FOOD FORWARD NDCs

Implementing agroforestry practices

Overview

Agroforestry (i.e., agriculture & forestry) is an important nature-based solution in agriculture. It describes land-use systems where woody perennial plants (trees, shrubs, palms, bamboos, etc.) are deliberately grown on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. Through the **integration of trees on farms and in the agricultural landscape**, agroforestry diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels.

In agroforestry systems there are both ecological and economical interactions between **three main components**:

- **'Flagship species':** the main species (one or more) in an agroforestry system, which is the **crop, livestock, or tree species** that the farmer considers the most important – often because it contributes most strongly to their livelihood.
- **'Auxiliary species':** the tree species included in an agroforestry system primarily for the agroecological services (e.g., shade, soil fertility) they provide both to the system and to the flagship species and for their role in diversifying income streams for farmers.
- **Soil:** more than simply the earth in which plants are anchored, it contains **living organisms** that play vital roles in the agroecosystem, including decomposing biomass into soil organic matter, making nutrients available to plants, and improving soil structure.

Concrete measures to implement

Successfully implementing agroforestry systems requires careful consideration of local ecological and social conditions, including farmer preferences, capacities, and markets.

- **Design:** involves deciding what will be produced, selecting the components of the system, determining how they will be arranged, and deciding when and how the system components will be established and managed.

    - Ensure inclusive and equity-sensitive design process: finding the optimal agroforestry system for a community is key to the success of agroforestry systems. Co-design is the process to bring scientific and technical expertise together with local knowledge and needs, with attention to equity in public agricultural and food systems research. Participatory procedures should be used to ensure engagement with those who carry out the physical tasks of farming, decisionmakers, and other community members (e.g., youth) and enable more equal access to benefits.
    - **Identify appropriate agroforestry options**, e.g., annual crops with trees, livestock with trees, and multi-strata perennial agroforestry.
    - **Select appropriate species:** species should be compatible with each other and capable of mutually beneficial interaction. Their products should have high market potential or other uses important to the farmer. Aspects to consider include soil type, microclimate, multifunctionality, and harvest.
    - **Assess costs, benefits, and market potential:** agroforestry systems need considerable effort, time, and expertise for their successful uptake. It is important to consider the availability of resources such as land, labour, technology, and capital. Other important considerations include the needs and priorities of landowners (e.g., whether products are for their own consumption or to sell in the market) and provision of environmental services. Assessments should further consider aspects such as market demand, product value chain, and prices.
    - **Prepare tree-planting plan:** a detailed and easy-to-access workplan should be prepared to ensure that planting proceeds efficiently and that any follow-up work, such as weeding, is carried out effectively.

Planting of trees and annual crops should be timed to coincide with favourable climatic conditions (e.g., the onset of the rainy season).

- **Establishment:** involves sourcing of planting material, site preparation, and marketing of products.

    - **Prepare agroforestry site:** may include preparing holes for planting seedlings, weeding to protect naturally-regenerated seedlings, and other work such as land clearing, terracing, fencing, irrigation, and fertilization.
    - **Source high-quality planting material:** planting material should be accessible, sufficient, and fit for purpose (i.e., it is able to yield products in the quantity and quality required).
    - **Maintain the new plantation:** includes activities such as survival count, replacement planting, weed control, and protection of newly planted trees.
    - **Promote products:** marketing is another essential element of agroforestry, in which the products generated by the system are converted into income. This involves selecting target markets, adding value to products, getting products to prospective buyers, setting the price, and promoting the products.

- **Management and monitoring:** involves system maintenance, performance monitoring, and dynamically adjusting the system to changing conditions.

    - **Maintain system:** carry out all farming operation (e.g., seedling protection, weed and pest control, animal browsing, fertilization, irrigation, thinning, pruning, coppicing, harvesting, post-harvesting operations), paying particular attention to interactions between system components.
    - **Monitor system:** elements to be monitored include the performance of agroforestry systems, in terms of productivity, environmental and social outcomes, and the impact of external factors (e.g., market, climate change). Effective monitoring requires good baseline information and a set of relevant and measurable criteria.
    - **Adapt system:** changing circumstances might require adjustments in the system over time. Management changes may be required when, for example, trees start competing with crops for space, sunlight, and

nutrients. Changes in the market, labour requirements, etc. may require revision of the economic model.

Enabling governance measures for agroforestry

Despite the large potential of agroforestry systems to contribute to sustainable development, it is not sufficiently addressed in public policies. **FAO provides guidelines on public policy options** to create favourable enabling environments for developing agroforestry systems:

- **Communicate the benefits and know-how:** raise awareness of the benefits of agroforestry and support agroforestry practitioners through activities such as extension services, plot demonstrations, farmer–farmer exchanges, farmer field schools, e-learning, and toolkits.
- **Ensure inclusive multistakeholder approaches:** policy development should use equitable and participatory approaches to ensure that outcomes are based on the needs and rights of local people and are enhancing policy coherence.
- **Strengthen security of land tenure:** secure and stable tenure rights can provide farmers the confidence to invest in trees on their land and allow them to make long-term plans. Interventions may include: reforming farmers' rights to access land (as well as the resources provided by the land; linking land and tree tenure; and devolving rights and responsibility for trees.
- **Scale-up incentives**: incentivize initial uptake of agroforestry practices (e.g., through grants, tax exemptions, cost-sharing programmes, microcredit, or delivery in kind) and reward the **environmental services generated by agroforestry** (e.g., through supporting the environmental certification of wood products, access of agroforestry to carbon markets, implementation of payment for ecosystem services (PES) schemes).

Tools and MRV systems to monitor progress

Calculators and Trackers

SFM Toolbox

FAO developed the Sustainable Forestry Measures (SFM) Toolbox modules that provide basic and in-depth information, tools and cases to expand knowledge and put SFM (including agroforestry) into practice.

Link: https://www.fao.org/sustainable-forest-management/toolbox/modules/en/

MRV Platform for Agriculture Toolbox

The MRV Platform for Agriculture provides tools, approaches, and case studies for MRV of GHG emissions and mitigation actions in the agriculture sector.

Link: https://www.agmrv.org/knowledge-portal/resources/

Guides and handbooks

CIFOR-ICRAF primer on agroforestry

CIFOR-ICRAF published a primer on agroforestry including design and management principles in 2022. The primer also includes a list of useful resources for agroforestry practitioners.

Link: https://www.cifor-icraf.org/publications/pdf/books/Agroforestry-primer.pdf

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EX-ACT

EX-ACT provides ex-ante estimates of the impact of agriculture and forestry practices on greenhouse gas emissions and removals.

Link: https://www.fao.org/in-action/epic/resources/ex-act-case-studies

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Climate change mitigation benefits

- Agroforestry systems have the potential to contribute to climate change mitigation in **multiple ways** depending on local context, including:
    - Higher carbon sequestration in woody biomass and soil compared to crop systems.
    - Increased farm-level availability of fodder which, in turn, avoids direct and indirect GHG emissions from fodder production.

    - Diversified diets for animals, which improves the digestibility of forage and therefore reduces methane emissions from enteric fermentation.
    - Reduce pressure on forests by providing fuelwood and reducing or eliminating the need for shifting cultivation which, in turn, avoids GHG emissions from land-use change.
- Mitigation potential of agroforestry systems is widely recognized. The **6th IPCC Assessment Report of 2022** provides the following estimates on agroforestry mitigation potential in the period 2020-2050:
    - Technical mitigation potential (i.e., what can theoretically be achieved with current techniques): 4.1 (0.3-9.4) $GtCO_2eq$ per year.
    - Economic mitigation potential (i.e., what can be achieved by limiting the cost of implementation below USD100 per tCO_2eq): 0.8 (0.4-1.1) $GtCO_2eq$ per year.

Other environmental benefits

Agroforestry systems contribute to additional environmental outcomes by:

- Enhancing soil organic matter, thus increasing water retention and decreasing runoff. The presence of roots aids infiltration, while ground litter or mulch minimizes evaporation, and lower wind speeds reduce soil drying.
- Retaining organic matter in the soil, which reduces nutrient loss. This allows farmers to increase crop productivity on their existing land while also reducing the need to clear more forests for agriculture. Additionally, agroforestry systems can decrease total crop loss by enhancing by increasing crop diversity.
- Maintaining the quantity and quality of forage production under increasing temperatures. In areas where rising stream temperatures may affect cold-water aquatic habitat, shade from riparian forest buffers can help maintain cooler water temperatures.
- Reducing heat stress on animals by providing shade. For more information see guidance on ***crop-livestock management***.

Women of the cooperative carry the harvested mate leaves out of the Atlantic forest.

Adaptation benefits

Agroforestry enhances resilience to climate change in multiple ways:

- Climate: trees improve system resilience to climate variability by regulating soil temperature and moisture, improving water infiltration, moderating drought effects, providing shelter from wind, or providing ecological niches for different crops. They also protect crops from climate-related heat stress through reduction of ambient temperatures.
- Soil: reduced soil erosion, greater soil fertility, enhanced soil productivity, and nutrient cycling.
- Biodiversity: agroforestry systems contribute to the protection and conservation of biodiversity by enhancing plant diversity while reducing the loss and fragmentation of habitats. This also helps to improve control of pests and diseases.
- Livelihoods: improved farm productivity results in diversified and increased farm income, and increased resilience to climate change. Agroforestry also provides useful and profitable goods and services to farmers such as fuelwood and livestock fodder.

- Improved food security: agroforestry provides edible by-products such as fruits, nuts, and edible leaves.

Other sustainable development benefits

- SDG 1 (No Poverty): Increased financial security through farm diversification
- SDG 2 (Zero hunger) & SDG 3 (Good health and well-being): Improved food security for both producers and livestock through increased yields and crop diversification and by-products
- SDG 6 (Clean water and sanitation): Improved water quality
- SDG 15 (Life on Land): Increased conservation of farm-level agricultural biodiversity. Improved soil health and reduced land degradation through reduced erosion and enhanced nutrient cycling.

Main implementation challenges and potential negative externalities and trade-offs

Challenges for agroforestry development include:

- Weak extension services and lack of appropriate training approaches for smallholder farmers.
- Lack of secure land and tree tenure.
- High upfront investment costs: acquiring tree seedlings and equipment may exceed immediate returns, leading to negative cash flows. Many farmers – who could benefit from adopting agroforestry practices – lack financial resources or access to credit to finance long-term investments.
- Potential for competition and conflict over resources between tree, crop, and livestock species.
- Potentially significant lag between an investment in agroforestry and the financial return on it.
- Weak marketing.
- Trees may compete with food crops for space, sunlight, moisture, and nutrients, thereby reducing crop yields.
- Food crops may be damaged during tree harvesting.

- Trees that form part of agroforestry systems may be hosts of insects and birds that can damage crops.
- The rapid regeneration of trees may displace food crops and even take over entire fields.

Measures to address potential negative externalities and trade-offs

- IPCC recommends that agroforestry should be implemented as part of support systems that deliver tools and information to increase farmers' agency to minimise risks and maximise benefits. Particular focus should be given to low income and marginalised populations.
- Appropriate selection of crop, tree, and livestock species and breeds to reduce competition.
- Woody species should be grown in a spatial design and seasonal cycles that reduce competition for resources with crops.
- Implementing rotational grazing practices to improve the quality of the pasture, crop, and livestock. For more information see guidance on ***crop-livestock management***.
- Adequate provision of input supplies and advisory services for farmers.
- Trade-offs between carbon sequestration and crop yields **can be minimized** with optimal management, involving use of a mix of tree species that store medium carbon stocks and can enhance yields, soil fertility and climate resilience.
- Linking project costs to government programmes and existing support (i.e., subsidy programmes and dedicated credit lines) as well as donor funding and blended finance can reduce costs.
- Developing financing models that ensure an adequate supply of materials, training, and assistance to farmers.
- Establishing inclusive producer organizations.
- Investing in public agricultural and food systems research, as well as other rural public investments, that are sensitive to ensuring equitable outcomes.

Implementation costs

Costs are highly variable and depend on location system design and need to be assessed on a case-by-case basis. Due to the large mitigation potential of these systems, one way to channel finance to promote agroforestry implementation is via climate policies and access to the **carbon markets**. According to **6th IPCC Assessment Report of 2022**, 0.8 (0.4-1.1) $GtCO_2eq$ per year of technical mitigation potential is available at USD 100 $GtCO_2eq$ per year.

Agroforestry in practice

- **Regreening the Sahel in Northern Africa**: Maradi/Zinder region in Niger is an epicentre of experimentation and scaling up of approaches. More than 200 million trees have been regenerated on more than 5 Mha in the Sahel through a technique named Farmer Managed Natural Regeneration (FMNR). The approach brought benefits such as climate mitigation, reduced soil erosion, animal fodder, groundwater recharge, nutrition, income, and an enhanced safety net for vulnerable rural households during climate and other shocks. Various factors have contributed to the regreening of the Sahel, including local policy reforms (e.g., easing of forestry regulations to give farmers greater control over the management and use of trees on their land), NGO-led experimentation, cash-for-work programmes, and training programmes. Farmers participated in planning and implementation of programmes, which enabled the aligning of activities with local knowledge and goals as well as market opportunities.
- The "**Mainstreaming Sustainable Cattle Ranching in Colombia**" project covers more than 2,500 farms in five regions of the country. It has introduced environmentally friendly cattle production on close to 50,000 ha, placed 51,900 ha under a Payment for Ecosystem Services (PES) scheme, improved stocking rates and productivity per animal by 15%, protected 50 globally endangered plant species on the farms, and sequestered 1.9 million Mg of CO2eq above and below ground. In addition, the project has significantly contributed to the development of public policies, the training of technicians and farmers, and the development of a network of demonstration farms and service providers.
- In **Southeast Asia**, livestock grazing often happens under plantation trees such as rubber, oil palm, or coconut. Studies have shown improvements in

yields and weed control on oil palm, rubber, and sugar cane plantations where small ruminants grazed on vegetative ground cover.

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