



Photo by Catherine Muthuri/CIFOR-ICRAF



Fruit Trees for Climate Change Mitigation and Adaptation in East Africa

Project highlights

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Project overview

The Fruit Trees for Climate Change Mitigation and Adaptation in East Africa is an Australian Centre for International Agricultural Research (ACIAR) funded project. The 18-month project has been implemented in Kenya and Rwanda and aims to enhance farm-level climate adaptation as well as household food security and nutrition for smallholders by increasing the stocking and strategic siting of fruit trees. In addition, it also took the first steps in exploring the potential for the carbon sequestered in fruit trees to provide access to additional international climate finance and provide information requested by farmers about their contributions to mitigating climate change.

Project implementation is led by World Agroforestry (ICRAF) in partnership with Rwanda Agriculture and Animal Resources Board (RAB) and Jomo Kenyatta University of Agriculture and Technology (JKUAT).

Key objectives

1. Scale out community-based fruit-tree growing, using multipurpose species where possible.
2. Ensure the right trees are in the right places to maximize climate adaptation benefits.
3. Estimate fruit tree carbon sequestration benefits to determine the potential for access to international climate finance that could further accelerate scaling out.

Project sites

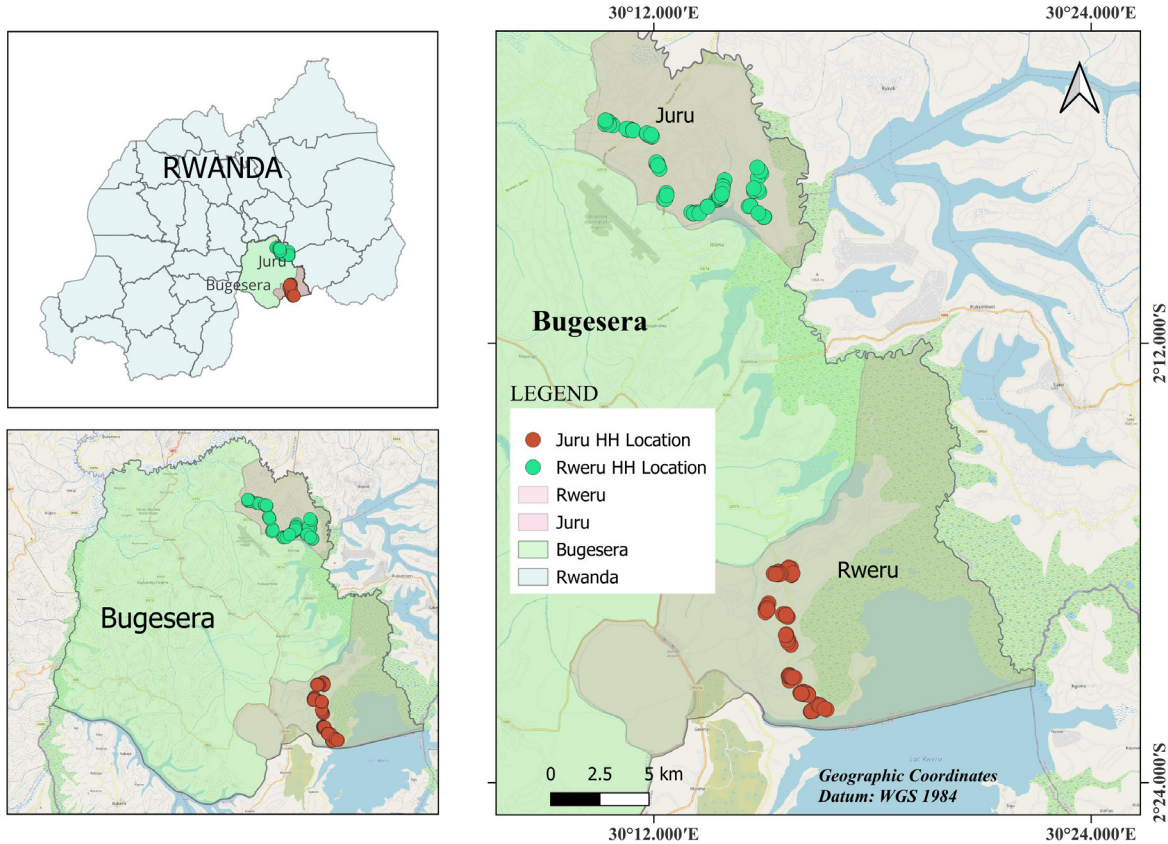


Figure 1. Map of project sites in Rwanda
Source: David Lelei/CIFOR-ICRAF

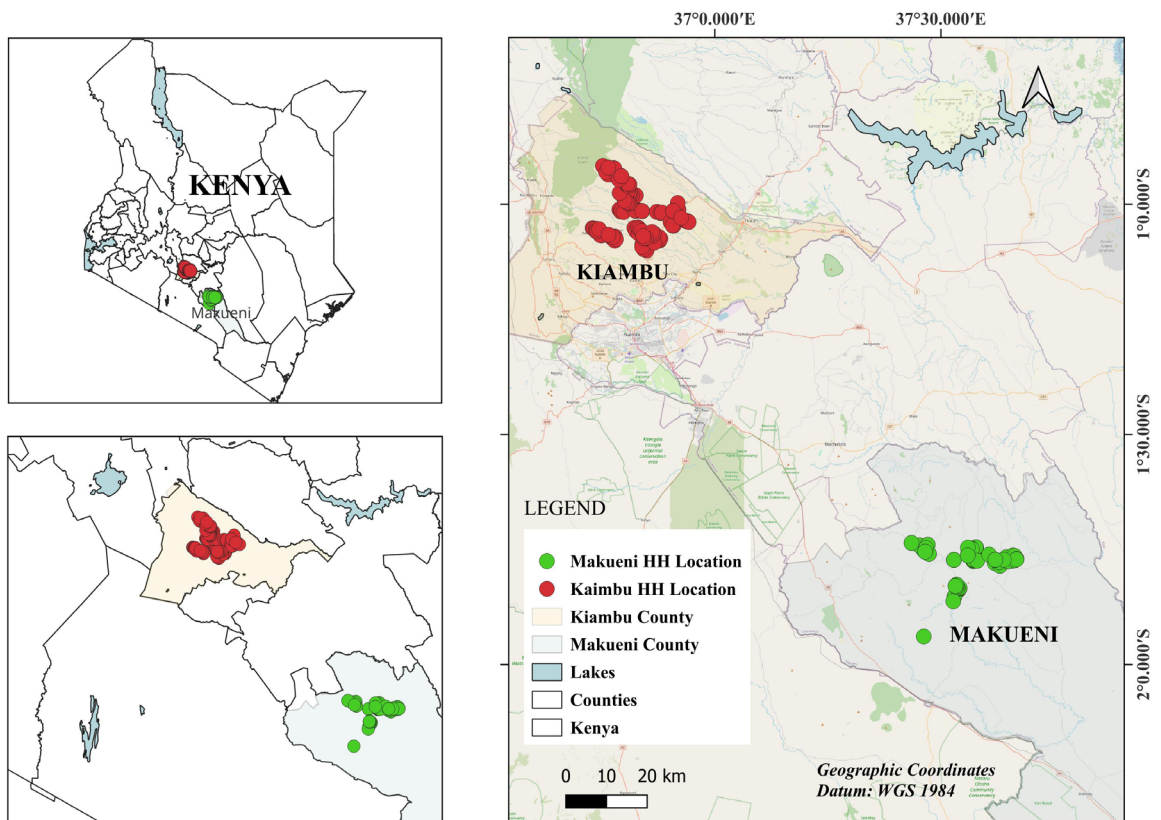


Figure 2. Map of project sites in Kenya
Source: David Lelei/CIFOR-ICRAF

Key challenges

The main challenges identified during the baseline study that may hamper the future willingness to increase tree planting



Lack of quality planting materials



Limited capacity/knowledge in tree growing and management



Climate change-related effects, especially prolonged droughts, leading to water shortages



Incidence of pests and diseases



Limited diversity of tree species, especially the indigenous ones



Lack of structured markets and an underdeveloped value chain.

Key achievements, outcomes and impacts

- **Enhanced understanding achieved of current agroforestry practices** and farmers' priorities, challenges, opportunities and motivations for integrating diversified trees on farms in Kenya and Rwanda. This was based on a baseline study conducted involving 222 and 169 households in Kenya and Rwanda, respectively.



Farm landscape with crops and trees in Githunguri in Kiambu County. Photo by Denis Wakaba/CIFOR-ICRAF

- **Fruit trees constitute a significant proportion of trees on farms.** Of the 178 tree species recorded in Kenya, 56 species (31%) were fruit trees. In Rwanda, 164 species were encountered – 77 in the current study – of which 37 (48%) were fruit trees and the other 87 species were recorded during the Trees for Food Security project. In both countries, avocado, mango and citrus fruit trees were prioritized.



Avocados among the widely preferred fruit trees in Kenya and Rwanda. Photo by Denis Wakaba/CIFOR-ICRAF

- **Development of the Interactive Suitable Tree Species Selection and Management Tool East Africa – for Kenya and expansion of the Rwanda tool.** This web-based tool aids users in understanding tree diversity and promotes the right tree for the right place, management and purpose for enhanced livelihoods and climate resilience
- **Enhanced capacity of farmers and key stakeholders to address climate change and the role of tree diversity, especially fruit trees, in mitigating climate change through:**
 - Provision of training on tree growing (from nursery to on-farm production). This included nearly 2400 participants (44% women) in Kenya and 1148 (43% women) in Rwanda.
 - Capacitating of tree nurseries is being supported, with 15 in each county in Kenya and 7 in Rwanda.
 - Provision of quality planting materials, for example, 430 true-to-type avocado seedlings were distributed to 101 farmers, 31 of whom provided their trees for destructive sampling. In Rwanda, 432 farmers received 3 fruit tree seedlings each (avocado, mango and papaya) during 'Umuganda' (A national holiday in Rwanda taking place on the last Saturday of every month for mandatory nationwide community work) as a contribution to the national campaign of 3 fruit seedlings per household towards improved food and nutrition security as well as increasing tree cover.



Teachers of Githaruru Primary School and PCEA Clergy during community treeplanting day. Photo by Denis Wakaba/CIFOR-ICRAF



Farmers' training on good agronomic practices for avocado and mango and tree nursery in Bugesera District. Photo by RAB

Table 1. Number of beneficiaries trained and engaged through the project in Kenya and Rwanda

Engagement/ Training/	The focus of Training/Engagement	Kenya			Rwanda		
		Male	Female	Total	Male	Female	Total
Training	Farmers reached by ToT and County government officers on GAPs and marketing of avocado	681	486	1167	64	46	110
	Farmers trained on GAPs, disease, and pest management, and marketing of avocado and Mango by ICRAF	64	72	136			
	Sensitization on tree growing and establishment of markets through collective action (TiVOMAC)	8	2	10			
	Tree nursery managers/operators trained directly by ICRAF	44	37	81			
	Training of women self-help groups on nursery and orchard establishments by ToT.	0	23	23			
	Fruit trees for climate change mitigation and adaptation and research Findings Feedback	88	77	165			
	Baseline/tree inventory	100	122	222	91	48	139
Public engagement	Enumerator training in Open Data Kit (ODK) for baseline data collection	13	7	20	23	7	30
	The basic protocol for destructive measurement	55	83	138	29	14	43
	County/sector government extension officer training/engagement	6	7	13	4	3	7
	Sub Totals	Training totals	1059	916	1975	211	118
Subtotal	Distribution of avocado seedlings	44	57	101			
	School tree planting day – information on tree growing	42	48	90			
	Children's Devolution Conference	133	117	250			
	Citizen Forum (Good Agricultural Practices)				186	201	387
	Umuganda (Good Agricultural Practices)				254	178	432
Grand Total	Other engagements	219	222	441	440	379	819
		1145	1021	2416	651	497	1148

- o Formation of the Avocado and Macadamia Cooperative (AVOMAC) bringing together 1150 (20% women) farmers in Gatundu South sub-county. ICRAF and Kiambu County Government collaborated to support the registration of the cooperative. The main purpose of this cooperative is to help enhance farmers' capacity on avocado/macadamia growing, price negotiation and marketing.
 - o Creation of a platform for network and knowledge sharing among farmers and tree nursery operators on matters involving tree nursery operation, fruit growing and markets.
 - o Awareness and sensitization of 145 farmers and extension workers on climate change, estimation of carbon in fruit trees, and role of trees in adapting to climate change and financing was undertaken in Kenya,
- **A systematic review of agroforestry's** contribution to livelihoods and carbon sequestration in East Africa. This helped provide evidence from past studies.
 - **Development of tools for assessing carbon.** These included a training manual on rapid carbon estimation and a **protocol for building allometric equations for the estimation of biomass in fruit trees in East Africa.** The manual aims to build the capacity of farmers, land managers and community facilitators to monitor carbon benefits in fruit trees. Additionally, it

brought users up to date with field measurements, selection of allometric equations and how to calculate carbon stocks.

- **Development of allometric equations for estimating aboveground biomass in mango and avocado.** In Kenya, mango trees were estimated to sequester carbon at $10.5 \pm 2.9 \text{ Mg C ha}^{-1}$, while avocados were at $9.7 \pm 2.9 \text{ Mg C ha}^{-1}$.
- **Context-appropriate partnerships** were forged with various organizations including national/ county governments, research and academic institutions, lead farmers, and local stakeholders such as community leaders and local extension agents in **trainings and in scaling up project interventions for sustainability.**



Destructive sampling to estimate above ground biomass in mango trees. Photo by Denis Wakaba-CIFOR-ICRAF

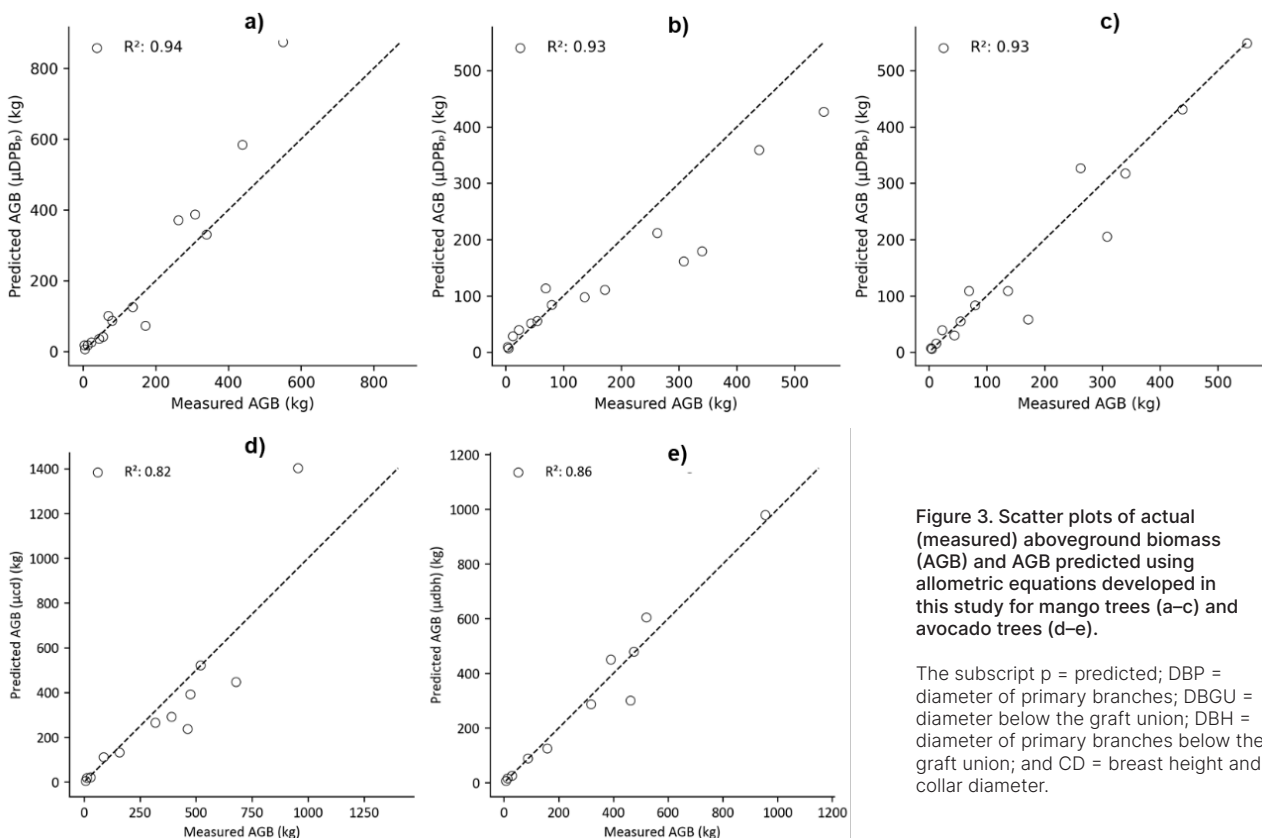


Figure 3. Scatter plots of actual (measured) aboveground biomass (AGB) and AGB predicted using allometric equations developed in this study for mango trees (a-c) and avocado trees (d-e).

The subscript p = predicted; DBP = diameter of primary branches; DBGU = diameter below the graft union; DBH = diameter of primary branches below the graft union; and CD = breast height and collar diameter.

Extension/Scaling approaches

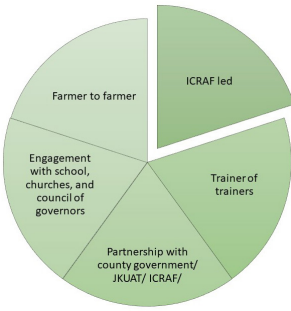


Figure 4. Extension approaches used in Kenya.

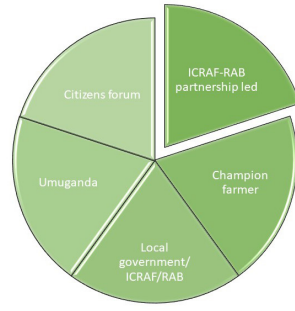


Figure 5. Extension approaches used in Rwanda.

Tools and knowledge products developed

Tailor-made knowledge products suited for different audiences, including farmers, extension agents and researchers include:

- **Mobile Apps-Kuza Matunda (Grow Fruit Trees) and Igiti (Tree)** to assist in fruit and multipurpose tree growing efforts by providing information on uses and management even without an internet connection.
- **Journal articles**
 - Published
 - Kuyah S, Muthuri CW, Wakaba D, Cyamweshi A R., Kiprotich P, Mukuralinda, A. 2024. Allometric equations and carbon sequestration potential of mango (*Mangifera indica*) and avocado (*Persea americana*) in Kenya. doi.org/10.1016/j.tfp.2023.100467
 - Muthuri CW, Kuyah S, Njenga M, Kuria A, Öborn I, van Noordwijk M. 2023. Agroforestry's contribution to livelihoods and carbon sequestration in East Africa. A systematic review. doi.org/10.1016/j.tfp.2023.100432
- **Protocol**
 - Kuyah S, Muthuri CW. 2022. A protocol for building allometric equations for estimation of biomass in fruit trees in East Africa.
- **Training guides and manuals**
 - Gachui A, Kori J, Carsan S, Wakaba D, Njoki C, Muthuri CW. 2023. Avocado production manual. Bogor, Indonesia: Center for International Forestry Research (CIFOR); and Nairobi, Kenya: World Agroforestry (ICRAF).
 - Cyamweshi RA. 2023. Imfashanyigisho ku buhinzi bw'avoka.
 - Kuyah S, Muthuri CW. 2023. Training manual on rapid carbon estimation.
- **Web-based interactive suitable tree species selection**

and management tools

- Muthuri CW, Wamaitha M, Wakaba D, Njoki C, Kuria A. 2023. Interactive Tree Species and Shrubs Selection and Management Tool for Climate Adaptation and Mitigation in Kenya.
- Kuria A, Cyamweshi RA, Wamaitha M, Mukuralinda A, Wakaba D, Njoki C, Muthuri CW. 2023. Interactive Tree Species and Shrubs Selection and Management Tool for Climate Adaptation and Mitigation in Rwanda.

Dissemination activities

- Project lessons sharing during ACIAR side event on **How to implement food systems change** at United Nations Framework Convention on Climate Change (UNFCCC) COP 27 held in November 2022.
- An oral presentation titled, '*Does Climate Change Mitigation and Adaptation Motivate Farmers to Grow Trees? A case study from Kiambu County, Kenya*' was made during the two-day 17th JKUAT's Scientific, Technological, and Industrialization Conference held in March 2023. The conference enabled sharing of findings with academics, researchers, policymakers and funders.
- 2023 Children's Devolution Conference panel on role of trees in climate change mitigation and adaptation held at M-PESA Foundation Academy, Kiambu County.

"It has become critical to build the capacity of avocado farmers to enable them to adjust their management practices, to overcome production-related challenges brought on by climate change, and contribute towards improved farm-level climate adaptation, household food security, and nutrition – as well as sustainable livelihoods."

Catherine Muthuri, CIFOR-ICRAF Kenya Country Director and Regional Convener for East Africa.



Catherine Muthuri (in purple) with ACIAR Team on a field visit in Waturu Farm, Kiambu County. Photo by Denis Wakaba/CIFOR-ICRAF



Gideon Mbugua on his farm with a false codling moth trap
Photo by Caroline Njoki/CIFOR-ICRAF

Farmer testimonials

"I now realize the costly mistakes of inadequate spacing, lack of pruning, and planting avocado varieties that result in below-expectation harvests. I learned that it is important to grow the right variety (Type A and Type B) combinations, as avocados have flowers with both female and male parts on the same plant, which open and close at different times of day, thus affecting the chances of successful self-pollination and fruit development. This necessitates the need for insect pollinators such as bees to increase the likelihood of pollen transfer in good time for fruit setting."

Gideon Mbugua, a farmer and ToT from Gatundu South, Kiambu County.

"We thank ICRAF, RAB, and ACIAR for bringing this project in our community. In our cooperative, we are challenged by watering practices. As you know, we currently use watering cans to water all tree seedlings. This is a time-consuming and labour-intensive process and not always effective. It is difficult to evenly water plants using a watering can as we often end up overwatering some seedlings and underwatering others. Also in the lake, there are animals that can attack people, like crocodiles. We had the idea of investing in a sprinkler system. This would allow us to water all the seedlings evenly and at the same time."

Mukantagara Eveliana, a lead farmer, Juru Sector, Bugesera.

"I have been planting mangos for the past 10 years and faced several challenges along the way. One of the biggest challenges is spacing. When I first started planting mangos, I did not know how far apart to plant the trees. As a result, my trees are too close together, and they are not getting enough sunlight and there is competition between trees. This has led to a decrease in fruit production. Another challenge I encountered is pests and diseases and did not know how to manage them. With the support of ICRAF and RAB

through the Fruit Trees project, I have attended training on how to identify and control diseases and pests. Additionally, I learned how to use pesticides safely."

Mufashimana Phocas, farmer, Juru Sector, Bugesera District.

"I am a member and co-founder of a voluntary youth group with membership across Makueni County. As the group leader in charge of environment and climate change, I was tasked to research the environment and climate change matters. We have heard of climate change finance on radio and from the government. I have been watching YouTube videos and reading the newspapers but could not find any information to report to the members. When I heard that ICRAF is doing work on climate change in our area, I lobbied farmers from my village to volunteer trees for the activities. I'm very excited that now I will have findings to report to members. Also, farmers from my village were trained on how to measure carbon from the farm. I look forward to working with ICRAF on carbon matters."

Julius Kyalo, Agroecology group Makueni County.

Media coverage

Including stories published and broadcast features

- o Smart Farmer Africa: Avocado farmers empowered on climate-smart practices to boost productivity
- o Farmers Review Africa: A new project launched in Kenya and Rwanda to empower avocado and mango farmers on climate-smart practices
- o Citizen TV Kenya: Makueni Farmers turn to fruits farming as Kenya is grappling with effects of climate change
- o Citizen TV Kenya: Mapato ya Hewa ya Kaboni | Mabadiliko ya tabianchi yachochea wataalamu kubadili mbinu ya upanzi



During project review in Rwanda. Photo courtesy of Catherine Muthuri-CIFOR-ICRAF

Recommendations

The gaps identified in this project were partially addressed through capacity building, particularly trainings and extension, using a participatory gender transformative approach. This has resulted in great interest in farming fruit trees, and there is a lot of goodwill and support by farmers and county governments to take this to the next level of scale in production, market and business. Therefore, a follow-on phase to support the implementation of the best-fit options or priority interventions in the following areas is needed.

- Markets and value chains development should be undertaken. With the increased growing of fruit trees, especially mangos and avocados, the whole value chain and market for fruit trees need to be developed.
- More investments in tree nurseries for quality seedling supply (fruit, other indigenous and exotic species) and achievement of certification to enable nurseries to be run as a business (Kenya) should be encouraged.
- Water is one of the biggest barriers to tree growing in the Arid and Semi-Arid Lands- ASAL districts/ counties such as Bugesera and Makueni. Investment support is needed to couple tree growing with water management such as rainwater harvesting.
- Development of allometric equations should be undertaken for: i) citrus fruits and grafted avocado varieties, and ii) belowground biomass allometric equations relating to avocado, mango and citrus.
- Capacity strengthening on the nutritional benefits of fruit consumption is required. Thus, there is a need for more education on nutrition and value addition.
- Investments are needed in the development of online apps to support farmers in accessing knowledge remotely from their phones about fruit growing.

Endline survey findings compared sites where training was carried out to non-training ones revealed 1) increased tree growing (125% and 109%) in Kiambu and Makueni counties 2) significantly higher enrollment in co-operatives and reactivation of agricultural groups 3) Improved knowledge on role of fruit trees in climate resilience and adoption of good agricultural practices in fruit farming particularly tree management, pest control, tree diversification, and quality seedlings sourcing.

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Project webpage:

<https://www.worldagroforestry.org/project/fruit-trees-climate-adaptation-and-mitigation-east-africa>



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