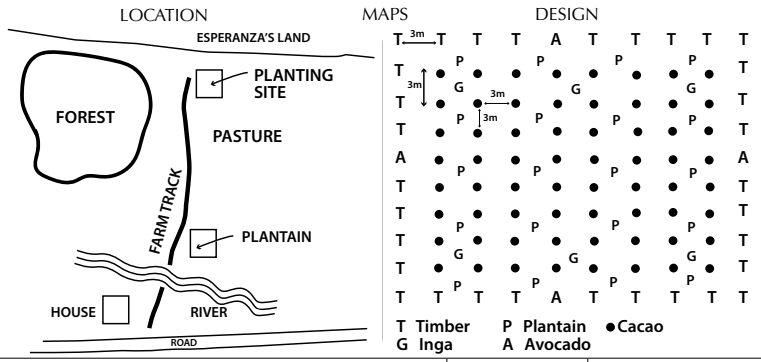
Co-design is guided by the **agroforestry principles**. However, while following these principles, wider considerations should not be neglected. Foremost among these is the safety of all concerned, particularly during establishment of agroforestry systems. Organizations involved in implementing agroforestry activities should ensure the following guidelines are adhered to:

- At the start of the establishment process, do a risk assessment to identify hazards and risks, and measures to eliminate or reduce them. 'Hazard' means the source of danger (for example, snakebite) and its potential severity (high, in the case of snakebite). 'Risk' means the probability of this happening (low, medium or high).
- Make sure that the planting plan specifies responsibilities (who does what). Consider individuals' wishes, skills and physical condition. Some tasks demand strength; others, attention to detail.
- Ensure that edged tools are sharp. Sharp tools speed up all operations and are safer if properly used.
- During establishment, follow the measures laid out in the risk management plan, including the wearing of any safety equipment.

Like agriculture and forestry, agroforestry is a relatively high-risk activity, and adhesion to safety guidelines will avoid accidents that could lead to injury or even be life threatening.

Planting Plan Description

Owner: *Nicholás Torres*	**Date of plan:** *November 2021*
Supporting organization: *Futuroverde (NGO)*	
System: *Multistrata, cacao with Inga, timber trees and avocado*	
Planned date of planting: *September 2022*	
Where:	
Description: *old shifting cultivation parcel of 0.5ha, on slope that runs up to the boundary with Esperanza Valverde's land*	



What	When	Who
Place order for 50 grafted avocado plants	*December 2021*	*Nicholás*
Arrange for help with site preparation (cleaning, marking, hole-digging) and planting of temporary shade	*February*	*Nicholás*
Place order for timber seedlings and Inga (see attached list) and 550 cacao seedlings. Check up on avocado plants	*March 2022*	*Nicholás*
Extract plantain suckers from parcel near river (225) and transport to site	*March*	*Nicholás (transport using Furturoverde's pickup)*
Ensure that all tools needed for preparation are available on site	*start of April*	*Miguel*
Clean site	*April*	*Nicholás and helpers or workers*
Mark site with guide stakes for temporary shade (plantain)	*April*	*Nicholás and helpers or workers*
Dig planting holes for plantation	*April*	*Nicholás and helpers or workers*
Plant temporary shade (plantain)	*April*	*Nicholás and helpers or workers*
Arrange for availability of grafting material (scions of fine flavour cacao varieties)	*July*	*Miguel from Futuroverde*
Clean site	*August*	*Nicholás and helpers or workers*
Dig planting holes for cacao, avocado, Inga, and timber trees	*August*	*Miguel with Nicholás and workers*
Transport all nursery plants to site	*September*	*Miguel*
Plant cacao, Inga, timber trees and avocado	*September*	*Nicholás and workers, helped by Miguel*
Grafting of fine flavour scions on cacao seedlings	*Start of dry season*	*Nicholás and Futuroverde cacao specialist*

Figure 5. A simple planting plan prepared using a template

Incentives

Farmers' main expectation from their land is for it to support their livelihoods, whether or not the farm is their main source of income. In recent years, however, wider environmental agendas have started to affect farmers. They face ever-increasing expectations from the international community and local authorities, who are looking to them to be custodians of the landscape as well as managers of productive small businesses. Sometimes – when agroforestry is both the best economic and environmental option – farmers will need little encouragement to invest

in it. But if farmers are to take on additional responsibilities for the landscape, especially if this involves costs to them, then they will need incentives.

Governments who wish to promote agroforestry for livelihoods, income, conservation or restoration should put in place effective incentive systems. Incentives might be financial (such as grants, loans, tax breaks, favourable interest rates for borrowing or access to insurance), or might involve improving the enabling conditions for agroforestry (such as nurseries, high-quality planting materials or improved markets for agroforestry products). They could include schemes of payment for ecological services, or social recognition for practising skilled and responsible farming. Where farmers are expected to contribute to global goals such as combating climate change, conservation or restoration, then they have a right to expect access to global funding – either directly through projects or via carbon-financing schemes (see also Box 4: Trees and biodiversity conservation).

Removing incentives to ecologically damaging agricultural practices, and disincentives to environmentally friendly practices, is also part of the picture. Around the world, conventional high-input agriculture has been subsidized, while farmers have been penalized for harvesting or transporting indigenous trees that they have cultivated on their own land (Box 4). If farmers are to become land stewards, as many policymakers expect, then incentive structures will need to change radically.