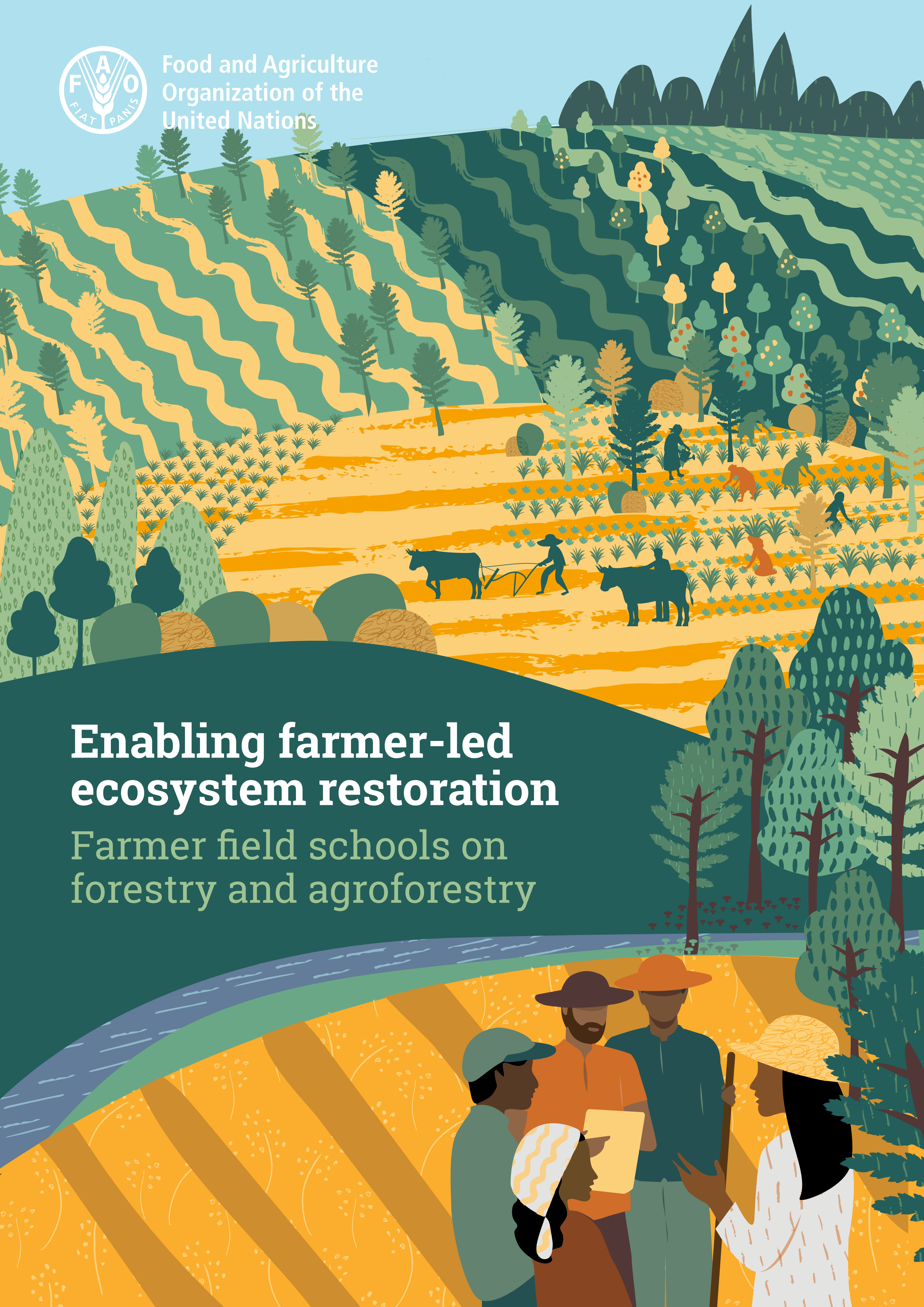
Food and Agriculture Organization of the United Nations



Enabling farmer-led ecosystem restoration

Farmer field schools on forestry and agroforestry

Agroforestry tea system in Gurue, Mozambique

Maximo Gerardo Ochoa Jacome

Enabling farmer-led ecosystem restoration Farmer field schools on forestry and agroforestry

Agrifood systems are responsible for a third of global greenhouse gas (GHG) emissions that contribute to climate change (Crippa et al., 2021). Recent research shows that the earth is reaching a dangerous tipping point where its biosphere may be shifting from a net sink to a source of atmospheric carbon in two to three decades (Duffy et al., 2021), putting into question the very possibility of agriculture in many parts of the planet. This situation of great concern presents a critical question: How can agriculture continue to feed growing populations while contributing to the urgent restoration of the planet's ecosystems?

Climate change mitigation programmes mostly aim to reduce emissions, protect natural forests and afforest abandoned areas. However, it would also be important to adequately address the issues of the two billion family farmers who cultivate a third of the planet's surface area. About 550 million family farms – 84 percent of which are less than 2 ha – produce a significant share of the world's food (Lowder, Sánchez and Bertini, 2021). Family farming impacts peoples' livelihoods as well as ecosystems. Smallholder farmers are especially vulnerable to climate change because their livelihoods often depend primarily on agriculture. Further, smallholder farmers often suffer from chronic food insecurity and poverty. As such, small-scale farms are uniquely positioned to be an integral part of the global solution for climate change. Healthy soils and diverse vegetation can provide a range of ecosystems services, including but not limited to the removal of existing GHGs from the Earth's atmosphere, agricultural emissions reductions, and mitigation of the effects of extreme weather. However, when involving smallholder farmers in developing countries in mitigation and adaptation, livelihood improvements and other rural development outcomes also need to be supported.

Created in Indonesia's rice fields in the late 1980s to strengthen farmer-led innovation, farmer field schools (FFS) have enabled tens of millions of farmers across the globe to sustain or improve productivity while reducing dependence on externally based inputs, such as synthetic pesticides and fertilizers. FFS have helped farmers and their communities *tackle other agronomic challenges, for example, those associated with access to seeds, soil degradation, water scarcity and animal production, as well as other rural concerns, such as child and maternal health, savings and credit, life planning and local governance.*

It emerged from a 2020–2021 stock-taking (FAO, forthcoming) that FFS on forestry and agroforestry-related areas have helped rural people to deepen their knowledge of trees and forests. It has also helped to stabilize and increase food, fibre and energy production while rehabilitating soils and pastures, and restoring biodiversity, shade trees, watersheds and landscapes. FFS on forestry and agroforestry can enable family farmers across the globe to advance the knowledge, skills and social organization needed for more regenerative natural resource stewardship in and through family farming. In the process, millions of families from across the Global South can become leaders committed to restoring ecosystems and mitigating and adapting to climate change.

Field visit and group discussion as part of the activities of a farmer field school on forestry supported by the Japan International Cooperation Agency (JICA), in collaboration with the Ministry of Forestry in Kenya.

Moving towards regenerative land management

According to the IPCC (2022), under current emission trends, limiting global warming to 1.5°C (2.7°F) is beyond reach. In the scenarios assessed, this limit requires global GHG emissions to peak before 2025 at the latest, and be reduced by 43 percent by 2030. Hence, achieving net zero carbon emissions by 2050 is fundamental to not exceeding the 1.5°C temperature threshold (IPCC, 2022).

In 2014, 51 countries joined the Bonn Challenge and agreed to restore 350 million ha of degraded and deforested landscapes by 2030. However, the success of restoration initiatives, as well as other carbon dioxide removal actions, depends on developing effective approaches to address feasibility and sustainability constraints, especially at large scales. For example, reforestation, improved forest management and soil carbon sequestration can enhance biodiversity and ecosystem functions, employment and local livelihoods. In contrast, afforestation or production of biomass crops could have adverse socio-economic and environmental impacts on biodiversity, food and water security, local livelihoods and on the rights of Indigenous Peoples, where land tenure is insecure (IPCC, 2022).

The 2021 IPCC report explains that there is not enough land to correct the carbon imbalance through afforestation due to present-day and future food demands. As Lal (2020) explains, while countries must continue to reduce emissions, protect existing forests, afforest deforested areas, and safeguard grasslands and savannahs, they also need to invest in approaches that are largely absent from the climate change mitigation and adaptation agenda, i.e. soil-based solutions, which could bring agriculture to the forefront of climate change mitigation.

In 2020, the total agricultural land area worldwide was about 4.7 billion hectares, about one-third of the global land area. One-third of agricultural land was cropland (nearly 1.6 billion hectares) while the remaining two-thirds were permanent meadows and pastures (around 3.2 billion ha) (FAO, 2022). Agricultural expansion is responsible for almost 90 percent of deforestation worldwide, making it a leading driver of biodiversity and habitat loss. Cropland expansion is the main driver, causing almost 50 percent of global deforestation, followed by livestock grazing, which accounts for 38.5 percent (FAO, 2022). The widespread adoption during the mid-20th century of agricultural technologies, such as total tillage, monoculture and reliance on synthetic fertilizers and pesticides, substantially increased agricultural production across the planet. Over time, however, the widespread uptake of such practices in agriculture and food production has significantly undermined agro-ecosystems (Pingali, 2012). According to the IPCC (2022), an estimated 23 percent of total anthropogenic GHG emissions (2007–2016) derive from Agriculture, Forestry and Other Land Use (AFOLU). Another study finds that industrial agriculture and food accounts for 34 percent of all GHGs, as a result of production, processing, transportation and waste (Crippa *et al.*, 2021).

In the 1980s, the limitations of the concept of sustainability as a driver for fast change in agriculture led Robert Rodale to suggest that the objective in agriculture should be 'regeneration' – i.e. the restoration of the biological fitness of ecosystems, rather than solely protection of our current environmental resources.

As Rattan Lal (2020) explains, large and smallholder farmers can engage in resource-conserving, regenerative agriculture, which can help stabilize and improve their production while reducing GHG emissions and increasing terrestrial carbon sequestration. Today, regenerative agriculture is a growing movement, organized around a system-based approach to farming that "reconciles the need of producing adequate and nutritious food with the necessity of restoring the environment, making farming a solution to environmental issues" (Box 1).

Box 1

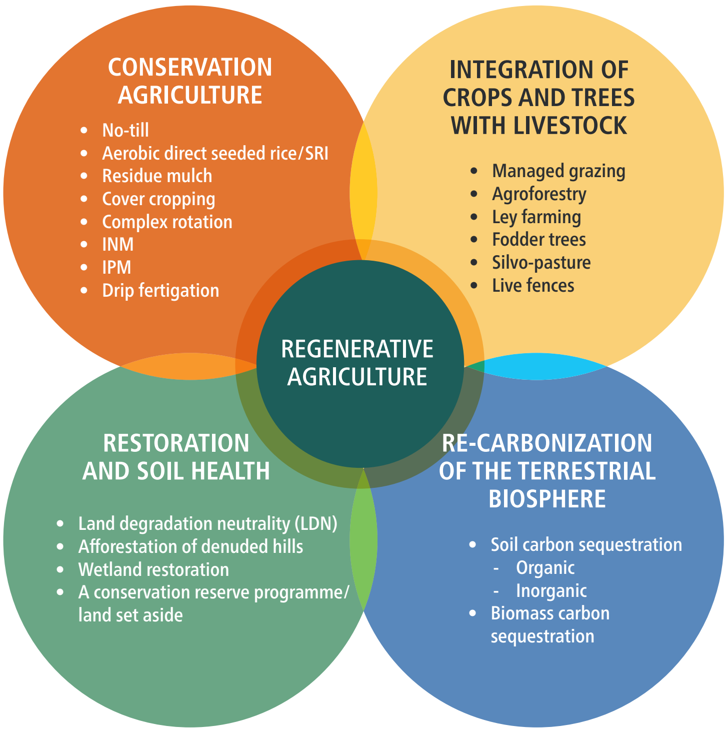
What is ‘regenerative’ agriculture?

Coined by Robert Rodale in the 1980s, pioneering farmers and researchers in the United States of America, Australia, New Zealand, South Africa and elsewhere have further developed and operationalized regenerative agriculture as a joint conservation and rehabilitation approach to food production (Newton *et al*., 2020). Building on decades of farming experience and scientific research in organic agriculture, agroecology, agroforestry and holistic rangeland management, regenerative agriculture is a farming approach that seeks to internalize present-day negative externalities of food production.

Regenerative agriculture encompasses a wide range of farming and grazing practices aimed at restoration and sustainable management of soil health through sequestration of soil organic carbon (Figure 1). At least six management strategies and practices guide a shift towards ecosystem rehabilitation in agriculture:

- reduction and elimination of biocides in farming;
- reduction or elimination of soil disturbance through limited to zero tillage;
- constant ground cover and cropping through the use of green manures and the integration of trees and herbaceous perennials;
- enhancement of biodiversity (in space and in time) to sustain diverse flora and fauna, both above and below ground;
- high organic amendments, mainly carbon for fungal populations favouring soil structure and healthy plant rhizospheres;
- animal integration and holistic management to enhance nutrient cycling and reduce greenhouse gas emissions.

Figure 1. The basic tenets of regenerative agriculture: renew carbon cycles and draw carbon dioxide from the atmosphere back to terrestrial systems



Sources: Lal, Rattan. 2020. “Regenerative Agriculture for Food and Climate.” Journal of Soil and Water Conservation 75 (5): 123A-124A https://doi.org/10.2489/jswc.2020.0620A

Newton, P., Civita, N. Frankel-Goldwater, L., Bartel, K. & Johns, C. 2020. What is regenerative agriculture? A review of scholar and practitioner definitions based on processes and outcomes. Frontiers in Sustainable Food Systems 4. https://doi.org/10.3389/fsufs.2020.577723

Notes: Specific practices depend on site-specific biophysical environments and human dimensions (Lal, 2020).
INM = integrated nutrient management; IPM = Integrated Pest Management; SRI = system of rice intensification.

Farmer field schools on forestry and agroforestry

Strengthening smallholder farming through knowledge and experimentation

According to Lowder, Sánchez and Bertini (2021), about 90 percent, or 550 million, of the 608 million farms on the planet are family-run. A shift to regenerative agriculture provides an opportunity for family farmers everywhere to become prominent actors in climate change mitigation while securing their agricultural production and livelihoods. How can innovation towards more regenerative farming be sparked?

According to Poore and Nemecek (2018), due to variation in family farming and the contexts in which it emerges, organizes and operates, regenerative agriculture demands unprecedented innovation in the fabric of the local knowledge base, adaptive research, and farmer-led experimentation on fundamental biological processes, particularly regarding on-farm carbon accrual. Over the last 35 years, FFS have demonstrated their relevance in answering the growing international call for a re-direction in agriculture.

Four centuries after the invention of the microscope and ensuing scientific developments, fundamental biological concepts such as insect metamorphosis, germ theory, pest-beneficial relations and photosynthesis have not entered rural knowledge systems in rural villages across the planet (Sherwood, 1997). The FFS is an action-learning approach that seeks to promote ecological literacy in fundamental biology associated with practical problem-solving (Box 2).

Experiences in forestry and agroforestry

FAO conservatively estimates that over the last 30 years, about 20 million participants from over 90 countries have graduated from an FFS (FAO, 2019). Not only do FFS help farmers solve practical problems and resolve production issues, but according to a recent meta-study,

"I did not understand the harm I was doing to my soil until I went to the forest and met with the trees… A forest never asks for chemical fertilizer or a pesticide."

FFS graduate, Yamaranguilla, Honduras

Box 2

What is a farmer field school?

Faced by the unwanted health, economic and environmental challenges associated with conventional agriculture, in the mid-1980s, a group of creative biologists and educators at FAO, working on issues of rice production in Southeast Asia, developed and applied an innovative knowledge-based, learning-action approach, which follows the phenological stages of crops and led to the farmer field school (FFS). The FFS draws on adult education, particularly self-directed, discovery-based learning that can help farmers discover the basic biological and ecological functioning that underlies agriculture.

Between 15 and 30 interested community members work with a facilitator to identify the challenges they face with a crop or animal of interest, and map local technical knowledge. Subsequently, the participants map out a series of technical alternatives and special topics to discuss during about 20 half-day sessions distributed across the productive cycle. An FFS does not seek to teach everything about a crop; instead, it focuses on what participants need to know in order to address their priority production concerns.

FFS keep lectures to a minimum. Meetings take place in the field. Instruction is hands-on and based on self-discovery, usually performed in comparative 'learning plots' where participants can test ideas and evaluate the outcomes of alternative practices. The facilitator guides participants through a series of learning experiments, for example, in an insect's life cycle, fertilization or nutritional regimes, and fungal growth (to understand pathogenicity). In addition, participants design a series of open-ended experiments to identify farming options and opportunities, such as in distance planting, new varieties and multi-cropping. By the end of the season, participants will typically have met 20 or more times. In addition, they will hold a field day to share their insights with neighbours.

The FFS close with graduation, but many groups decide to carry on with further activity. Graduates may choose to conduct an FFS focusing on a new theme of interest, carry out new experiments, or plant a crop together to raise money for a revolving fund. Options depend on the participants' motivation and creativity. Participants acquire the self-esteem and practical problem-solving skills needed for devising effective alternatives. In addition, many FFS graduates develop leadership and social skills for strengthening organizational capacities through their group work and collective activities both during and after the FFS.

Source: FAO. 2019. *Farmers taking the lead – Thirty years of farmer field schools*. Rome. 72 pp.

Cards showing FFS participants' perceived threats and opportunities in coffee cultivation in Uganda.

they foster self-esteem, unlock creativity, and promote social organization (van den Berg *et al.*, 2020a). FFS have helped rural people's organizations, non-governmental organizations (NGOs), research centres, governments and donor agencies across the globe advance their development objectives.

Since their creation in the rice fields of Indonesia in the late 1980s, communities have requested that FFS address new themes, including other crops, animals and integrated production systems, before branching out to include landscape management, human health and governance (van den Berg *et al.*, 2020b). While not as much as in crop production, numerous programmes have applied the FFS approach to different aspects of agroforestry.

FAO considers agroforestry a part of an integrated multi-dimensional approach to food production and natural resource conservation and management. Generally, it refers to either simultaneous integration of perennial woody species in crop or animal production systems, or to the sequential alternation of annual crops and trees. During a 2020–2021 stocktaking of FFS on forestry and agroforestry, applications of the FFS approach were found in fruit tree production in Southeast Asia as early as the mid-1990s (FAO, forthcoming). Overall, the report identified 21 major FFS programmes in forestry and agroforestry, with over 200 000 graduates distributed across every region of the Global South. Facilitators worked with participants to find a way to adapt the agro-ecosystem analysis to perennials. In addition, the forestry application of FFS focuses on discovery-based learning exercises, ecological literacy and farmer-led experimentation.

Common themes in FFS include Integrated Pest Management (IPM) for coffee, cacao, citrus, mango, and other fruit trees, overall plantation management, the use of trees in soil conservation, pastoral/rangeland management, timber and fuelwood production, and watershed and landscape management. While specific FFS programmes addressed aspects of climate change adaptation, the themes of terrestrial carbon sequestration and climate change mitigation remained largely untapped opportunities. Outstanding experiences from five different regions are highlighted below.

Managing Forests with the Community, Indonesia: In 2001, Indonesia's state forestry corporation established *Pengelolaan Hutan Bersama Masyarakat* (PHBM, Managing Forests with the Community). Led in part by previous FFS-IPM graduates, PHBM provided communities living within or adjacent to state forest lands with clear access rights and management responsibilities, thus creating the need to represent their interests and negotiate agreements with other stakeholders, including actors in communities, private enterprises, and the state. PHBM field schools helped farmers build individual and collective capacities in upland agroforestry within the broader context of integrated watershed management. From 2004 to 2010, the United States Agency for International Development (USAID) financed the Environment Services Program, a collaborative project implemented

Farmers learning to assess characteristics of healthy soil as part of an FFS implemented under the Andhra Pradesh Community Managed Natural Farming programme in India.

by government agencies, NGOs and community organizations. The primary objective was to promote watershed management and clean drinking water from 'ridge to reef'. The project supported upland communities in FFS for watershed management, focusing on forest rehabilitation, conservation, and water for lowland, urban and peri-urban populations.

The Mesoamerican Agroenvironmental Program (MAP) of the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE, Tropical Agricultural Research and Higher Education Center), Central America: Beginning in 2008, MAP-CATIE in Costa Rica worked with national partners in Guatemala, Belize, Honduras, Nicaragua, Costa Rica and Panama to promote rural development and sustainable natural resource management. One of its primary action learning platforms has been FFS on agroforestry, especially in the cocoa sector, focusing on soil rehabilitation. In Honduras, colleagues from 18 producer groups involving over 3 600 families came together to form the National Federation of Cacao Producers (FENAPROCACAHO). As part of their activity with MAP-CATIE, FENAPROCACAHO set up a programme to address technical and social challenges (FENAPROCACAHO, 2018). Based on a long tradition of farmer-led extension in the country, the work has focused on volunteer facilitators, who manage FFS curriculum design and group formation, carry out FFS training and research, and provide guidance for follow-up activties. FENAPOCACAHO found that FFS on agroforestry was promising in building self-esteem and local ownership over change processes, filling knowledge gaps, and enabling income generation and social organization.

The Intensified Social Forestry Project in Semi-arid Areas in Kenya, later followed by programmes in other parts of East Africa: Beginning in 2004, the Kenyan Forestry Service, the Kenyan Forestry Research Institute and the Japanese International Cooperation Agency (JICA) worked with local partners to develop and intensify the use of trees and forestry in dryland farms. The project sought to offset pressures on state-protected forests located in medium and high rainfall areas. In particular, it has helped farmers manage arid and semi-arid woodlands, bushlands and wooded grasslands. Later, the project expanded into the United Republic of Tanzania and Ethiopia. It included on-farm reforestation, community forestry and urban forestry. Technical topics covered seedling production, tree planting within farmlands, including woodlots, boundary planting, homestead planting, windbreaks, pasturelands, and degraded areas for rehabilitation, non-wood forest products, and tree biomass for soil fertility. Through FFS on social forestry, partners worked with farmers and communities to increase the stock of trees in private farms and communal pasturelands to overcome timber and fuelwood deficits.

The Kagera Transboundary Agroecosystem Management Project (Kagera-TAMP), East Africa: Beginning in 2009, the Global Environmental Facility (the GEF), FAO and the Governments of Burundi, Rwanda, Tanzania and Uganda worked with smallholder farmers in 21 districts to test and adapt sustainable land management (including, interactive crop, livestock, soil, water interests) and integrated production systems. They targeted the restoration of degraded lands; carbon sequestration and adaptation to climate change; agrobiodiversity conservation and sustainable use; and increased agricultural production. The project used FFS to help families address, *inter alia*, land rehabilitation, soil fertility, crop-livestock integration, horticultural, and climate change adaptation at the farm, village and regional levels. FFS promoted experimentation in 'win-win' production and environmental protection towards the following outcomes: soil health;

recovery of rainwater catchment and waterway recovery, diversified yields; and resilient livelihoods and ecosystems.

Zero-Budget Natural Farming (ZBNF), India: In 2015, the Government of Andhra Pradesh in India, its Rythu Sadhikara Samstha institute and FAO initiated the Andhra Pradesh Community Managed Natural Farming (AP-CNF) programme. The AP-CNF programme adapts FFS to natural farming in order to advance food security and environmental conservation. While activities have initially favoured short-term annuals, they subsequently included trees and other perennials. The programme aims at accompanying the transition of the 6 million agricultural producers towards regenerative agriculture by 2030. Currently, the programme aims to train 2 000 champion farmers. In collaboration with the German Government, NGOs, community-based organizations, central and state government agencies, it is organizing a centre of excellence on natural farming to help bring learning and experiences to other states and more remote regions with Indigenous Peoples. Working with self-held groups (SHGs),[1] lead farmers and FFS, the programme aspires to reach over half a million farmers in 250 00 villages by 2026.

Over three decades, FFS partners across the planet have gained substantial knowledge in applying non-formal education principles to forestry and agroforestry, leading to a wealth of lesson plans, technical guides and testimonies in diverse geographic, environmental, and social contexts – from arid and semi-arid savannahs to high rainfall mountain environments. This experience builds rich, well-tested, local knowledge based on which rural families can become influential actors in climate change mitigation across the Global South.

1 A SHG is a community-based group with 12-25 members. Members are usually women from similar social and economic backgrounds, all voluntarily coming together to regularly save small sums of money.

FFS members visit an agroforestry nursery in Honduras.

©Hanns R. Neumann Stiftung

Farmer-led ecosystem restoration: actions that need to be taken

Decades ago, development practitioners and foresters affirmed the importance of directly involving people in problem-solving (Gilmore, 2016). The UN Decade on Ecosystem Restoration proposes a set of principles that can help inform and guide investments in the rehabilitation and restoration of ecosystems (Box 3). Forest and landscape restoration activities have significant benefits for addressing climate change-related impacts, including carbon sequestration and reduction of GHG emissions, improving the resilience of

Box 3

Principles for ecosystem restoration to guide the United Nations Decade on Ecosystem Restoration 2021-2030

Principle 1. Ecosystem restoration contributes to the United Nations Sustainable Development Goals and the Goals of the Rio Conventions: Restoration projects, programmes and initiatives at all spatial scales, from individual sites to large landscapes and seascapes, play an essential role in achieving ambitious global targets for sustaining life on Earth. Successful ecosystem restoration aims to contribute to the achievement of the 2030 Agenda and its 17 Sustainable Development Goals (SDGs), and supports achievement of the goals of the Rio Conventions – CBD, United Nations Convention to Combat Desertification (UNCCD) and United Nations Framework Convention on Climate Change (UNFCCC) – and allied global initiatives.

Principle 2. Ecosystem restoration promotes inclusive and participatory governance, social fairness and equity from the start and throughout the process and outcomes: All stakeholders, right-holders, and especially under-represented groups should be equitably and inclusively provided with opportunities to be engaged and integrated in meaningful, free and active ways. Inclusive participation is necessary for achieving the desired outcomes of restoration over the long term, and should be promoted as much as possible throughout the process, from planning to monitoring.

Principle 3. Ecosystem restoration includes a continuum of restorative activities: Ecosystem restoration encompasses a wide range of activities that aim to repair degraded ecosystems of all kinds. To be considered ecosystem restoration, the activity must result in net gain for biodiversity, ecosystem health and integrity, and human well-being, including sustainable production of goods and services.

Principle 4. Ecosystem restoration aims to achieve the highest level of recovery for biodiversity, ecosystem health and integrity, and human well-being: Ecosystem restoration should enhance and not be a substitute for nature conservation, especially in areas with high value for ensuring ecological integrity and connectivity, including those within the territories of Indigenous Peoples and traditional communities. The use of native species should be favoured, whereas non-native species potentially or proven invasive should be avoided.

Principle 5. Ecosystem restoration addresses the direct and indirect causes of ecosystem degradation: Restoration projects should start with identifying the degree and causes of degradation. If the root causes are not addressed, restoration initiatives will fail over the long term. Restoration plans landscapes and reducing disaster risks (Garrett et al., 2022). As a result of growing recognition of the complexities and dynamics of terrestrial ecologies, particularly the microbial activity involved in above- and belowground plant carbon sequestration, ecosystem restoration requires a shift to acknowledging and valuing the inter-dependence and co-existence of different elements. This also includes putting human beings at the core of resilient ecosystems.

The FAO stocktaking study (forthcoming) identified opportunities, challenges and lessons learned in the application of the FFS approach applied to forestry and agroforestry. Through the review of over 400 documents (peer-reviewed and grey literature), 35 in-depth key informant interviews and a stakeholder workshop, the stocktaking evidenced the challenges and opportunities of advancing family farming through FFS on forestry and agroforestry related themes. Given the intrinsic benefits of increasing soil organic

and policy instruments should incorporate ecological, cultural and socio-economic considerations. Moreover, it is important to work on the harmonization of policies and plans that govern the management and use of natural resources in order to avoid confusion and conflicts.

Principle 6. Ecosystem restoration incorporates all types of knowledge and promotes their exchange and integration throughout the process: Ecosystem restoration should strive to integrate all types of knowledge – including, but not limited to, indigenous, traditional, local and scientific ways of knowing – and practices in order to achieve greater kinship with nature, cooperation and effectiveness. Such integration will foster inclusive and consensual decision-making throughout the process while enabling full participation of local stakeholders and right-holders.

Principle 7. Ecosystem restoration is based on well-defined short-, medium-, and long-term ecological, cultural and socio-economic objectives and goals: Restoration projects' planning phase should set realistic and achievable short-, medium- long-term ecological, cultural, socio-economic objectives based on a shared vision of desired outcomes. Trade-offs among ecological, cultural, and socio-economic objectives and goals should be addressed and reconciled through fair and transparent negotiation.

Principle 8. Ecosystem restoration is tailored to the local ecological, cultural and socio-economic contexts, while considering the larger landscape: Although ecosystem restoration activities can take place at any spatial scale, it should consider the ecological, cultural and socio-economic contexts at both the local and larger landscape throughout the entire process. Considering the local context facilitates alignment of project objectives and goals with local needs.

Principle 9. Ecosystem restoration includes monitoring, evaluation and adaptive management throughout and beyond the lifetime of the project or programme: The monitoring of biodiversity, ecosystem health and integrity, and human well-being responses to restoration is essential to assess the achievements of objectives and goals. It should already begin at the inception of the project and value different methodological approaches. The engagement of stakeholders in monitoring can promote social learning, capacity development and communication among groups and communities of practice, at all scales.

Principle 10. Ecosystem restoration is enabled by policies and measures that promote its long-term progress, fostering replication and scaling-up: Ensuring an enabling policy environment, including through intersectoral policy coordination, is important for achieving restoration objectives and goals over the long term. It requires the coordinating actions among institutions, sectors and stakeholders, through a well-functioning governance system.

Source: FAO, IUCN CEM & SER. 2021. Principles for ecosystem restoration to guide the United Nations Decade 2021–2030. Rome, FAO.

carbon to water retention, the soil biome and plant growth, the stocktaking highlighted that farmers have a vested interest in improving the land for today's production as well as restoring ecosystems for future generations. FFS on forestry and agroforestry could help rural families develop multiple strategies and actions to reduce the negative environmental impacts of agriculture and contribute to restoring ecosystems.

Lessons learned in conservation and natural farming provided insights with which growers could work to reduce their negative environmental impacts while securing their livelihoods. Rural families and their communities needed to understand how climate change mitigation and adaptation impacted their well-being, as well as to set impact targets, to work with alternatives that improve productivity and carbon sequestration, and to communicate changes to a broader public (FAO and WRI, 2019). Farmers felt that setting local and sectorspecific targets could help them navigate trade-offs and make choices that address local and global priorities.

When possible, participants argued that initiatives needed to help local actors build on experience, address youth and social inclusion, and link joint learning with income generation, leadership and social organization. Given the challenging economics of farming, carbon sequestration had become cost-effective for families, if not profitable, for example, through payment for environmental services or the creation of public incentives.

Recommendations to enable farmer-led ecosystem restoration through farmer field schools

The following recommendations are made for ecosystem restoration through FFS on agroforestry.

- **Strengthen current efforts:** Many regions already have examples of promising agroforestry experiences, including that of traditional forest dwellers. Over the last quarter of a century, many relevant movements have emerged to rehabilitate degraded agricultural land, including agroecology, regenerative agriculture, farmer-managed natural regeneration (FMNR), permaculture, analog forestry, syntropic agriculture and holistic rangeland management. Just as they did with IPM in the 1980s, where possible, FFS should strengthen rather than replace these initiatives.
- **Prioritize youth and social inclusion:** In many areas, rural villages face a continual emigration of youth to urban centres, which creates brain drain and labour shortages. FFS programmes need to involve all members of the household and community while creating income-generating opportunities around agroforestry and restoration activities. In particular, they must help villages develop opportunities for marginalized segments of the population, such as women, youth, children and the landless.
- **Build on local experiences and promote creativity:** Ecosystems are diverse, complex and dynamic. Avoid ready-made formulas; rather start from the experiences, priorities and needs of participants in their immediate environment. Work on ecological literacy to help them to better understand and address fundamental ecological principles and to take steps and action towards ecosystem restoration. The hallmark of a successful FFS is creativity. Start with what farmers know, and through hands-on discovery learning, help them test ideas and expand on their analysis and experience.
- **Involve participants from the start:** Farmers – and adults generally – are part of thriving knowledge systems with a great deal of practical expertise

on their agricultural and forestry landscapes. Do not arrive with a pre-defined curriculum; instead, work with stakeholders in pilot sites to conduct participatory assessments of local technical knowledge. Results can help prioritize learning and identify technical support needs. Technical staff may have limited knowledge in soil biology, carbon cycle, regenerative agriculture, forest management, ecosystem restoration, etc. Hence, they can benefit from FFS learning.

- **Provide technical backstopping and open-ended discovery opportunities:** Traditional, local knowledge and expert science in applied agriculture and forestry should work together in concert. Update technical resources, provide support to training and include farmer-led experimentation in scientific research. When new questions arise, recruit researchers, for example, to help participants measure changes in soil organic carbon. Gather, test and adapt useful indicators and methods for local assessment.
- **Develop learning activities and facilitation guides in diverse aspects of forestry and agroforestry:** According to local needs, identify and test discovery learning activities. Document and share lessons learned and FFS curricula.
- **Incorporate participant-led impact assessments:** While it is helpful to involve outsiders in feedback and evaluation, if there is an interest in strengthening local ownership of action-learning processes, projects need to incorporate collaborative FFS monitoring and assessment that would allow participants to set their targets, measure progress, and determine an ameliorative course of agroforestry and restoration actions.
- **Train local FFS facilitators and master trainers:** Identify outstanding FFS graduates and forestry and agroforestry practitioners for subsequent training, and invest in their proposals.
- **Support seed saver/genetic resource management groups:** Provide specialized training and coordination support for in-situ conservation, genetic diversity and quality control for seed and seedling collection and management, and exchange of experiences across farms and villages to scale up restoration activities.
- **Ensure economic development and self-financing:** In many areas, gastronomy, forest product development and ecotourism have provided opportunities for farmers. Initiatives need to generate quick financial returns that can help inspire and sustain increasing investment in farmer-led rehabilitative and restorative activity.

REFERENCES

Crippa, M., Solazzo, E., Guizzardi, D., Monforti-Ferrario, F., Tubiello, F.N. & Leip, A. 2021. Food systems are responsible for a third of global anthropogenic GHG emissions. *Nature Food*, 2 (3): 198–209. https://doi.org/10.1038/s43016-021-00225-9

Duffy, K.A., Schwalm, C.R., Arcus, V.L. Koch, G.W. Liang, L.L. & Schipper., L.A. 2021. How close are we to the temperature tipping point of the terrestrial biosphere? *Science Advances*, 7: 3: eaay1052 https://doi.org/10.1126/sciadv.aay1052

FAO. 2022. *FRA 2020 Remote Sensing Survey*. FAO Forestry Paper No. 186. Rome. https://doi.org/10.4060/cb9970en

FAO. 2022. Land Use Statistics and Indicators. Global, Regional and Country Trends 2000–2020 FAOSTAT Analytical Brief Series No 48. Rome. www.fao.org/3/cc0963en/cc0963en.pdf

FAO. (forthcoming). *Enabling 'Response-ability': A stock-taking of farmer field schools in smallholder forestry and agroforestry*. Rome.

FAO. n.d. Agroforestry. www.fao.org/forestry/agroforestry/80338/en

FAO and WRI. 2019. *The Road to Restoration: A Guide to Identifying Priorities and Indicators for Monitoring Forest and Landscape Restoration*. Rome, Washington, D.C.

FENAPROCACAHO. 2018. Modelos de Escuela de Campo Como Opción Metodológica Para Brindar Asistencia Técnica Local al Sector Cacaotero Hondureño. Honduras, FENAPROCACAHO, Bélgica Servicio para el Desarrollo, RIKOLTO.

Gann, G.D., McDonald, T., Walder, B., Aronson, J., Nelson, D.R., Jonson, J., Hallett, J.G. *et al.* 2019. International principles and standards for the practice of ecological restoration. Second Edition. *Restoration Ecology* 27 (S1): S1–46 https://doi.org/10.1111/rec.13035

Garrett, L., Lévite, H., Besacier, C., Alekseeva, N. and Duchelle, M. 2022. *The key role of forest and landscape restoration in climate action*. Rome, FAO. https://doi.org/10.4060/cc2510en

Gilmour, D. 2016. Forty years of community-based forestry: a review of its extent and effectiveness, *FAO Forestry Paper* 176, Rome: FAO. www.fao.org/3/a-i5415e.pdf

IPCC. 2022. Summary for Policymakers. In: H.-O. Pörtner, D.C. Roberts, E.S. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Craig, *et al.*, eds. *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3–33. doi:10.1017/9781009325844.001

IPCC. 2022. Summary for Policymakers. In: P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, *et al.*, eds. *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi:10.1017/9781009157926.001

Lal, Rattan. 2020. "Regenerative Agriculture for Food and Climate." *Journal of Soil and Water Conservation* 75 (5): 123A-124A https://doi.org/10.2489/jswc.2020.0620A

Lowder, S. K., Sánchez, M.V. & Bertini, R. (2021). Which farms feed the world and has farmland become more concentrated? *World Development* 142. https://doi.org/10.1016/j.worlddev.2021.105455

Pingali, P.L. 2012. Green revolution: impacts, limits, and the path ahead. *Proceedings of the National Academy of Sciences* 109(31): 12302–8 https://doi.org/10.1073/pnas.0912953109

Poore, J. & Nemecek, T. 2018. Reducing Food's Environmental Impacts through Producers and Consumers. *Science* 360, no. 6392: 987–92 https://doi.org/10.1126/science.aaq0216

SERA. 2018. *National Standards for the Practice of Ecological Restoration in Australia*. 2nd ed. Sydney, Australia: Standards Reference Group, Society for Ecological Restoration Australasia (SERA) www.seraustralasia.com/standards/National%20Restoration%20Standards%202nd%20Edition.pdf

Shaxson, T.F. 1996. Conservation at the cross-roads in tropical countries. *Journal of Soil and Water Conservation* 51 (6): 471.

Sherwood, S. 1997. Little things mean a lot: working with Central American farmers to address the mystery of plant disease. *Agriculture and Human Values* 14 (2): 181–89.

Van den Berg, H., Phillips, S., Dicke, M. & Fredrix, M. 2020a. Impacts of farmer field schools in the human, social, natural and financial domain: a qualitative review. *Food Security*, 17 https://doi.org/10.1007/s12571-020-01046-7

Van den Berg, H., Phillips, S., Poisot, A.S. Dicke, M. & Fredrix, M. 2020b. Leading issues in the implementation of farmer field schools: A global survey. *The Journal of Agricultural Education and Extension*, 27(3): 341–353 https://doi.org/10.1080/1389224X.2020.1858891

FFS participants engaging in a group dynamic exercise in Andhra Pradesh, India. Group dynamics enable participants to build their teamwork, problem-solving and leadership skills as well as strengthen mutual trust that is the foundation for future collective activities.

Forestry Division
Natural Resources and Sustainable Production
NFO-Publications@fao.org
www.fao.org/forestry/en

Plant Production and Protection Division
Natural Resources and Sustainable Production
Farmer-Field-Schools@fao.org

Food and Agriculture Organization of the United Nations
Rome, Italy

global environment facility
INVESTING IN OUR PLANET

IFAD
Investing in rural people

Resilient
FOOD SYSTEMS

Required citation:
FAO. 2023. *Enabling farmer-led ecosystems restoration – Farmer field schools on forestry and agroforestry*. Rome. https://doi.org/10.4060/cc6315en