

Agroforestry and precision farming in Kenya

Integrating ecosystem services for climate-resilient and sustainable agriculture

 Kenya



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Introduction

East African smallholder farmers are increasingly affected by the converging challenges of climate change, land degradation, food insecurity and biodiversity loss. In response, agroforestry and precision farming are emerging as promising, transformative solutions capable of addressing these interconnected challenges. Farm Africa supports farmers in Kenya's Central, South and North Rift regions in adopting climate-smart practices, thereby building resilience, improving productivity and promoting environmental sustainability across farming landscapes.

This technical paper synthesises Farm Africa's integrated approach across multiple projects such as; Strengthening Regenerative Agriculture in Kenya (STRAK) funded by IKEA Foundation through AGRA, Acorn funded by Rabobank, Improving Resilience of Smallholder Tea Farmers project funded by Waitrose & Partners, Climate Resilience project funded by Waitrose Foundation together with Work and Opportunities for Women (WOW) programme (UK Foreign, Commonwealth and Development Office) to illustrate how integrating agroforestry with digital precision technologies enhances ecosystem services, climate resilience and sustainable rural livelihoods.

Why practise payment for ecosystem services?

1. Extra income for farmers
2. Improved soil fertility and yields through practices like agroforestry
3. Better water availability and climate resilience due to protected rivers, forests and wetlands
4. Stronger market linkages and partnerships through tree nurseries.

It provides a structured analysis of how these interventions have measurably impacted ecosystem functions and services, focusing on reducing carbon emissions in these areas.

Agroforestry system

At the heart of Farm Africa's approach to environmental conservation is the promotion of a diverse agroforestry system, which involves integrating trees into farming systems to enhance soil health, retain water and increase productivity and biodiversity. Farmers in Central and North Rift have successfully adopted this model, planting trees such as avocado, macadamia, moringa, neem, calliandra, grevillea and others alongside their crops.

Incentives for ecosystem service restoration

A total of 7,351 farmers practising agroforestry from the STRAK and Acorn projects benefited from payment for ecosystem services in 2024 through carbon credit incentives issued as cash and in-kind payments for sequestering carbon in the soil, with 24,945 tonnes of carbon sequestered across 14,175 hectares of land in Embu and Tharaka Nithi Counties. 379,642 tree seedlings were distributed in the process to promote environmental restoration and livelihood diversification.

A total of 11,559 farmers (6,163 men and 5,396 women) were supported in payment for ecosystem services through agroforestry, receiving tree seedlings from Farm Africa and establishing 11 women-led tree nurseries.

Tree seedlings distributed in the STRAK project

County	Seedling type	Quantity
Embu	Avocado	87,546
	Grevelia	50,364
Tharaka Nithi	Mango	13,536
	Mellia	9,594
Total		379,642

Authored by Patrick Nyaga with contributions from Mary Nyale, Nura Aman, Dr Diana Onyango, Libby Plumb and Bertha Lutome.

Front cover photo: Purity Njue at a tree nursery in Embu County. Photo: Farm Africa/ Bertha Lutome.



James Mwangi at his farm in Kenya. Photo: Farm Africa / Bertha Lutome

Project locations



"I always encourage young people to plant trees so they can help conserve the environment and also make a living through it. Some trees actually have long-term financial benefits"

Vallery
Village-Based Advisor based in Iten

Between 2022 and 2024, Farm Africa also distributed 1,250 tree seedlings in Uasin Gishu and Murang'a counties through the Climate Resilience project. The tree seedlings distributed to farmers include: cashew nuts, grevillea, neem, moringa, calliandra, leucaena and gliricidia, chosen for their multi-purpose use in environmental restoration and diversified livelihoods, such as food, fodder, nitrogen fixation and ecosystem restoration.

These trees serve a variety of purposes and provide multiple benefits:

- **Provisioning services:** Income from high-value fruits (avocado, macadamia, mango); timber and fuelwood from grevillea and mellia; fodder from leucaena and calliandra; and medicinal and nutritional products from moringa and neem.
- **Supporting services:** Nitrogen-fixing species (calliandra, gliricidia) restore soil fertility and enhance microbial activity; tree litter improves soil organic matter; and canopy cover reduces erosion, improves infiltration and enhances microclimate.
- Soil organic matter content improved. 81 percent of farmers reported higher yields per acre, while 92 percent reported improvement in water retention and a significant reduction in crop failure and soil erosion.
- Increase in yield from intercrops in agroforestry plots compared to monocultures.
- Reduced carbon emissions.

Digital innovation in agriculture

Farm Africa integrates digital tools to enhance data-driven decision-making and field management in Embu and Tharaka Nithi Counties. Through the use of digital apps for geolocation points, 21,658 farms belonging to 10,342 (47.7%) women, 11,316 (52.2%) men and 3,458 (15%) youths have

been geo-located between 2022 and 2024.

This enables the use of satellites to follow up on agroforestry biomass assessment, improving decision-making and accountability in tree planting initiatives. Precision agriculture relies on the data generated from these digital tools and other technologies like GPS to optimise crop production and resource use. It uses data to calculate the exact amounts of inputs such as seeds, fertiliser and pesticides that should be used in which exact locations on farms.

This approach has enabled farmers to apply inputs such as water and fertiliser more efficiently, improving yields while reducing environmental impact. Farmers applying integrated agroforestry and precision techniques demonstrate lower emissions intensity and improved yields by 60% indicating strong synergies for climate-smart production.

Precision farming outcomes

Through this precision farming approach, farmers have realised several benefits as follows:

- Reduced chemical usage, limiting environmental pollution.
- Smart irrigation (eg drip lines) improves water-use efficiency.
- Soil testing enables targeted nutrient management.
- Lowered costs of production, maximised profits and increased productivity/yields

These practices cut agriculture's carbon footprint by reducing waste, fuel use and improving field efficiency.

60%

improved yields by farmers practising agroforestry and precision agriculture.

Scaling agroforestry and precision farming

Challenges that hinder the scaling of agroforestry and precision farming include socio-economic and policy-related factors.

Land tenure insecurity discourages long-term investment in tree planting, while market constraints and poor infrastructure limit farmers' ability to sell tree-based products such as fruits and timber.

Additionally, inadequate extension services and limited policy incentives hinder the broader adoption of integrated agroforestry systems. From a technical standpoint, the integration of agroforestry into precision farming adds complexity, requiring specialised knowledge to manage diverse data sources, monitor biomass, and adapt technology to mixed farming systems.

Nonetheless, there are significant opportunities for scaling these practices. Leveraging technology to enhance communication, streamline field operations, and expand farmer reach is essential.

21,658

farms have been geo-located

10,342

female-led farms geo-located

3,458

youth-led farms geo-located

“Our women-led tree nursery members know that planting trees is planting income and a green future.”

Caroline Gakii
Village-Based Advisor

Photo: Farm Africa / Bertha Lutome



Farm Africa is already using digital apps and satellite geolocation tools to map farms. Over 21,000 farms have been digitally mapped to date, supporting agroforestry biomass assessment and remote monitoring. Further scaling requires investment in farmer training and skills development, especially among youth. Strategic partnerships with data platforms and research organisations, such as Akvo Foundation, can support infrastructure development and technical capacity building.

Policy engagement is equally crucial. There is a need to strengthen regulatory frameworks that support agroforestry and data-driven farming, such as through subsidies for precision equipment, simplified certification for carbon credits, and alignment with national environmental and agricultural policies.

Several policy frameworks already support aspects of this agenda. The National Land-Use Guidelines (2011) encourage soil protection and agro-ecological farming, including organic practices near water bodies. The Forests Policy (2014) aims to increase tree cover to 10% of Kenya's land area, while the Wildlife (Conservation and Management) Act mandates mechanisms for

human-wildlife conflict compensation, which is increasingly relevant in agroforestry buffer zones.

Additionally, the Climate Change Act requires environmental impact assessments before carbon-related project implementation and mandates that at least 40% of carbon credit income supports community-based sustainability initiatives.

As these programmes evolve, there is a growing need to articulate their broader impact beyond carbon markets. Agroforestry in Kenya is not only sequestering carbon but also restoring degraded land, protecting biodiversity, increasing food security, and improving livelihoods. Precision farming, on the other hand, is helping farmers adapt to climate stress, reduce their environmental footprint, and become more resilient to future shocks.

Multi-dimensional impacts

Impact area	Agroforestry contribution	Precision farming contribution
Carbon footprint	Integrated tree planting, rehabilitated degraded land, increased biomass and ecosystem restoration.	Reduced fuel use and emissions
Food security	Diversified crop/tree products	Improved water and input efficiency hence increasing productivity
Climate resilience	Buffer against soil degradation and drought - improves farmer adaptability to drought and weather variability.	Data-driven, adaptive production systems
Livelihoods	Income from fruits, timber, and ecosystem services - diversifies incomes via tree products, reduces dependence on annual crops.	Optimised yields, lower input costs

In conclusion, Farm Africa's integrated approach, combining agroforestry with precision farming is delivering measurable, multidimensional impact. Farmers have reduced carbon emissions by 24,945 tonnes of carbon dioxide, generating income through the sale of an equivalent number of Carbon Removal Units (CRUs).

At the same time, the combined adoption of agroforestry and precision farming has led to a 60% increase in yields among participating farmers. Together, these results demonstrate that climate-smart agriculture can simultaneously cut emissions, boost productivity and strengthen farmer incomes, proving that environmental sustainability and economic resilience can go

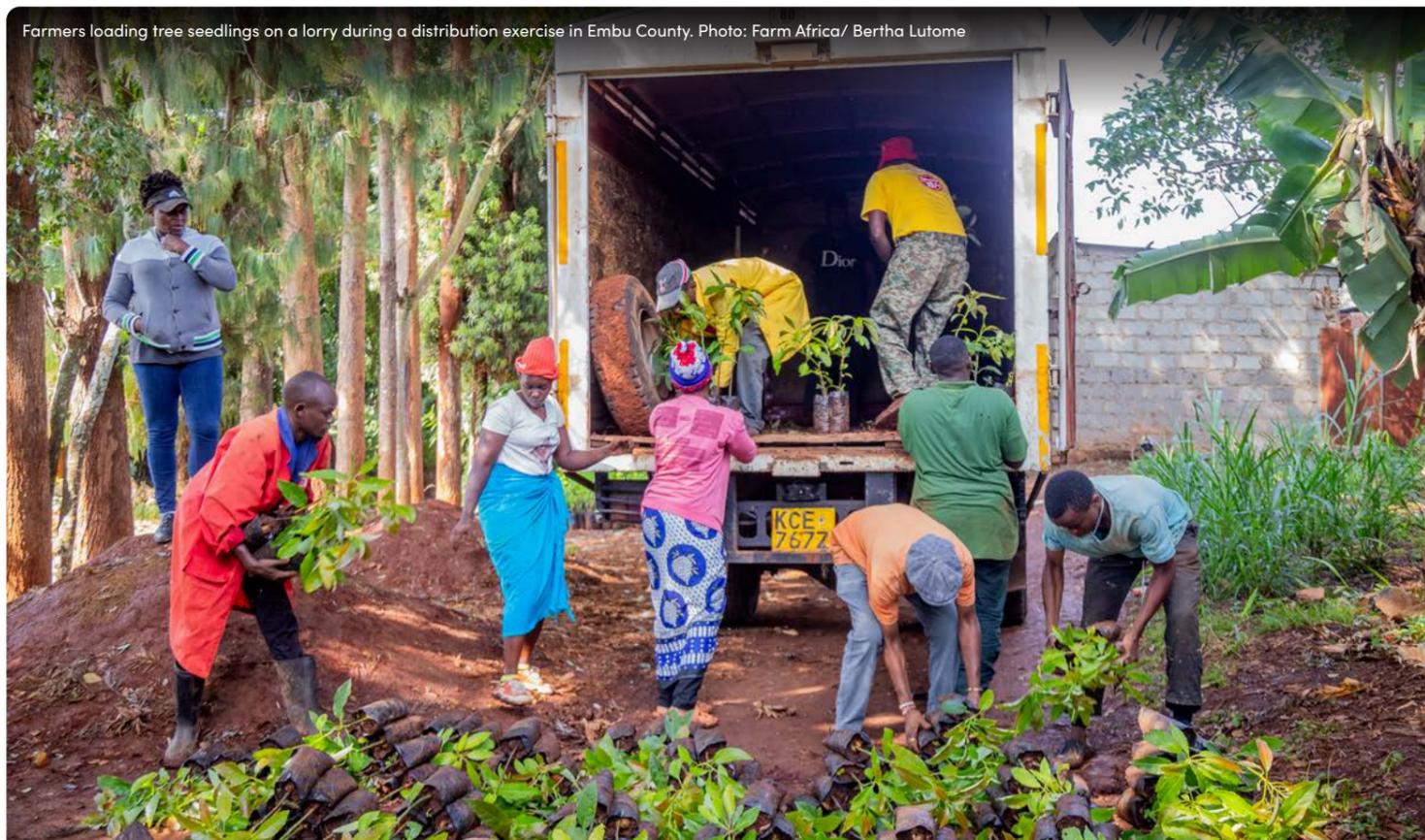
hand in hand.

By increasing productivity, restoring landscapes and empowering farmers as environmental stewards, this model holds significant promise for wider adoption. As we look forward, scaling these efforts through supportive policy, robust partnerships and targeted investments will be critical to unlocking their full potential across Kenya and the broader eastern Africa region.

“I used the payment that I received from planting trees to pay school fees for my daughter. This is a good idea because people trust me as a VBA when I tell them to plant more trees because they know they will be rewarded.”



RoseBeth Karauri
Village-Based Advisor



Farmers loading tree seedlings on a lorry during a distribution exercise in Embu County. Photo: Farm Africa/ Bertha Lutome

7,351

farmers benefited from payment for ecosystem services in Embu and Tharaka Nithi Counties

24,945 tonnes

of carbon sequestered from farmers practising agroforestry in Tharaka Nithi and Embu Counties between 2020 and 2023



Jacob Kariungu at his tree nursery in Tharaka Nithi. Photo: Farm Africa/ Bertha Lutome

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Disclaimer

This publication was authored by Farm Africa. The views expressed herein do not necessarily reflect the official policies or positions of AGRA, the IKEA Foundation, Acorn/ Rabobank, Waitrose & Partners, the Waitrose Foundation, or the UK Foreign, Commonwealth and Development Office.

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