

# Synthesis report on the co-design of agroecological innovations in the Agroecological Living Landscapes (ALLs) in Kenya

Lisa E. Fuchs,<sup>1</sup> Hezekiah Korir,<sup>2</sup> Peter Bolo,<sup>1</sup> Michael Sakha,<sup>2</sup> Pius Gumo,<sup>2</sup> Machio Mbelwa,<sup>2</sup> Anne Kuria,<sup>3</sup> Beatrice Adoyo,<sup>3</sup> Edith Anyango,<sup>3</sup> Nicholas Syano,<sup>4</sup> Esther Kiruthi,<sup>5</sup> Frederick Baijukya,<sup>6</sup> Frédéric Baudron<sup>7</sup>

<sup>1</sup> International Centre for Tropical Agriculture (CIAT), Nairobi, Kenya

<sup>2</sup> International Institute for Tropical Agriculture (IITA), Nairobi, Kenya

<sup>3</sup> Center for International Forestry Research and World Agroforestry (CIFOR-ICRAF), Nairobi, Kenya

<sup>4</sup> Drylands Natural Resources Centre (DNRC), Nairobi, Kenya

<sup>5</sup> Community Sustainable Agriculture Healthy Environmental Program (CSHEP), Kiserian, Kenya

<sup>6</sup> International Institute for Tropical Agriculture (IITA), Dar es Salaam, Tanzania

<sup>7</sup> Centre de coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), Montpellier, France

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# Acknowledgements

This report was developed in the context of the CGIAR Initiative on Agroecology (also referred to as Agroecology Initiative, or AE-I). The Agroecology Initiative is a collaborative partnership of eight CGIAR entities (Alliance Bioversity-CIAT, IMWI, CIMMYT, CIP, ICARDA, IFPRI, IITA, WorldFish), as well as CIFOR-ICRAF, and the French research institute CIRAD under the auspices of the Agroecology Transformative Partnership Platform (TPP). Funded by the CGIAR System Council, the Agroecology Initiative was implemented in eight countries from 2022 to 2024 - five in Africa (Burkina Faso, Kenya, Senegal, Tunisia, Zimbabwe), two in Asia (India, Lao PDR), and one in the Americas (Peru). The Agroecology Initiative aimed to promote the application of contextually appropriate agroecological principles by farmers and communities in various contexts, with support from other food system actors in so-called agroecological living landscapes (ALLs). The ALLs are geographically bound landscapes in which smallholder farmers, agroecology practitioners, researchers, and other development actors identify, test, and promote agroecological innovations across sectors and scales.

In Kenya, the AE-I team was led by CIFOR-ICRAF, and involved teams from the Alliance of Bioversity International and CIAT, the International Institute of Tropical Agriculture (IITA) and WorldFish. The Initiative has fostered the emergence of two ALLs: one in Kiambu, and another in Makueni County. The Initiative's interaction and engagement with the ALLs was organised via central points referred to as "ALLs host centres": the Community Sustainable Agriculture and Healthy Environment Program (CSHEP) in Ndeiya, Kiambu County, which focuses on organic agriculture; and the Drylands Natural Resource Centre (DNRC) in Mbumbuni, Makueni County, focusing on permaculture. The ALLs host centres represent and provide a physical space where food system actors can meet, interact, and co-create knowledge.

This report documents work conducted under work package 1 (WP1) of the AE-I, which focused on the co-creation of innovations in the ALLs. WP1 entailed two key components: the establishment of flourishing multi-stakeholder partnerships and collaboration in the designated ALLs (also referred to as "ALL establishment"), and the co-design of on-farm innovations. Both were to be achieved through transdisciplinary co-design processes, in line with broader agroecology approaches and ontologies. This report provides an overview of the innovation co-design process, its results, the scientific performance of co-designed practices and related reflections.

The documented activities engaged numerous partners of the Agroecology Initiative, as well as farmers, and many other food system actors from government, civil society, and the private sector. We are grateful for the support, team effort, and commitment of all persons involved.

We specifically thank our partners from the Drylands Natural Resource Centre (DNRC) in Mbumbuni Market, Makueni County, and specifically CEO and founder Nicholas Syano, for their engagement, guidance, and support. DNRC is a locally registered non-governmental organization (NGO) whose primary goal is to promote sustainable development of resources of the drylands regions of Kenya to improve livelihoods of the marginalized communities and people living there.

We are grateful to our partners from the Community Sustainable Agriculture Healthy Environmental Program (CSHEP) in Ndeiya, Kiambu County, and specifically director and founder Esther Kiruthi, for their mobilisation, passion, and contribution. CSHEP is a registered community-based organization focused on training small-scale farmers on agroecological and organic practices, especially women in Kajiado north, the Ndeiya areas of Kiambu County, and peri-urban areas southwest of Nairobi city.

We thank our partners from the Participatory Ecological Land Use Management (PELUM Kenya) team, and specifically Patrick Ngunjiri Kihoro, Zonal coordinator for Lower Eastern and Coast zone, for their continuous interest, support, and involvement. PELUM Association is a network of civil society organizations/NGOs working with small-scale farmers in East, Central, and southern Africa. The Association membership has grown from 25 pioneer members (in 1995) to more than 280. PELUM Kenya, the Kenyan country chapter of the PELUM Association, has over 60 members, including DNRC and CSHEP. PELUM Kenya promotes agroecological principles and practices through advocacy and policy influence, networking, capacity development, information, and knowledge sharing.

# Executive summary

In Kenya, the CGIAR Agroecology Initiative (AE-I) has two agroecological living landscapes (ALLs), one in Kiambu County and a second in Makueni County. Work package 1 (WP1) of the AE-I entailed two key components: ALL establishment, and innovation co-design. In line with broader agroecology approaches and ontologies, both were to be achieved through transdisciplinary co-design processes. This report provides an overview of the innovation co-design process, its results, the scientific performance of co-designed practices and related reflections. First, the report introduces the three-pronged co-design approach, which included a preparatory phase, a co-design phase, and a trial phase; and outlines the many different steps involved in the process. It then provides details of the specific practices co-designed across the three identified focus areas in which most attention was required: soil management, water management, and integrated pest management. The respective practices for the Kiambu ALL included the use of compost manure, mulch, and chili-based biopesticides, and farmyard manure, planted terraces, and neem-based biopesticides in Makueni. In the first cycle of trials, each of these practices was put under trial on 10 farmers' fields. The experimental design included on 5x6 m controlled test trial plot, and a second 5x6 m "uncontrolled" control plot. While the inputs used (including seeds, seedlings, and treatments) were centrally provided, and kept constant, the trial participants used their conventional practice in the control plots. With a few exceptions, this conventional practice is largely organic in Kiambu, and followed permaculture principles in Makueni. Third, the agronomic assessment of two consecutive experimentation cycles (October 2023-March 2024; May 2024-September 2024) revealed generally positive performance of the co-designed practices. A preliminary contextual climate analysis showed that both areas received excessive rainfall in the second cycle, with more than twice the long-term average in April and May. Experienced flooding and water logging considerably influenced agricultural production during that cycle. Considering gross productivity, yields only significantly improved in the Makueni ALL, while differences in Kiambu ALL were not significant. In Makueni, only farmyard manure had a significant effect on maize yields, while all three practices significantly improved bean yields. Considering pest and disease pressure, pests were significantly lower for cabbages in the IPM trials in Kiambu, but not for compost or mulch. In Makueni, pests were significantly lower for both maize and beans in the IPM trial, as well as for beans in the manure trial. Despite experiencing difficulties related to planting timing, the climatic conditions, the quality of the inputs used, and market constraints, the participating farmers evaluated the practices and their participation in the trials very positively. In the last two sections, the report discussed adoption and scaling approaches, and broader reflections on successes and challenges with the co-design process, and recommends a continuation of highly methodical and structured transdisciplinary innovation co-design. This report complements the detailed co-design report prepared by the WP1 Kenya team in 2023 (Fuchs et al., 2023b).

# 1. Introduction

In Kenya, the CGIAR Agroecology Initiative (AE-I) has two agroecological living landscapes (ALLs), which are localized at the sub-national and sub-county level in Kiambu County and in Makueni County. The AE-I team engages with numerous and diverse stakeholders in the ALLs, as well as with core agroecology stakeholders at the national level. Formal partnerships with the Inter-sectoral forum for agrobiodiversity and agroecology (ISFAA) and PELUM Kenya provide anchorage and scaling of engagements at the sub-national ALL level. The Initiative's interaction and engagement with the ALLs is organized via central points referred to as so-called "ALLs host centers". These include the Community Sustainable Agriculture and Healthy Environment Program (CSHEP) in Ndeiya, Kiambu County, which focuses on organic agriculture, and the Drylands Natural Resource Centre (DNRC) in Mbumbuni, Makueni County, focusing on permaculture. The ALLs host centers represent and provide a physical space where food system actors can meet, interact, and co-create knowledge.

Work package 1 (WP1) of the AE-I, which focused on transdisciplinary co-creation of innovations in the ALLs, entailed two key components: the establishment of flourishing multi-stakeholder partnerships and collaboration in the designated ALLs (also referred to as "ALL establishment"), and the co-design of on-farm innovations. In line with broader agroecology approaches and ontologies, both were to be achieved through transdisciplinary co-design processes. This report provides an overview of the innovation co-design process, its results, the scientific performance of co-designed practices and related reflections. It complements the detailed co-design report prepared by the WP1 Kenya team in 2023 (Fuchs et al., 2023b).

The innovation co-design workshops that led to the identification of innovative practices for on-farm experimentation were embedded in a broader engagement and co-creation process that involved diverse stakeholders (see Fuchs et al., 2023b for more details). The co-design workshops that led to the first cycle of on-farm experimentation were held in August 2023, and involved about 45 persons per ALL. Stakeholders included farmers, ALL host centers, the AE-I team, and additional research, technical, and extension stakeholders, including from Kenya Agriculture and Livestock Research Organization (KALRO), County Agricultural Extension Department and Participatory Ecological Land Use Management (PELUM) Association. The leads of both ALL host centers participated in the co-design workshops in both ALLs, as did the zonal manager of PELUM-Kenya, one of the key scaling partners.

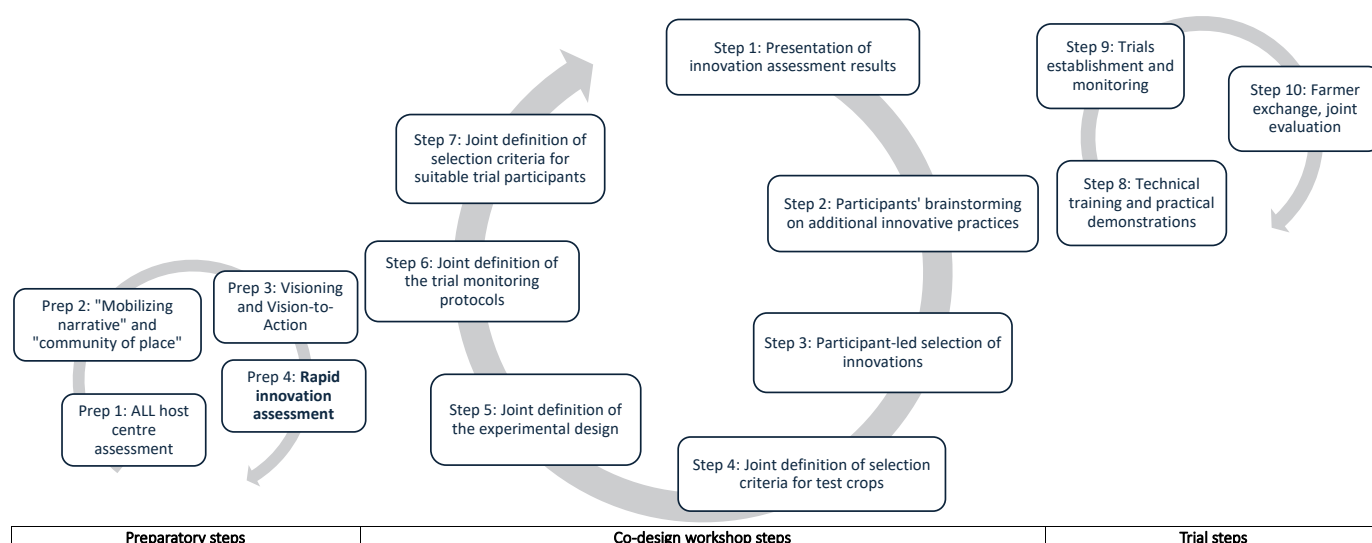
Farmers were purposively selected from a total of 15 farmer groups per ALL, half of which had previously been trained by the ALL host centers, and half of which had not. The identified farmer groups were invited to observe gender and age balance in their selection of representatives who would participate in the workshop.

In view of the practices and test crops selected, and the agricultural cycles in the Kenyan ALLs, two consecutive rounds of co-design workshops were held with the trial participants and other stakeholders in April 2024, and October 2024 respectively. These led to the establishment of a second and third cycle of trials.

# 2. Process and steps followed for codesigning innovations

## 2.1 The process and specific activities

The broader co-design process involved three distinct but inter-related phases: (1) preparation, (2) co-design workshops, (3) trial implementation (Figure 1). The last loop involved consecutive iteration cycles, and the re-design of the technical options for a second and third cycle.



**Figure 1: Steps in the broader co-design process.**

Source: Kuria et al., 2024.

The three phases included several distinct activities, including workshops at different levels and research activities (Table 1). These co-design focused activities were complemented by other activities implemented by the AE-I that did not specifically focus on the co-design of innovative agroecological options.

**Table 1: Description of workshops and activities conducted at different levels**

<b>Title</b>	<b>Type</b>	<b>Scale</b>	<b>Date</b>	<b>Objective</b>	<b>Output/Outcome</b>
<b><i>Preparatory stage</i></b>					
Prep 1: ALL host center assessment	Study	Centers	Sept 2022	<ul style="list-style-type: none"> <li>Appreciative characterization of potential ALL host centers for purposive selection</li> </ul>	<ul style="list-style-type: none"> <li>Characterization of 5 centers and identification of the most suitable options</li> </ul>
Prep 2: Partners' planning workshop	Workshop	Partners (Nairobi)	Nov 2022	<ul style="list-style-type: none"> <li>Familiarization and relationship building with partners (DNRC, CSHEP, PELUM)</li> <li>Identification of agroecological status</li> <li>Training of engagement methodology (sustainability planning)</li> <li>Identification of a "community of place" via the "mobilizing narrative" as per step 1 of sustainability planning</li> </ul>	<ul style="list-style-type: none"> <li>Agroecological status of both ALL host centers</li> <li>Mapping of the mobilizing narrative including land-scape level threats and opportunities in both ALLs</li> <li>Identification of initial "community of place" that would be invited for first sustainability planning/visioning workshops</li> </ul>
Prep 3: Visioning and vision-to-action workshops	Workshop	Kiambu ALL; Makueni ALL	Nov 2022, May 2023	<ul style="list-style-type: none"> <li>Engage communities of place and build relationships</li> <li>Develop joint vision, desired future changes, transition pathways, and concrete action plans for the ALLs</li> </ul>	<ul style="list-style-type: none"> <li>Visions</li> <li>Desired future changes</li> <li>Transition pathways</li> <li>V2A plans</li> </ul>
Prep 4: Innovation assessment	Study	40 farmers in each ALL	Feb 2023	<ul style="list-style-type: none"> <li>Inventory of innovative agroecological options</li> <li>Evaluation of function and performance of options</li> <li>Farmer preferences</li> </ul>	<ul style="list-style-type: none"> <li>List of existing options</li> <li>Evaluation of contextual suitability</li> <li>Indication of preference per function</li> </ul>
<b><i>Co-design workshops</i></b>					
Co-design workshops	Workshops	Kiambu ALL; Makueni ALL	Aug 2023	<ul style="list-style-type: none"> <li>Identify potential AE innovations</li> <li>Select AE innovations</li> <li>Develop a strategy for setting up trials for selected AE innovations</li> <li>Develop adequate protocols for assessing selected AE innovations</li> <li>Select the participants and understanding their preferences</li> <li>Plan for next steps</li> </ul>	<ul style="list-style-type: none"> <li>Innovative practices selected</li> <li>Experimental design identified</li> <li>Preliminary monitoring protocols designed</li> <li>Selection criteria for trial participants defined</li> </ul>
<b><i>Trial establishment and evaluation</i></b>					

Technical training	Workshops	Kiambu ALL; Makueni ALL	Sept 2023	<ul style="list-style-type: none"> <li>• Train farmers on the technical aspects of selected agroecology practices</li> <li>• Finalize data monitoring templates</li> <li>• Train farmers on trial establishment, management, monitoring and data collection</li> </ul>	<ul style="list-style-type: none"> <li>• Technical skills developed</li> <li>• Monitoring protocols finalized</li> </ul>
Soil sampling	Study	Kiambu ALL; Makueni ALL	Sept 2023	<ul style="list-style-type: none"> <li>• Determine the status of trial participants' soils</li> </ul>	<ul style="list-style-type: none"> <li>• Soil samples collected from all trial participants</li> </ul>
Trial establishment	Activity	Kiambu ALL; Makueni ALL	Oct 2023	<ul style="list-style-type: none"> <li>• Establish trials as per experimental design with the help of ALL host centers</li> </ul>	<ul style="list-style-type: none"> <li>• 30+ trials established per ALL</li> <li>• Composite trials established in both ALL host centers</li> </ul>
Trial monitoring	Study	Kiambu ALL; Makueni ALL		<ul style="list-style-type: none"> <li>• Monitor the performance of the innovations across three levels: (1) research team - every 2 weeks; (2) ALL host center - every 2 weeks; (3) farmers - continuous.</li> </ul>	<ul style="list-style-type: none"> <li>• Records on the performance of the trials collected according to the co-designed monitoring protocols</li> </ul>
Intra-ALL exchange visits	Workshop	Kiambu ALL; Makueni ALL	Jan 2024	<ul style="list-style-type: none"> <li>• Foster inter-all knowledge exchange between participants in the same ALL.</li> <li>• Visit each others' trials to co-learn</li> </ul>	<ul style="list-style-type: none"> <li>• Within-ALL knowledge exchanged among trial participants regarding their experiences with trial implementation.</li> <li>• Contextual solutions for challenges discussed and agreed.</li> </ul>
Farmer perception survey	Study	Kiambu ALL; Makueni ALL	March 2024	<ul style="list-style-type: none"> <li>• Collect data on farmers' perceptions about the trials</li> </ul>	<ul style="list-style-type: none"> <li>• Farmer perception data collected</li> </ul>
Harvest	Activity	Kiambu ALL; Makueni ALL	March-April 2024	<ul style="list-style-type: none"> <li>• Harvest the trials</li> </ul>	<ul style="list-style-type: none"> <li>• Harvest data collect</li> </ul>
<b>Consecutive cycles and activities</b>					
Inter-ALL exchange visits with integrated co-design of second cycle	Workshop	Kiambu ALL; Makueni ALL	March 2024	<ul style="list-style-type: none"> <li>• Foster cross-ALL knowledge exchange among participating farmers regarding their experiences with trials.</li> <li>• Deliberate on potential adjustments for the second phase of trial implementation.</li> </ul>	<ul style="list-style-type: none"> <li>• Cross-ALL knowledge exchanged among trial participants regarding their experiences with trial implementation.</li> <li>• Opportunities for adjusting the 2nd cycle of the trials identified</li> <li>• Insights on modes of operations and agroecological business</li> </ul>

				<ul style="list-style-type: none"> <li>Visit pivotal value chain actors in Makueni to gain insights into modes of operations and agroecological business models.</li> </ul>	models in key value chains in the Makueni ALL gained.
Technical training	Activity	Kiambu ALL; Makueni ALL	May 2024	<ul style="list-style-type: none"> <li>Confirm technical aspects of selected agroecology practices</li> <li>Finalize data monitoring templates</li> <li>Train on improved monitoring protocols</li> </ul>	<ul style="list-style-type: none"> <li>Technical skills confirmed</li> <li>Monitoring protocols finalized</li> </ul>
Trial establishment and monitoring	Study	Kiambu ALL; Makueni ALL	May 2024	<ul style="list-style-type: none"> <li>Establish trials as per experimental design with the help of ALL host centers</li> <li>Monitor the performance of the innovations across three levels: (1) research team - every 2 weeks; (2) ALL host center - every 2 weeks; (3) farmers - continuous.</li> </ul>	<ul style="list-style-type: none"> <li>30+ trials established per ALL</li> <li>21 new trials established in Kiambu ALL</li> <li>Composite trials established in both ALL host centers</li> <li>Monitoring protocols improved</li> <li>Records on the performance of the trials collected according to the co-designed monitoring protocols</li> </ul>
Harvest	Activity	Kiambu ALL; Makueni ALL	Aug-Sept 2024	<ul style="list-style-type: none"> <li>Harvest the trials</li> </ul>	<ul style="list-style-type: none"> <li>Harvest data collect</li> </ul>
Co-design of third cycle + farmer perception survey	Workshop + study	Kiambu ALL; Makueni ALL	Oct 2024	<ul style="list-style-type: none"> <li>Exchange about experience with the first and second cycle of trials</li> <li>Discuss further options by context for third phase</li> <li>Co-design practices for third phase</li> <li>Collect data about farmer perceptions of second cycle of the trials</li> </ul>	<ul style="list-style-type: none"> <li>Innovative practices selected</li> <li>Experimental design identified</li> <li>Preliminary monitoring protocols designed</li> <li>Existing 84 trial participants confirmed, and 21 new ones added for Makueni</li> <li>Farmer perception data collected</li> </ul>
Technical training	Activity	Kiambu ALL; Makueni ALL	Oct 2024	<ul style="list-style-type: none"> <li>Train farmers on the technical aspects of selected agroecology practices</li> <li>Finalize data monitoring templates</li> <li>Train farmers on the innovative practices of trial establishment, management, monitoring and data collection</li> </ul>	<ul style="list-style-type: none"> <li>Technical skills developed</li> <li>Monitoring protocols finalized</li> </ul>

## 2.2 The innovative practices put under trial

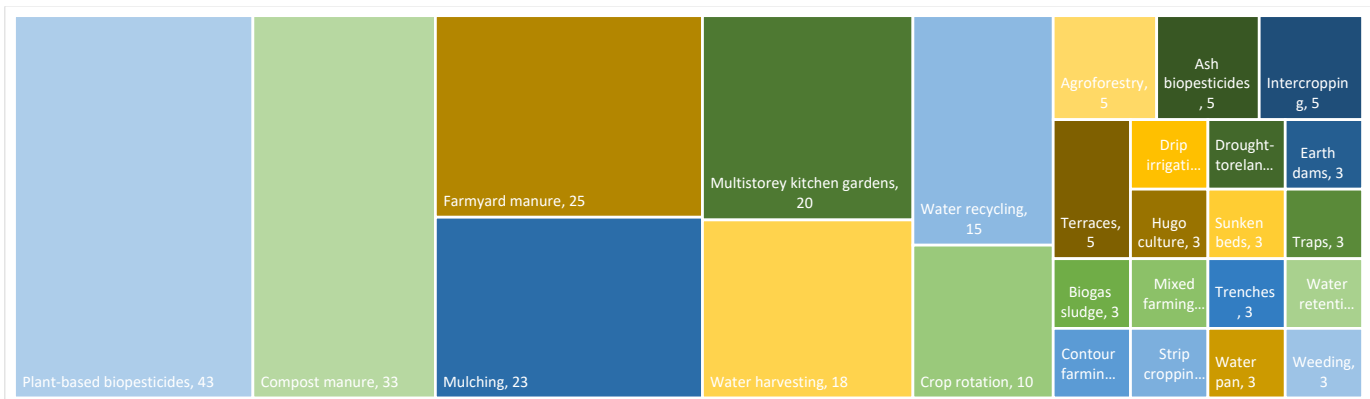
The Kenya team proceeded in a highly methodical manner in its co-design process. The main challenges identified in the initial stages of engagement already established core areas of interest for agroecological innovation (Table 2). These echoed aspects highlighted in the center characterization, and were further developed in the vision-to-action plans. Key was the identification of three focus areas in which there was considerable interest for innovative agroecological on-farm practices: soil management, water management, and integrated pest management.

**Table 2: 'Mobilizing narrative' identified for the Kiambu and Makueni ALLs**

Aspects	Threats	Opportunities
<b>Kiambu</b>		
<b>Natural Resource Management</b>	Water Scarcity	The surrounding community have water conservation practices including rainwater harvesting and on farm practices like mulching and drip irrigation. More efficient water conservation practices desired.
<b>Pest and Disease Control</b>	High pesticide use in Kiambu; Despite IPM, continuous pest problem in the drier-hotter seasons.	CSHEP relates well with biopesticide companies and has trainings on use (and production?).
<b>Value Chains</b>	Insufficient supply for organic veg demand; unstable pricing	Existing Markets. Demand for indigenous crops is growing especially in their Nairobi organic markets.
<b>Current Policies and Governance</b>	GMO ban lifted; land fragmentation leading to intensification; government gives certified conventional seeds	Governance is currently giving out relief food due to the drought. There is an opportunity to build on the food security and safety discussion.
	Farmer groups not well connected and accessible	Already has a good network of PGS (Participatory Guarantee System). Innovative solution to collect produce and provide transport can be further developed
<b>Knowledge and Information</b>	Lacking knowledge and capacity on existing interests (fruit trees, indigenous vegetables etc.)	Fruit tree farming and organic farming are popular.
<b>Makueni</b>		
<b>Natural Resource Management</b>	Water Scarcity and Quality	Already existing water management programs that can be built upon.
	Climate Change	The current Government is rolling out a 12 million tree planting campaign to adapt to and mitigate the effects of climate change.
	Soil Degradation	Availability of land -Makueni county has large tracks of land that allows for building of terraces. -Existing soil and water conservation practices for local government and NGOs.
	Biodiversity Decline	DNRC has a charcoal making program that focuses on making charcoal sustainable via pruning of tress. This is a program by the Kenya Forestry Service (KFS)
<b>Pest and Disease Control</b>	Persistent pest problem	There is an opportunity to further explore and research pest and disease management with the use of biopesticides.
<b>Value Chains</b>	Limited processing capacity limiting gains	Existing Markets. There are local and international markets for the different value addition products of the Moringa. There are also local markets for mango that are currently saturated.
<b>Current Policies and Change in Governance</b>	Lift of the GMO ban	Current agricultural management practices -There is political good will with the current country government promoting sustainable agriculture. -GMO ban lifting by the current national government is an opportunity to educate more on sustainable agricultural practices whilst
<b>Social Structures</b>	Unemployment, drug use, out-migration	Have an active community that is motivated, interested and invested in their own development.

Source: Fuchs et al., 2023a.

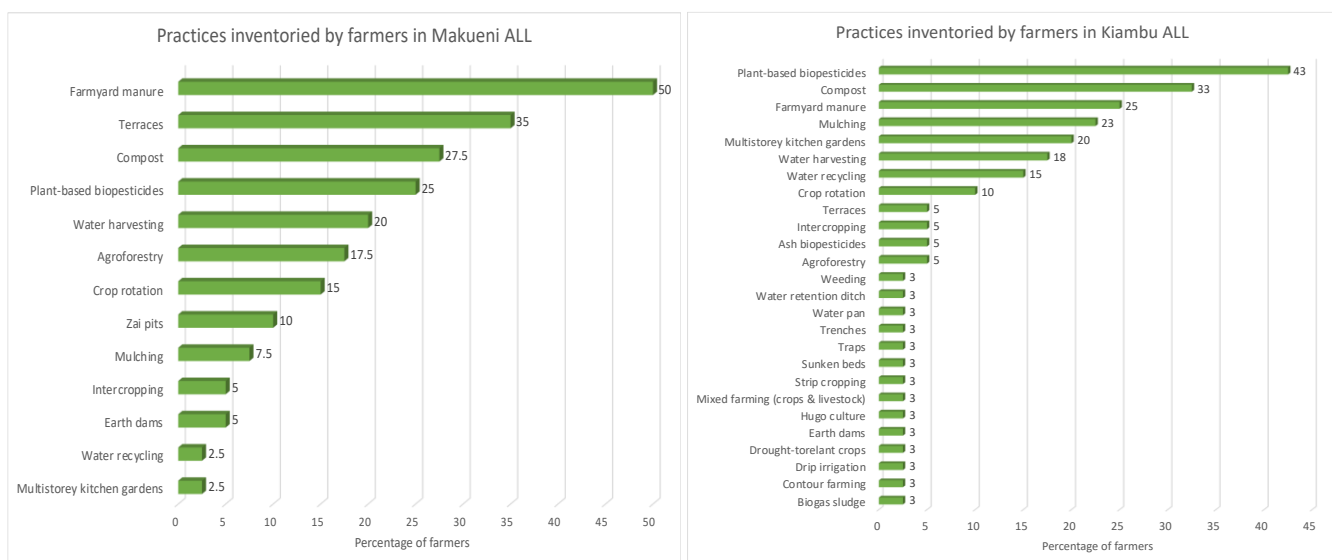
Key was the identification of three focus areas in which there was considerable interest for innovative agroecological on-farm practices: soil management, water management, and integrated pest management. The subsequent innovation assessment, carried out as part of the preparatory phase (Kuria et al. 2023) inventoried 27 unique practices in both ALLs (Figure 2), 26 in Kiambu and 13 in Makueni.



**Figure 2. Existing innovative practices ('options') in both ALLs in Kenya.**

Source: Fuchs et al., 2023b.

Of these, four practices were implemented by at least a quarter of respondents in both ALLs (Figure 3).



**Figure 3. Extent of implementation of innovative practices in the Makueni ALLs (left) and in the Kiambu ALL (right).**

Source: Kuria et al. 2023.

Building on the functional distinction introduced by the ALL stakeholders, the preference assessment carried out in the same vein revealed key preferred practices for each focus area - but also highlighted the multifunctional nature of many of the practices (Figure 4).

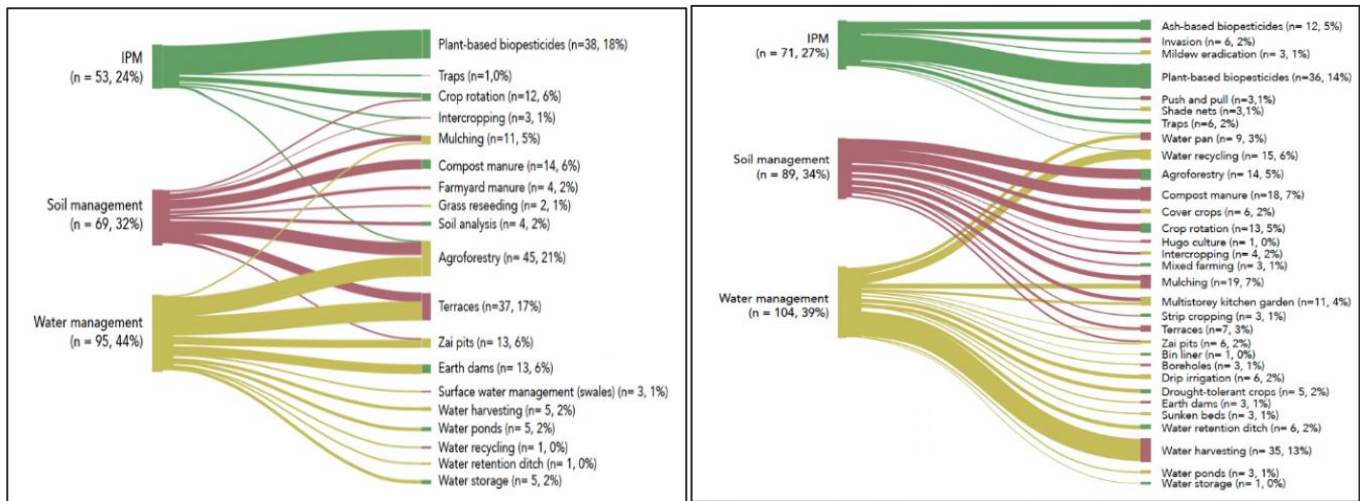


Figure 4. Prioritization of options in the Makueni ALL (left) and Kiambu (right).

Source: Kuria et al. 2023.

During the co-design workshops, context-specific priorities emerging from the prioritization assessment were presented to participants. Participants, on the other hand, presented their preferences. Ultimately, three practices per focus areas were selected collectively for each ALL (Table 3).

Table 3. Priority listings and final selection of innovative practices

Makueni		
Priorities from AE-I WP1 assessment	Workshop participants' top priorities	Final selection
<b>Soil management</b>		
1. Agroforestry 2. Compost manure 3. Terraces 4. Mulching	1. Animal manure 2. Terraces 3. Compost manure	Farmyard (animal) manure
<b>Water management</b>		
1. Agroforestry 2. Terraces 3. Earth dams 4. Zai pits	1. Farm ponds 2. Terraces 3. Wastewater recycling	Terraces (Farm ponds)
<b>Integrated pest management</b>		
1. Plant-based biopesticides 2. Intercropping 3. Crop rotation 4. Repellent crops	1. Intercropping 2. Plant-based biopesticides 3. Ash-based biopesticides	Plant-based biopesticides
Kiambu		
Priorities from AE-I WP1 assessment	Workshop participants' top priorities	Final selection
<b>Soil management</b>		
1. Compost manure 2. Farmyard manure 3. Crop rotation 4. Mulching	1. Agroforestry 2. Compost manure 3. Mulching	Compost manure
<b>Water management</b>		

1. Water harvesting 2. Water recycling 3. Mulching 4. Water pans	1. Water harvesting (water tanks) 2. Boreholes 3. Shade nets 4. Water pans	Mulching
<b>Integrated pest management</b>		
1. Plant-based biopesticides 2. Ash-based biopesticides 3. Repellent crops 4. Traps 5. Shade nets	1. Repellent crops 2. Plant-based biopesticides 3. Mulching 4. Ash-based biopesticides	Plant-based biopesticides

Source: Fuchs et al., 2023b.

After identifying the innovative practices, the test crops and overall experimental design were co-designed as well. This led to the identification of six practices (Table 4). Importantly, farmers decided to use their conventional practice on the control plots. Additional information can be found in Annex A.

**Table 4. Summary overview of the innovative practices and their controls in the Kenyan ALLs**

ALL location	Focus area	Test crop	Test plot (innovation)	AE principle addressed	Control plot (farmer practice)
<b>Kiambu</b>	Soil	Spinach	Compost manure	Recycling, input reduction, soil health, synergy	Combination of manure and fertilizer
	Water	Spinach	Mulch	Recycling, input reduction, soil health, synergy	Without mulch
	Integrated pest management	Cabbage	Plant-based biopesticide (chili)	Recycling, input reduction, soil health, synergy	Other biopesticides or chemical pesticides
<b>Makueni</b>	Soil	Beans-maize intercrop	Farmyard (animal) manure	Recycling, input reduction, soil health, synergy	Combination of manure and fertilizer
	Water	Beans-maize intercrop	Terraces with planted edges	Recycling, input reduction, soil health, synergy	Terraces with bare edges
	Integrated pest management	Beans-maize intercrop	Plant-based biopesticide (neem)	Recycling, input reduction, soil health, synergy	Chemical pesticides

Source: Korir et al., 2024a.

## 2.3 Experimental design

During co-design, it was decided that the experimental set-up would include two 5 m by 6 m plots located next to each other. Each practice was established by about 10 farmers, and all three practices per ALL were established at the respective ALL host center. The general trial set-up was as follows:

- Two plots; a control and a test plot.
- Each plot (test and control) measuring 6m x 5m (30m<sup>2</sup>)
- The two plots were side by side to account for farm variations.
- The orientation of the plots/beds was across the slope in case of a slopy land

Table 5 lists the details for each of the six practices. While the practices themselves were kept constant across the first and second cycle of trials, some of the details were adapted (see last column of Table 5).

**Table 5. Detailed description of innovative practices in the Kenyan ALLs**

<b>Makueni</b>				
<b>Test crop and planting pattern</b>	<b>Innovation test plot</b>	<b>Application frequency and rate</b>	<b>Control plot (existing farmer practice)</b>	<b>Adjustment in the second cycle</b>
Intercrop of traditional Kinyanya maize and original Katumbuka bean variety; 1 line - 1 line	Soil management: Cow manure	15 kg/plot (5tons/ha) applied at planting	Individual conventional practice, including a combination of manure and fertilizer	Different bean variety; increased manure application rate from 15kg per plot to 30kg per plot (10t/ha)
Intercrop of traditional Kinyanya maize and original Katumbuka bean variety; 1 line - 1 line	Water management: Terraces with Napier on the edges	Initial establishment; maintenance over time, especially after rains	Terraces whose edges are left bare	Different bean variety
Intercrop of traditional Kinyanya maize and original Katumbuka bean variety; 1 line - 1 line	Integrated pest management: Plant-based biopesticides - Neem	Preventative application every two weeks; additional application in case of pest presence	Individual conventional practice, including other plant-based biopesticides such as chili, Mexican marigold, sodom apple, <i>Tithonia diversifolia</i> , and/or application of chemical pesticides	Different bean variety
<b>Kiambu</b>				
<b>Test crop</b>	<b>Test plot</b>	<b>Application frequency and rate</b>	<b>Control plot (existing farmer practice)</b>	<b>Adjustment in the second cycle</b>
Spinach	Soil management - compost manure	12 kg/plot (4t/ha)	Individual conventional practice, including a combination of manure and fertilizer	
Spinach	Water management: Mulch	Apply grass (hay); reduce mulch in case of heavy rains to prevent moisture capture	Without mulch	Adaptive management of mulch thickness
Cabbages	Integrated pest management: Plant-based biopesticides (chili)	Preventive application every two weeks; additional	Individual conventional practice, including other biopesticides such as	

		application in case of pest presence	Mexican marigold, neem, Sodom apple, <i>Tithonia diversifolia</i> , and ash and/or application of chemical pesticides	
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Source: Korir et al., 2024a.

The specific experimental set-up for each of the trials is described in Table 6.

**Table 6. Detailed description of the trial set-up per practice**

Practice	Set-up	Management
<b>Makueni</b>		
<b>Farmyard manure on maize-bean intercrop</b>	<ul style="list-style-type: none"> <li>▪ Add the appropriate amount of the mature composted farmyard manure to the soil (approximately 5 tons of well decomposed manure is required per hectare depending on the nutrient quantity in the manure, soil nutrient status and crop type).</li> <li>▪ Intercrop the maize and beans from the local varieties adapted to the region (i.e., maize varieties <i>Kinyaanya</i>; and beans <i>Katumbuka</i> for Makueni County).</li> <li>▪ Spacing: Maize - plant maize seeds singly at 75cm x 25cm</li> <li>▪ Spacing: Beans - plant beans between the maize rows at an interrow spacing of 10 cm</li> <li>▪ After planting is completed, add water to the plant. This water will lead the plant to absorb the nutrients in the farmyard manure compost along with water.</li> </ul>	<p><b>Weeding</b>- Weeding should be done depending on the weed pressure.</p> <p><b>Pest management</b> - Use plant based biopesticide to manage pests once pests are noticed on the crops.</p>
<b>Planted terraces on maize-bean intercrop</b>	<ul style="list-style-type: none"> <li>▪ The test plot should comprise an area within the terraces having the edges planted with Napier grass while the control plot should comprise the normal farmer terrace management (commonly left bare or planted with trees on the terrace edges).</li> <li>▪ Intercrop the maize and beans from the local varieties adapted to the region (i.e., maize varieties <i>Kinyaanya</i>; and beans <i>Katumbuka</i> for Makueni County).</li> <li>▪ Spacing: Maize - plant maize seeds singly at 75cm x 25cm</li> <li>▪ Spacing: Beans - plant beans between the maize rows at an interrow spacing of 10 cm</li> </ul>	<p><b>Compost/manure application:</b> Apply a uniform amount of compost/manure for both test and control plots: 1-2 handfuls per hole.</p> <p><b>Weeding</b>- Weeding should be done frequently depending on the weed pressure.</p> <p><b>Pest management</b> - Use IPM techniques to manage pests once they are observed on the crop.</p>
<b>Neem-based biopesticide on maize-bean intercrop</b>	<ul style="list-style-type: none"> <li>▪ Intercrop the maize and beans from the local varieties adapted to the region (i.e., maize varieties <i>Kinyaanya</i>; and beans <i>Katumbuka</i> for Makueni County).</li> <li>▪ Spacing: Maize - plant maize seeds singly at 75cm x 25cm</li> <li>▪ Spacing: Beans - plant beans between the maize rows at an interrow spacing of 10 cm</li> <li>▪ Spray the plant material extracts               <ol style="list-style-type: none"> <li>a. once pest infestations have been observed on the crop<sup>1</sup>, and</li> <li>b. in fine weather - not when windy/rainy; preferably in the evening or morning hours before noon.</li> </ol> </li> </ul>	<p><b>Compost/manure application:</b> Apply a uniform amount of compost/manure for both test and control plots: 1-2 handfuls per hole.</p> <p><b>Weeding</b>- Weed frequently depending on the weed pressure.</p>

	<ul style="list-style-type: none"> <li>Apply at weekly intervals, unless other intervals are determined according to the specific biopesticide efficacy</li> <li>Spray early in the morning or later in the evening depending on the pest feeding time and their vulnerable growth stages and target stage of growth i.e. egg, larvae, pupa or adults.</li> </ul>	
<b>Kiambu</b>		
<b>Compost on spinach</b>	<ul style="list-style-type: none"> <li>For the test plot, apply compost in the planting holes and thoroughly mix with the soil at the rate of 4t/ha (12kg per plot), while for the control, adopt the normal farmer practice.</li> <li>Transplant spinach (<i>Spinacia oleracea</i>) seedlings from a previously prepared nursery, at the spacing of 30cm x 30cm</li> <li>Transplanting should be done late in the evening when the temperature is low.</li> <li>The soil should be wet before uprooting them from the nursery to prevent root damage.</li> <li>Plant the seedlings in the beds at the same depth they were previously growing at while in the nursery.</li> </ul>	<p><b>Weeding</b>- Weed frequently depending on the weed pressure. Since spinach roots are shallow and easily damaged, care must be taken when weeding.</p> <p><b>Pest management</b> - Plant-based biopesticides will be used to manage pests once pests are noticed on the crops.</p>
<b>Mulch (hay) on spinach</b>	<ul style="list-style-type: none"> <li>Grass hay should be used as mulch for the test plot while for the control plot, it will be the farmers' normal practice in relation to soil-water management.</li> <li>The mulch materials are to be applied to the plots by hand per treatment after transplanting by measuring the thickness of 5–10cm (2–4 inches).</li> <li>The materials should be applied both in between the rows and around the crops.</li> </ul>	<p><b>Regular Inspection:</b> Check the mulch layer periodically to ensure it hasn't thinned or shifted.</p> <p><b>Weed Management:</b> Monitor for weed growth at the mulch edges and remove any weeds promptly.</p> <p><b>Irrigation Management:</b> Adjust irrigation practices based on soil moisture levels under the mulch.</p>
<b>Chili-based biopesticide on cabbage</b>	<ul style="list-style-type: none"> <li>Planting spacing (cabbage) to be inter-row spacing 50 cm and intra-row spacing of 40 cm planted in raised beds for ease of operations. Each bed should have three rows of cabbage.</li> <li>Spray the plant material extracts <ul style="list-style-type: none"> <li>once pest infestations have been observed on the crop<sup>2</sup>, and</li> <li>in fine weather - not when windy/rainy; preferably in the evening or morning hours before noon.</li> </ul> </li> <li>Apply at weekly intervals, unless other intervals are determined according to the specific biopesticide efficacy</li> <li>Spray early in the morning or later in the evening depending on the pest feeding time and their vulnerable growth stages and target stage of growth i.e. egg, larvae, pupa or adults.</li> </ul>	<p><b>Compost/manure application:</b> Apply a uniform amount of compost/manure for both test and control plots: 1-2 handfuls per hole.</p> <p><b>Weeding</b>- Weed frequently depending on the weed pressure.</p>

Source: Korir et al., 2024b.

The trial participants in both ALLs opted to make significant changes to the practices put under trial in the third cycle. The participants in Kiambu opted to maintain the practices (compost, mulch, biopesticides), but changed the crops to include a more diversified planting arrangement that includes rosemary and pumpkins. Both crops were identified to have significant market and value-addition opportunities, and farmers preferred to test high-value crops and diversify practices for improved economic returns. In Makueni, the trial participants developed an integrated farm design that combines the existing practices (farmyard manure, planted terraces, biopesticides) with additional contour planting (agroforestry practice where mango trees are included on the terrace edges), and

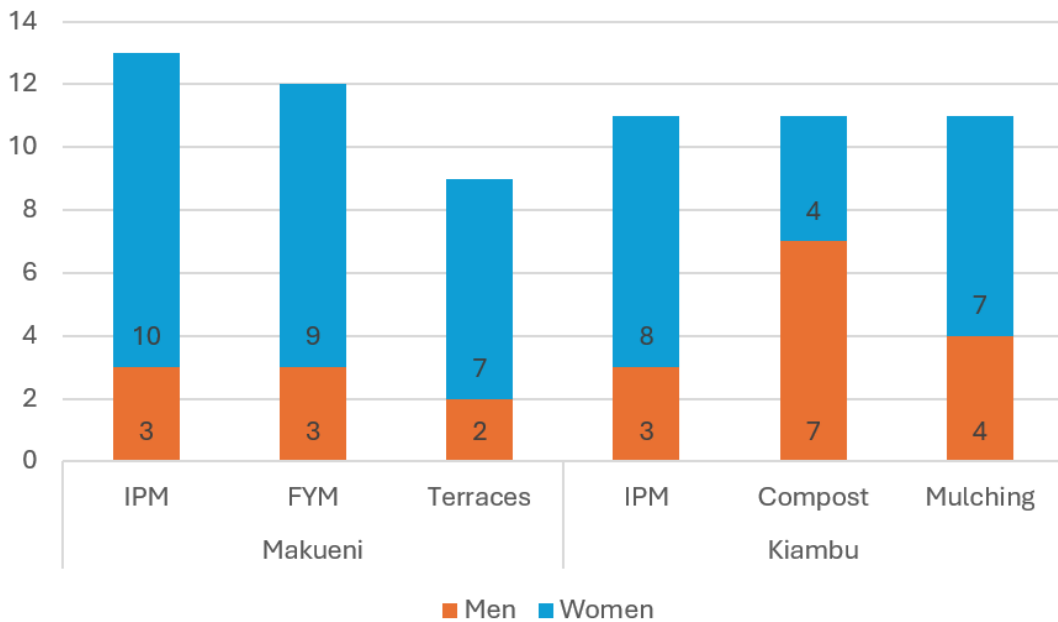
Zai pit planting basins and/or kitchen gardens for vegetable production. Some Makueni trial participants also indicated planning to implement multiple practices, depending on their respective goals (e.g., home consumption or sale). The detailed practices retained for the third cycle of experimentation are listed in Table 7.

**Table 7. Summary overview of the innovative practices and their controls in the Kenyan ALLs**

ALL location	Focus area	Existing practice	Test plot (innovation) modifications
<b>Kiambu</b>	Soil	Compost manure on spinach	Compost manure on spinach + pumpkin + rosemary
	Water	Mulching on spinach	Mulching on spinach + pumpkin + rosemary
	Integrated pest management	Chili-based biopesticide on cabbage	Chili-based biopesticide on cabbage + pumpkin + rosemary
<b>Makueni</b>	Soil	Farmyard manure on beans-maize intercrop	FYM + Zai pits
			FYM + kitchen garden
	Water	Planted terraces on beans-maize intercrop	IPM + Zai pits
			IPM + kitchen garden
	Integrated pest management	Neem-based biopesticide on beans-maize intercrop	Terraces + Zai pits
			Terraces + kitchen garden

## 2.4 Trial implementation and monitoring

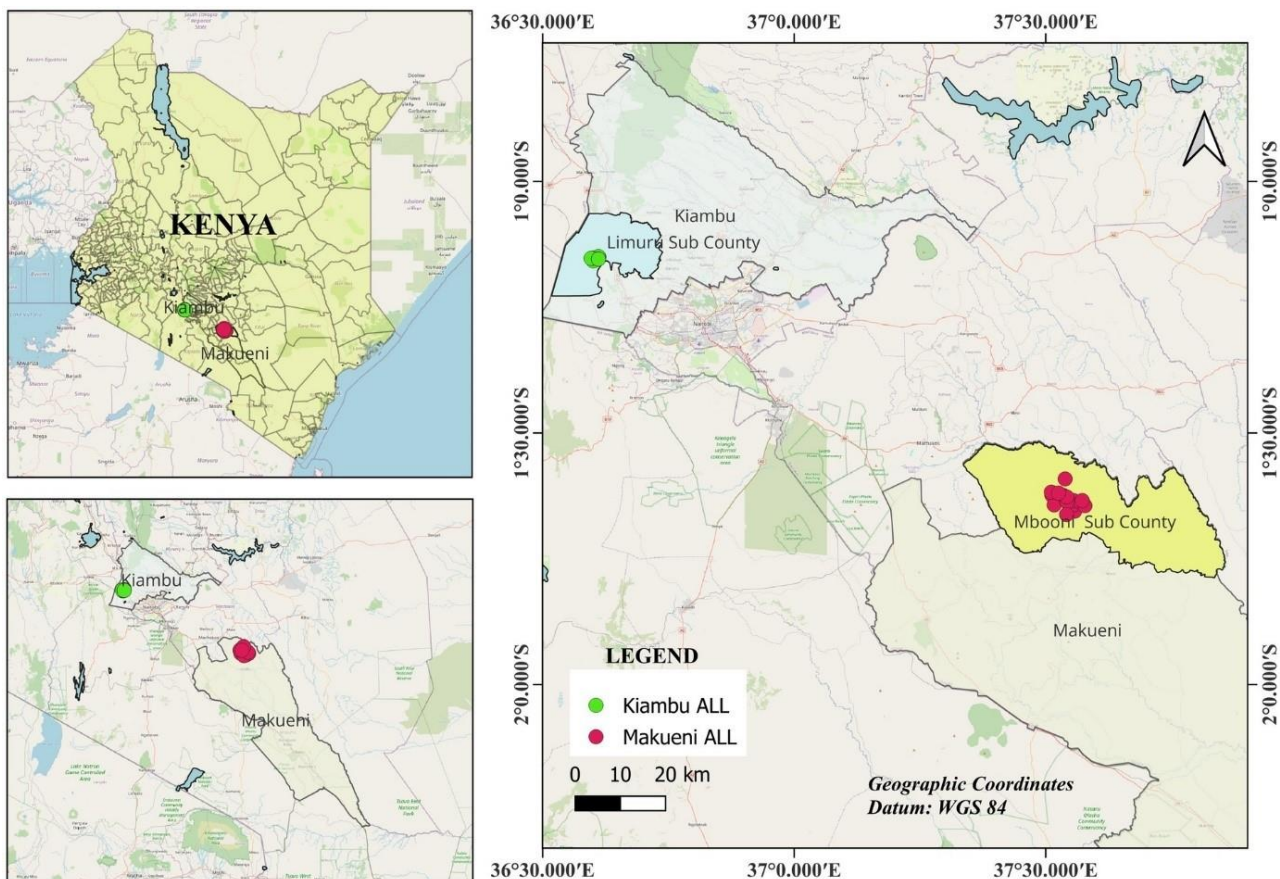
The number of participating farmers increased steadily over the engagement period. The team initially provided support for the ALL host centers and 30 farmers per ALL. Since the ALL host centers and a small number of farmers adopted more than one practice, trials were established on a total of 45 women-managed and 22 men-managed plots (see Figure 5) initially. In the second cycle, 21 farmers were added in Kiambu, and another 21 in Makueni in the third cycle. Additional information can be found in Annex B.



**Figure 5: Practice and gender distribution in the first cycle of trials in the Kiambu and Makueni ALLs**

Source: <https://www.cgiar.org/news-events/news/farmer-exchange-visits-accelerate-knowledge-co-creation-for-agroecological-transition/>

The experimental sites were located on farmers' fields within the Kenyan ALLs in Kiambu and Makueni Counties, respectively (Figure 6).



**Figure 6: Experimental sites in the Kiambu and Makueni ALLs.**

Source: Kuria et al. 2024.

Throughout the trial period, each participant had one monitored test and one monitored control plot from which data was collected continuously. Interest and demand among farmers in both ALLs remained high, and more farmers expressed interest in participating in the trials. Beyond that, participants expanded the land parcels in which the respective practices were implemented, adopted more practices, and supported other farmers to adopt the practices in their farms independently. While the team developed and implemented an elaborate trial monitoring protocol and schedule, changes made outside of the trial plots were not monitored consistently by the team.

Various variables were monitored through a three-pronged monitoring approach that entailed (1) continuous monitoring by the trial participant, (2) bi-weekly monitoring by the ALL host centers, (3) regular monitoring by the scientific team. A summary overview of monitored parameters can be found in Annex C, and sample photos of filled monitoring sheets in Annex D.

Monitoring extended to several components and differed by practice. First, the farmer practice was monitored with the help of a general trial documentation sheet (Table 8), which was filled by the trial participants themselves.

**Table 8. General trial documentation sheet**

S/No.	Practice/Activity	Test	Control
1	History of the plot during previous cycles (at least 2 or 3 years)		
2	Inputs used (type of input, and variety (crops))		
3	Planting date		
4	Input application method		
5	Input amount		
6	Weeding frequency (collected as the dates of weeding, i.e. first, second etc.)		
7	Pest control		
8	Land topography		
9	Cost of (input, labor and transport of inputs and produce)		
10	Harvest duration and cost		
11	Any cost related to transformation / packaging of harvest		
12	Any cost related to credit		
13	Labor input for each operation (number of hours or day, and who does it, whether family or hired, man/woman/youth)		
14	Labor cost (including in-kind payment such as food given to hired labor)		
15	Markets		
16	Any costs related to transport and marketing		
17	Cash income from sales of produce		
18	Challenges/constraints		

Source: Korir et al., 2024a.

In Makueni, the performance of farmyard manure (soil management) and planted terraces (water management) on maize and beans was documented with the help of a rather sophisticated data recording protocol (Table 9).

**Table 9. Data collection on the effect of plant-based biopesticide on growth and yield of maize and beans (A= All; M=Maize; B=Beans)**

S/No	What to measure	When to measure	How to measure
1	Pest infestation	<b>Maize:</b> at V8-V10; 50% tasseling and at grain filling stage: <b>Beans=</b> at branching, 50% flowering and pod filling stage	Score rating
2	Leaf damage		Score rating
3	Grain damage	At harvest	Score rating
4	Depth of color (A)	<b>Maize:</b> at V8-V10; 50% tasseling and at grain filling stage: <b>Beans:</b> at branching, 50% flowering and pod filling stage	Record the leaf color using the color chart
5	Plant Height (A)		Measure by using a meter rule by measuring from the ground to the topmost part of the plant.
6	Duration to flowering (B) and tasseling (M)	At 50% flowering/tasseling	Record the date when 50% of the plants flowered/tasseled
7	Ear (cob) length and diameter (M)	At harvest	Measure the length of the cob using a ruler and the diameter using a tape measure
8	Number of ears (M)	At harvest	Count the number of cobs/ears harvested from the plot (or from the sampling area)
9	Size of kernels (M)	At harvest	Record the size of kernel as either <i>small, medium or large</i>
10	Kernel filling (A)	At harvest	Record as either <i>wrinkled, dented or flinted</i>
11	Number of pods (B)	At harvest	Count the number of pods per plant from a random sample of 10 plants
12	Pod length (B)	At maturity	Measure the length of the pod using a ruler
13	Pest pressure/prevalence (A)	2-week interval	Record the type and severity of damage (using the severity score) by insect pest and diseases
14	Yield (A)	At harvest	Sun-dry the maize and bean grain and weigh them with a scale
15	Stover yield	At harvest	Count the number of harvested plants, cut them and measure their field weight.
16	Maize ear and bean pod health	At harvest	Record damaged cobs (maize) and beans and record type of damage and severity (none, low, medium, severe)

Source: Korir et al., 2024a.

In Kiambu, the performance of compost (soil management) and mulch (water management) was documented with the help of a few indicators (Table 10).

**Table 10. Data collection for spinach to measure effect of compost and mulch**

S/No.	What to measure	When to measure	How to measure
1	Number of leaves	2-week interval	Count the number of leaves per plot
2	Number of spoilt/unmarketable leaves	2-week interval	Count the number of spoilt leaves per plot
3	Leaf color	2-week interval	Record the leaf color using a leaf color chart

4	Vegetable yield (kg)	2-week interval	Weigh the harvested spinach leaves per plot using a weighing scale
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Source: Korir et al., 2024a.

Further in Kiambu, the performance of chili-based biopesticide on cabbage was documented with the following parameters (Table 11).

**Table 11. Data collection for cabbage to measure effect of chili-based biopesticide**

S/No.	What to measure	When	How to measure
1	Pest infestation	Weekly	Score rating
2	Leaf damage	Weekly	Score rating
3	Other pests	Weekly	Record other insect pests found on the cabbage
4	Head damage	At harvest	Score rating
5	Plant Leaf color	2-week interval	Record the plant color which might range from yellow, pale green to deep green
6	Weight (kg or g)	At harvest	Weigh the heads of the cabbage using the weighing scale
9	Head size (cm)	At harvest	Measure the circumference of the head using a tape measure

Source: Korir et al., 2024a.

For all trials, pest infestation was documented in terms of infestation rate (on a scale of 0 to 5) and damage (on a scale of 0 to 9 for spinach and maize, and on a scale of 0 to 3 for cabbage).

# 3. Key results obtained

As indicated, the performance of the trials was assessed through a three-pronged monitoring design. The results reported here differentiate between the scientific assessment, and participating farmers' assessments.

## 3.1 Scientific assessment

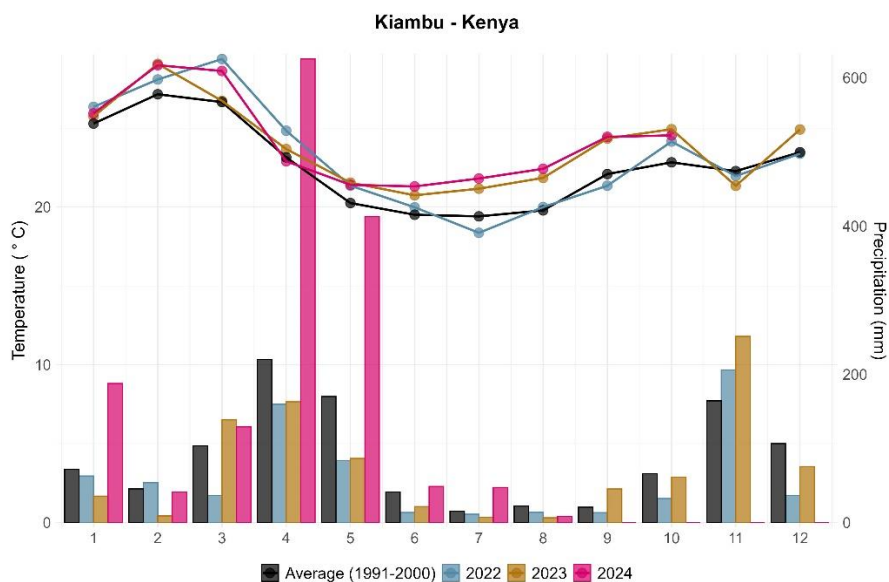
The performance assessment conducted by the scientific team extended to both the productivity and other agronomic dimensions. The agronomic performance assessment included data collected from two cycles of experiments on 30+ farms in each ALL. Each trial participant maintained the same practice in both cycles.

In what follows, predicted values obtained from linear mixed models, rather than raw data, are presented. Codes (and notebooks in html format) for the various analyses conducted and visualizations produced are available here: <https://github.com/FBaudron/AE-I-Agronomy-Assessment/tree/main/Kenya>.

In all linear mixed models used, farm was used as a random factor, and season as a fixed factor. For measurements that were conducted more than once per season (pest monitoring, and harvest for spinach), models included measurement time as a fixed factor as well. A gaussian distribution was used when using grain and stover yields as response variables, a Poisson distribution when using value form a color scale, and a binomial distribution when using pest damage prevalence. All codes for these models can be found here: <https://github.com/FBaudron/AE-I-Agronomy-Assessment/blob/main/Kenya/3.%20Data%20analysis%20AE-I%20Kenya.R>.

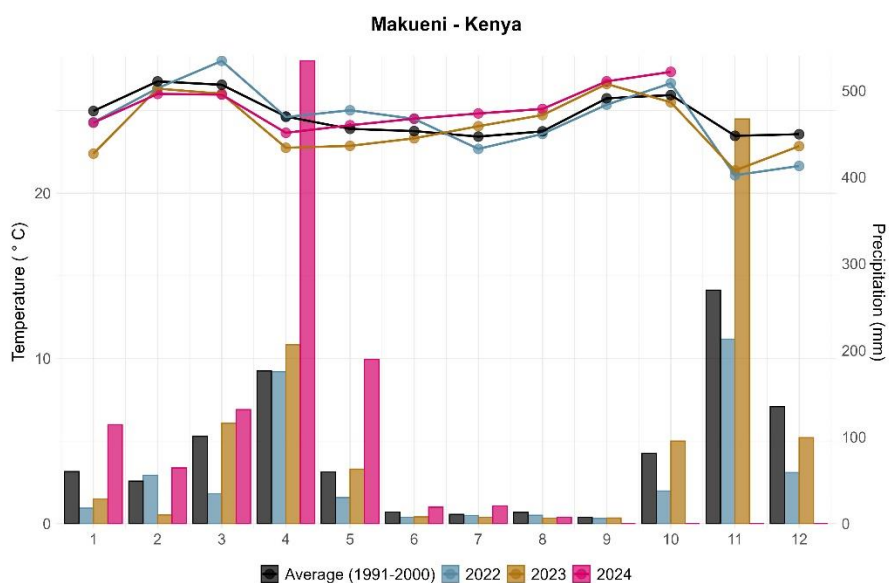
Beyond other factors, both were strongly influenced by unusual climatic and weather patterns observed during the experimentation period. Generally, Kiambu receives an average (1991-2000 average) of about 1,045 mm of rainfall per year, mainly between October-December and March-May (bimodal pattern), with a mean maximum temperature (1991-2000 average) of 23°C (Figure 7). Makueni receives an average (1991-2000 average) of about 976 mm of rainfall per year, mainly between October-December and March-April (bimodal pattern), with a mean maximum temperature (1991-2000 average) of 25°C (Figure 8).

The first season of experimentation (October-December 2023) was average in both sites (though Makueni received above average rainfall in November). However, the second season of experimentation (March-April 2024) was characterized by heavy rains in April and May, with rainfall received more than twice the long-term average. This affected the performance of the trials severely.



**Figure 7. Climograph for the ALL of Kiambu, Kenya, comparing maximum temperature and monthly rainfall for 1991-2000, 2022, 2023, and 2024**

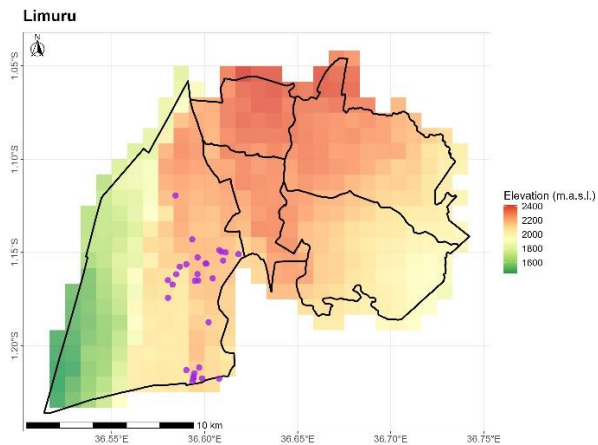
Source: Korir et al., 2024b.



**Figure 8. Climograph for the ALL of Makueni, Kenya, comparing maximum temperature and monthly rainfall for 1991-2000, 2022, 2023, and 2024**

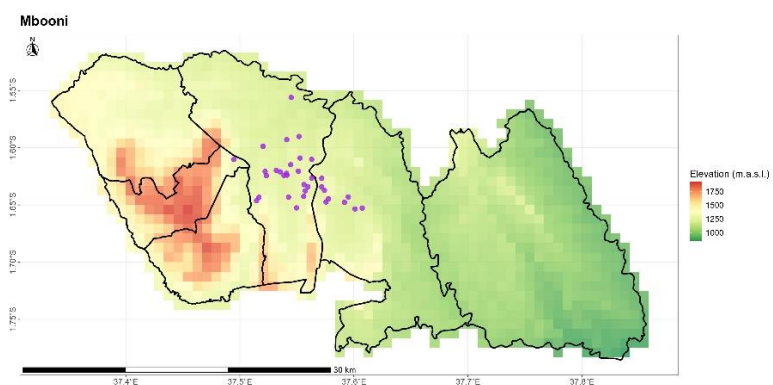
Source: Korir et al., 2024b.

Additional landscape factors include the land slope, which can be characterized as flat (0-2%) to gentle (3-5%) in both sites (Figures 9 and 10).



**Figure 9. Elevation map of Limuru with trial sites from the Kiambu ALL**

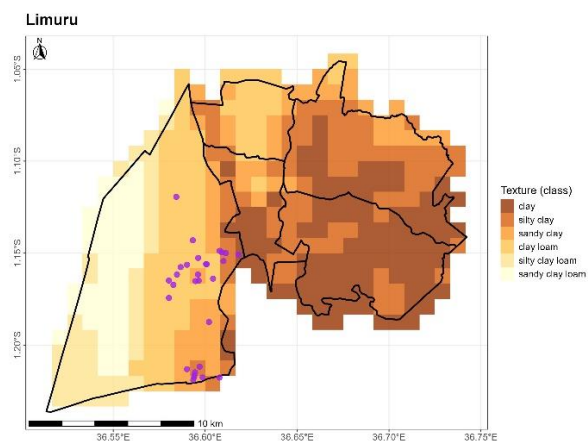
Source: Korir et al., 2024b.



**Figure 10. Elevation map of Mbooni with trial sites from Makueni ALL**

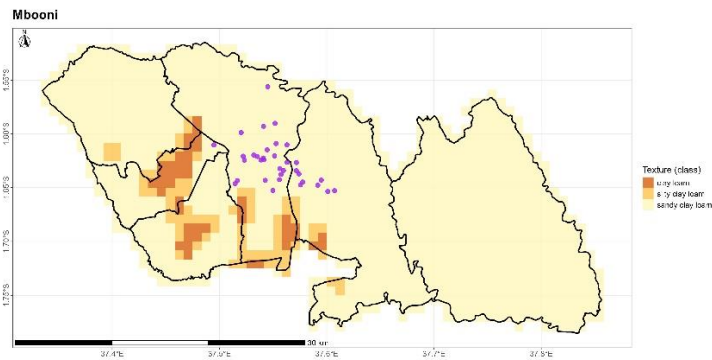
Source: Korir et al., 2024b.

Furthermore, soil texture can be classified as sandy loam and silt loam, with cases of loam (Figures 11 and 12).



**Figure 11. Soil texture class map of Limuru with trial sites from the Kiambu ALL**

Source: Korir et al., 2024b.



**Figure 12. Soil texture class map of Mbooni with trial sites from Makueni ALL**

Source: Korir et al., 2024b.

### Productivity dimension: Gross productivity

During the two seasons under observation, the only agroecological treatment that led to a significant increase of maize grain yield was manure, with a predicted grain yield of 4.0 and 4.7 t/ha for the control and the test, respectively.

No significant difference was found between the control and the test for IPM (predicted yield of 4.2-4.3 t/ha) and for terrace (predicted yield of 3.8 t/ha for both) (Figure 13).

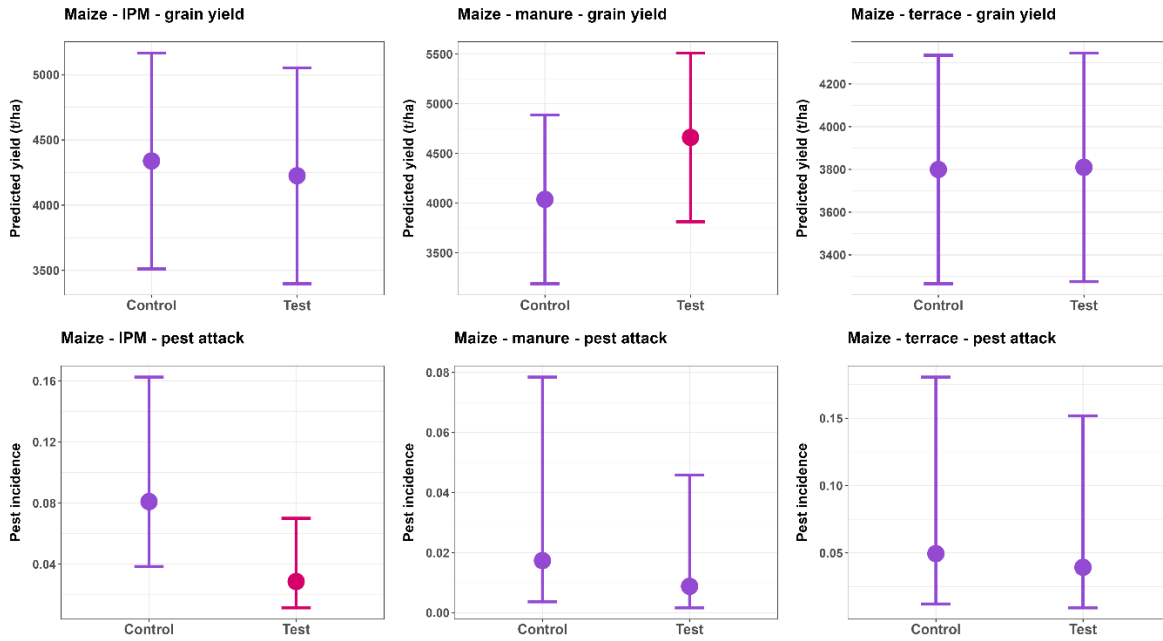
Conversely, all agroecological treatments being tested - IPM, manure and terrace - had a significantly higher bean yield compared to the control, with predicted yield of 0.6 vs. 0.5 t/ha for IPM, 0.5 vs. 0.4 t/ha for manure, and 0.5 vs. 0.4 t/ha for terrace (Figure 14).

In opposition, none of the agroecological treatments being tested on cabbage and spinach - IPM, compost and mulch - led to a yield significantly different from the control, with predicted yield between 1.3 and 1.4 kg/head for cabbage, between 6.6 and 7.4 kg/plot for spinach in the compost trial and between 8.1 and 8.9 kg/plot for spinach in the mulch trial (Figures 15 and 16).

### Technical - agronomic dimension: Pest and disease pressure

Pest incidences were lower for both maize and bean in the IPM treatment compared to the control treatment, with predicted values of 2.9 vs. 8.1 % for maize and 17 vs. 39 % for bean (Figures 13 and 14). Pest incidence of bean in the manure treatment was also significantly lower than in the control, with predicted values of 13 vs. 34%.

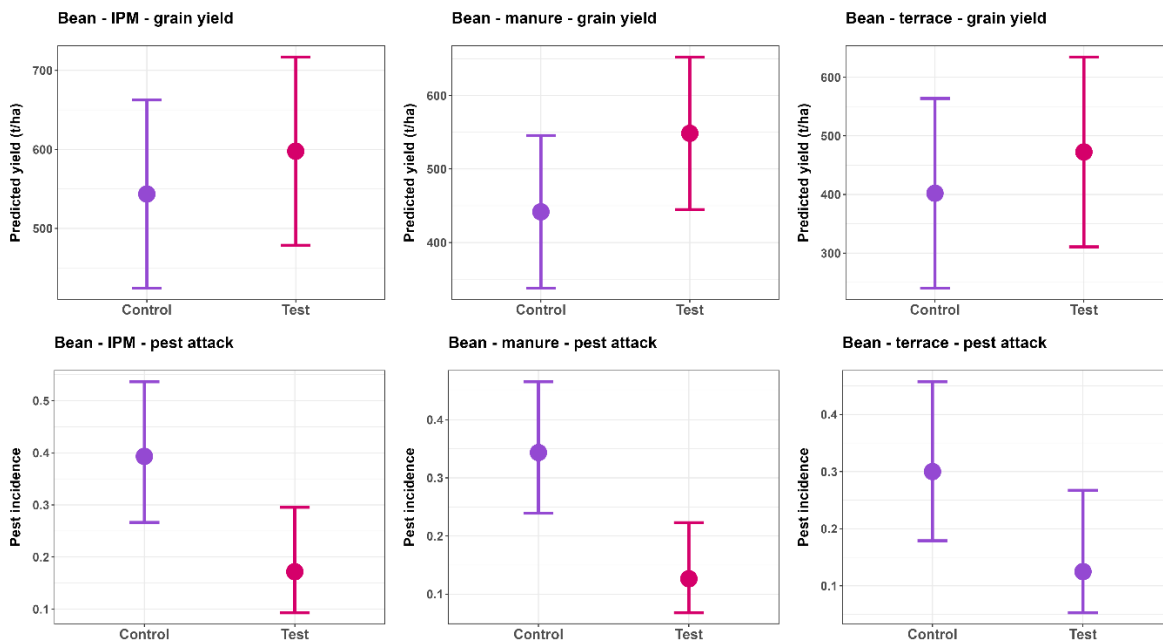
Pest incidence was significantly lower for cabbage in the IPM treatment compared to the control treatment, with predicted values of 11 vs. 16% (Figure 15). Conversely, compost and mulch had no impact on the color of spinach (which can be considered a proxy of pest and disease incidence) compared to the control (Figure 16).



**Figure 13. Predicted grain yields and pest incidences - from mixed models' outputs - of the different treatments tested on maize in Makueni during the two seasons under observation.**

Note. Dots represent predicted values and whiskers the 95% confidence interval. The predicted value of a treatment differs significantly from the predicted value of the control if the corresponding dot and whiskers are colored in pink (no significant difference if colored in purple).

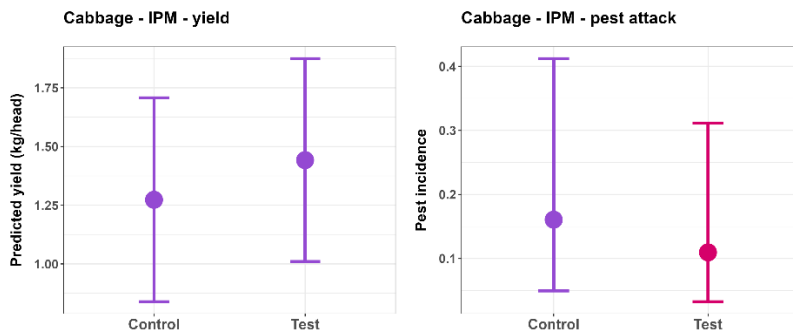
Source: Korir et al., 2024b.



**Figure 14. Predicted grain yields and pest incidences - from mixed models' outputs - of the different treatments tested on bean in Makueni during the two seasons under observation.**

Note. Dots represent predicted values and whiskers the 95% confidence interval. The predicted value of a treatment differs significantly from the predicted value of the control if the corresponding dot and whiskers are colored in pink (no significant difference if colored in purple).

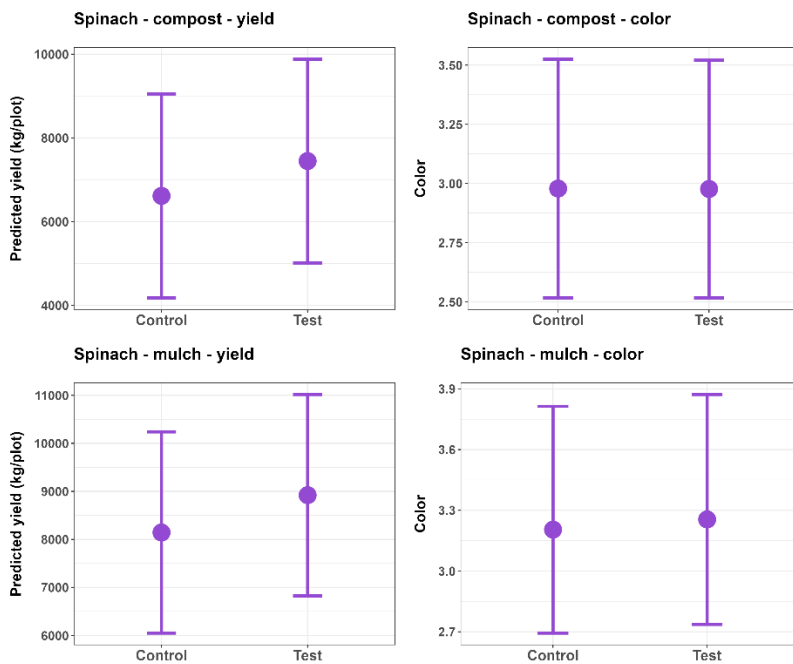
Source: Korir et al., 2024b.



**Figure 15. Predicted yields and pest incidences - from mixed models' outputs - of cabbage in the control and in the IPM treatment in Kiambu during the two seasons under observation.**

Note. Dots represent predicted values and whiskers the 95% confidence interval. The predicted value of a treatment differs significantly from the predicted value of the control if the corresponding dot and whiskers are colored in pink (no significant difference if colored in purple).

Source: Korir et al., 2024b.



**Figure 16. Predicted yields and colors - from mixed models' outputs - of spinach in the control vs. the compost treatments and in the control vs. mulch treatments in Kiambu during the two seasons under observation.**

Note. Dots represent predicted values and whiskers the 95% confidence interval. The predicted value of a treatment differs significantly from the predicted value of the control if the corresponding dot and whiskers are colored in pink (no significant difference if colored in purple).

Source: Korir et al., 2024b.

### 3.2 Farmers' assessment

As indicated, participants collected the same data using the same monitoring protocols as the scientific team. Rather than analyzing their data sheets, their perceptions and summary assessments were noted during the exchange visits, including both the intra-ALL and inter-ALL visits. The inter-ALL visit conducted in March 2024 was

scheduled to coincide with the end of the first experimentation cycle to allow for the co-design of the second phase. This entailed a discussion of the performance of the trials, and contextual factors that might have influenced it. The summary assessment is listed in Table 12.

**Table 12. Challenges encountered during the establishment and life cycle of the first phase of trials reported by participating farmers**

<i>Kiambu</i>	<i>Makueni</i>
<ul style="list-style-type: none"> <li>Late initial planting.</li> <li>Torrential rains and floods in Kiambu county (as in many parts of the country), leading to parts of the trials being swept away.</li> <li>Heavy rain led to blight.</li> <li>Compost had cutworms, which affected spinach, leading to the need for gapping.</li> <li>Mulch contributed to water logging, leading to stunted growth and root rot.</li> <li>Preparation of chili concoction was discomforting.</li> <li>Spraying of chili concoction did not manage all pests, only some.</li> <li>Market challenges.</li> </ul>	<ul style="list-style-type: none"> <li>Late initial planting.</li> <li>Identified local bean variety seems to have had two types, one of which was a climbing bean that strangled the maize.</li> <li>Manure had cutworms, which needed to be managed.</li> <li>Initial manure application rate was too low, affecting yields.</li> <li>Napier grass planted on terraces affected the growth of neighboring crops.</li> <li>Spraying of neem concoction led to scorching of maize leaves.</li> </ul>

Source: Korir et al., 2024b.

In March 2024, the team also conducted a farmer perception survey, which captured the individual perceptions and assessments of each trial participant. The same survey was repeated in October 2024. The results are yet to be reported.

Further assessments were collected during the co-design workshop for the third trial cycle, held in October 2024. Trial participants in Kiambu shared their general experiences, challenges, and successes, including that (1) compost manure significantly improved yields; (2) chili-based concoctions were effective against pests; (3) challenges included waterlogging, crop stagnation, cutworms, and root rot diseases; and (4) IPM techniques were ineffective against fungal and bacterial diseases. Trial participants in Makueni mentioned broad observations including that (1) Napier grass for push-pull technology reduced pest infestation and increased maize yields despite erratic rainfall; optimized maize-bean spacing improved yields, though manure availability was insufficient; and (3) Neem concoction effectively controlled pests and should be continued. Through focus area-group work, benefits, challenges, and proposed solutions were discussed more comprehensively (Table 13).

**Table 13. Challenges encountered during the establishment and life cycle of the second phase of trials reported by participating farmers**

	<i>Kiambu</i>	<i>Makueni</i>
<b>Benefits</b>	<ol style="list-style-type: none"> <li>Significant yield improvements in crops planted with compost manure.</li> <li>Effective pest control using hot pepper concoctions.</li> </ol>	<ol style="list-style-type: none"> <li>Increased yields on small plots due to better spacing.</li> <li>Enhanced knowledge of organic farming techniques.</li> <li>Reduced input costs through local resource utilization.</li> <li>Improved household food security and livelihoods.</li> </ol>
<b>Challenges</b>	<ol style="list-style-type: none"> <li>Waterlogging and crop stagnation from excessive rainfall.</li> <li>Cutworms and root rot diseases impacted crop performance.</li> <li>Heavy rains compromised crop growth.</li> </ol>	<ol style="list-style-type: none"> <li>Erratic rainfall patterns disrupted crop performance.</li> <li>Labor-intensive practices (e.g., terrace construction, planting).</li> </ol>

	<ol style="list-style-type: none"> <li>4. IPM techniques were ineffective against fungal and bacterial diseases.</li> <li>5. Yield inconsistencies due to non-uniform seedling sizes.</li> </ol>	<ol style="list-style-type: none"> <li>3. Pests (e.g., squirrels, termites) damaged seeds and plants.</li> </ol>
<b>Proposed solutions</b>	<ol style="list-style-type: none"> <li>1. Focus on high-value crops such as rosemary and pumpkin.</li> <li>2. Introduce crops with longer post-harvest storage and value-addition potential.</li> <li>3. Enhance training on effective water management techniques.</li> <li>4. Mitigate climate-related challenges like waterlogging and heavy rainfall.</li> </ol>	<ol style="list-style-type: none"> <li>1. Increase manure quantities to support plant growth.</li> <li>2. Expand plot sizes for trials.</li> <li>3. Introduce multiple practices for farmers.</li> <li>4. Train farmers on digital data collection using smartphones.</li> <li>5. Promote knowledge transfer through field days and group-based farming approaches.</li> <li>6. Focus on high-value crops such as rosemary and pumpkin for marketability and adaptability.</li> <li>7. Train farmers on water harvesting techniques, e.g., Zai pits.</li> </ol>

This assessment and feedback fed into the design of the third cycle of trials, and subsequent training and trial establishment.

## 4. Agroecological assessment of technologies

A holistic assessment of the performance of the different treatments tested in on-farm trials was conducted in both Kiambu and Makueni in November 2024, following the Tool for Agroecology Performance Evaluation (TAPE). Data was collected from a small representative sub-sample of trial participants in both ALLs, and scores were devised by establishing a consensus among workshop participants in each ALL rather than by averaging individual scores. Scores (0-4) are presented in Table 14, and aggregate values - expressed in % and averaged along the 10 elements - are presented in Figures 17 and 18.

**Table 14. Results of the TAPE assessment in the Kiambu and Makueni ALLs**

Element	Category	Kiambu - Vegetables				Makueni - Maize			
		Control	IPM	Compost	Mulch	Control	IPM	Manure	Terraces
Diversity	Crops	1	1	1	1	2	2	2	3
Diversity	Animals	0	0	0	0	0	0	0	0
Diversity	Trees	0	0	0	0	0	0	0	0
Diversity	Activities	1	2	2	2	1	1	1	2
Synergies	Livestock-crops-others	1	2	2	2	1	2	2	2
Synergies	Soil Management	1	1	2	3	3	3	3	3
Synergies	Trees	0	0	0	0	0	0	0	0
Synergies	Connectivity	0	0	0	0	0	0	0	0
Efficiency	External Inputs	3	3	3	3	3	3	3	3
Efficiency	Soil Fertility	4	4	4	4	4	4	4	4
Efficiency	Pest and diseases	4	4	4	4	4	4	4	4
Efficiency	Productivity	2	3	3	3	1	1	1	1
Recycling	Biomass	2	4	4	4	3	3	3	3
Recycling	Water	2	3	3	3	2	2	2	3
Recycling	Seeds and Races	0	0	0	0	0	0	0	0

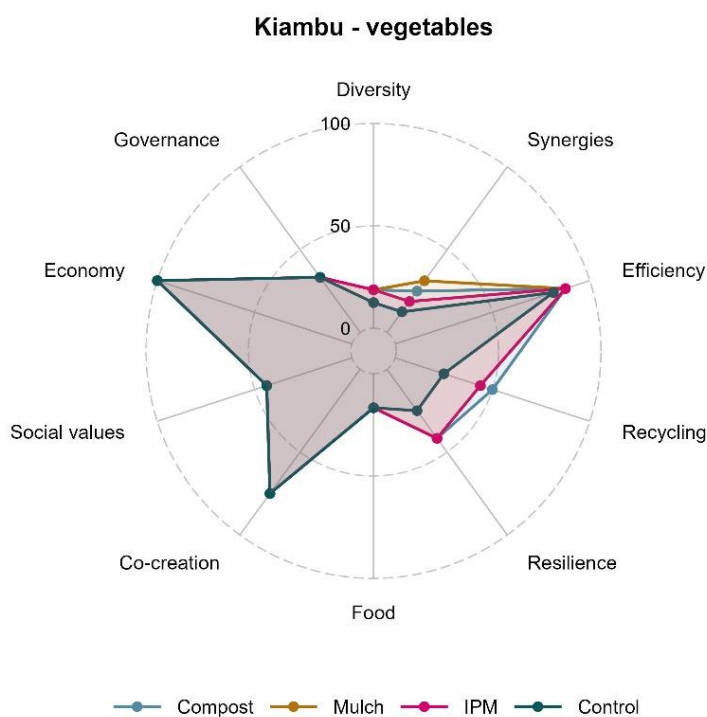
Recycling	Energy	0	0	1	0	0	0	0	0
Resilience	Resilience	2	3	3	3	1	2	2	2
Resilience	Mechanism	0	0	0	0	0	0	0	0
Resilience	Environmental resilience	1	2	2	2	1	2	2	2
Culture and food traditions	Diets	2	2	2	2	3	3	3	3
Culture and food traditions	Traditions	0	0	0	0	0	0	0	0
Culture and food traditions	Local breeds and varieties	0	0	0	0	3	3	3	3
Co-creation and knowledge exchange	Horizontal exchange	3	3	3	3	3	3	3	3
Co-creation and knowledge exchange	Sharing knowledge	3	3	3	3	3	3	3	3
Co-creation and knowledge exchange	Growers' participation	3	3	3	3	1	1	1	1
Human and social values	Women	3	3	3	3	3	3	3	3
Human and social values	Work	1	1	1	1	1	1	1	1
Human and social values	Migration	3	3	3	3	3	3	3	3
Human and social values	Animal welfare	0	0	0	0	0	0	0	0
Circular economy and solidarity	Local markets	4	4	4	4	4	4	4	4
Circular economy and solidarity	Networks	4	4	4	4	1	1	1	1

Circular economy and solidarity	Local food system	4	4	4	4	4	4	4	4
Responsible governance	Empowerment	0	0	0	0	0	0	0	0
Responsible governance	Organizations	4	4	4	4	0	0	0	0
Responsible governance	Growers' participation	0	0	0	0	0	0	0	0

Source: Korir et al., 2024b.

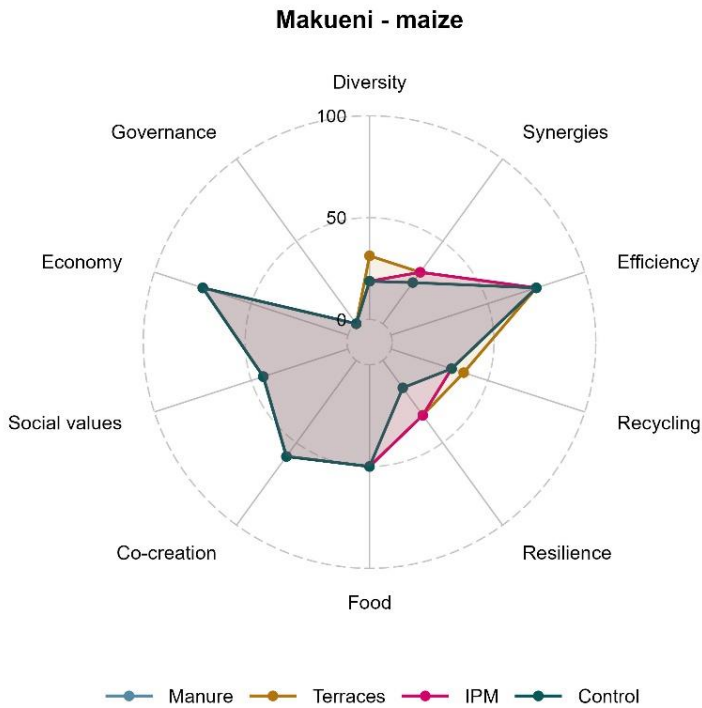
Across both sites, controls scored lower on all dimensions, demonstrating the contribution of the agroecological technologies tested to the agroecological transition of the systems considered, and their adaptation to the needs of the participating farmers.

All three treatments received the same scores for 'Culture and food traditions', 'Co-creation and knowledge exchange', 'Human and social values', 'Circular economy and solidarity', and 'Responsible governance' in both ALLs, since processes related to these elements take place at a scale higher than the plot/treatment-scale, and were influenced by the participation in the trial/initiative rather than by the individual treatment. The score is high for 'Co-creation and knowledge exchange' in both sites, as taking part in the trials allowed horizontal creation and transfer of knowledge, as well as access to agroecological knowledge. Participants highlighted that they learnt through the trials the importance of monitoring/scouting and record keeping. In the case of Kiambu, being part of the initiative also gave farmers access to growers' networks (for the marketing of vegetables). It is also high for 'Circular economy and solidarity' in both sites, as inputs (seeds, manure/compost, etc.) were sourced locally and food is sold locally. In Makueni, it was also rated high on 'Culture and food traditions' as local varieties were used across the different treatments.



**Figure 17. Comparative assessment of the six treatments in Kiambu, using the Tool for Agroecology Performance Evaluation (TAPE), following Mottet et al. 2020.**

Source: Korir et al., 2024b.



**Figure 18. Comparative assessment of the six treatments in Makueni, using the Tool for Agroecology Performance Evaluation (TAPE), following Mottet et al. 2020.**

Source: Korir et al., 2024b.

For other dimensions - 'Diversity', 'Synergies', 'Efficiency', 'Recycling' and 'Resilience' - only small differences between treatments were recorded in both sites, including between agroecological technologies and controls.

***This is because most trial participants based their control practices on principles of permaculture in Makueni and organic farming in Kiambu: therefore, the control used in both sites can itself largely be considered 'agroecological'.*** While the use of synthetic inputs was hypothetically included as options for the control plots in the co-design process, most farmers did not in fact use them. The highest score was given to the 'Efficiency' element in both sites, as all inputs are produced in the farm or community, and no synthetic fertilizer or pesticide is being used.

# 5. Potential adaptation and adoption of technologies tested

As indicated, the co-designed practices were adopted and used in at least three ways:

1. Trial participants increased land surface under treatment
2. Trial participants adopted additional practices and combined them with their initial singular treatment
3. Other farmers adopted singular or several co-designed practices

The dissemination pathways for the co-designed practices included three main pathways:

1. Farmer-to-farmer extension
2. ALL host center training and extension
3. Other stakeholders adopting and championing the co-designed practices

The Kenya AE-I team structured the entire co-design process in a manner that would support the future adoption of the co-designed practices. Specific adoption and scaling focused activities included:

1. The overall embeddedness of the co-design process in a purposive engagement and co-design strategy that involved two main players at the national level: PELUM Kenya and the Inter-Sectoral Forum on Agrobiodiversity and Agroecology (ISFAA).
2. The structured engagement and structural empowerment of existing farmer training centers as ALL host centers, and their active role in mobilizing farmers, in providing a physical meeting space for participants to come together and exchange, in the provision of training (and the inclusion of the co-designed practices into their regular training schedules), and in the regular monitoring of the trials on farmers' fields.
3. The structured and participatory trial participant selection, which included (a) the invitation of participants from 15 farmer groups, half of which had previously worked with the ALL host centers and half who had not, (b) the co-design of participant selection criteria which deliberately involved desired characteristics in view of their likely willingness and ability to act as lead farmers who would train others, (c) the empowerment of farmer groups to designate their representatives based on the established selection criteria.
4. The focus on co-designing and co-implementing trial monitoring to strengthen participants capacity to act as farmer researchers.
5. The structured co-design process itself, which emphasized periodic exchange visits within the respective ALL, and between the ALLs, to foster collective learning and motivate farmers and incentivize further engagement.
6. The involvement of relevant stakeholders from government, extension, NGOs and private sector in the co-design and testing of the specific agroecological practices
7. The development of the technical trial establishment manual (Korir et al., 2024a).
8. The structured, periodic, and experience-focused and reflection-based "seeing is believing" exchange visits, including intra-ALL, inter-ALL and international ALL (INALL) visits.

Considering the level of maturity of the practices themselves, it is important to emphasize that the practices selected in both ALLs are fairly basic, and were selected due to farmers' familiarity with the practices (see Kuria et al. 2023, 2024 for more details), as well as their affordability, and the relative ease of implementation, which contributed to their broad adoption. The Kenya team initially prioritized the establishment of good relationships between the team and the partners on the ground, and well as the development of farmers' capacity in terms of research and experimentation skills. After agreeing to keeping to the initially co-designed practices with only minimal variation for the first two cycles, the practices were adapted and diversified in the third cycle. Going forward, more complex and innovative practices will be co-designed and tested.

# 6. Reflections, lessons and recommendations

## 6.1 Reflections, lessons and recommendations on how to engage in and conduct the codesign process and overall methodological considerations

The Kenya team took a highly structured approach to the co-design of innovative practices, which, initially, included three main cycles (Figure 1). The last loop involved consecutive iteration cycles, and the re-design of the technical options for a second and third cycle.

### What worked well

Altogether, the co-design process was highly successful in Kenya, and the team, partners and participating farmers greatly appreciated the contribution the process made to knowledge co-creation through respectful and responsive (demand-driven) collaboration. The detailed descriptions in this report provide numerous details that evidence these successes, including the details of the team's adoption and scaling strategy provided in section 5.

One additional aspect that deserves mention in terms of what worked well is that, from the outset, the team prioritized data visualization and data feedback. Partners and farmers greatly appreciated this deliberate data sharing approach. Some specifics involved:

1. Preparing posters that featured the main results of the innovation assessment per practice for each ALL, which were used as background for the first co-design workshop; which have remained with the ALL host centers
2. Personalized soil data reports, and a general data feedback workshop session
3. Personalized agronomic performance reports, and data feedback workshop session
4. Printing and sharing of posters and reports
5. Printing and distribution of the technical training manual
6. Anchoring of each workshop in a brief recap of previous activities and results

Other, broader, aspects that contributed to the successful co-design process pertain to the general organization and management of the interactions and relationships between the Kenya team and AE-I partners, including the designation of a central engagement lead within the team to streamline communication with the partners; the empowerment and capacitation of the ALL host centers to lead the engagement with farmers on the ground, and their leadership in mobilizing participants in activities held at the centers; the preparation and sharing of activity information sheets with the ALL host centers ahead of time to foster fair and transparent engagements; the adoption of uniform transport reimbursement rates that align with PELUM's etc.

### What could have been improved

Despite setting up institutional processes that should have guaranteed uniform communication with the partners on the ground, early and consistent planning, and the set-up of all logistical necessities, delays incurred by the AE-I lead implementing organization in organizational and logistics aspects at times hampered the smooth implementation of planned activities. This also led to unnecessary pressure on the partners, especially the ALL host centers, which hosted most of the co-design related activities.

Another difficulty pertained to data feedback and sharing: While the team was very explicit in its emphasis on the importance of transparent and quick data feedback, and while farmers repeatedly expressed interest in such data feedback, the team was at times much slower than desired. Unfortunately, the team struggled to receive good and reliable soil analyses after drawing initial soil samples ahead of the first trial establishment – and data had to be re-analyzed. This led to delays, and the resulting personalized data reports only being shared at the end of Y3 of the project (see Annex E for a sample) – at a time when trial participants were already planning for the third cycle of trials.

Another omission was late verification of the quality of inputs used. In line with the broader recycling, input reduction, synergy and other nutrient and economic circularity considerations of agroecology, the participating farmers decided to use locally available compost and farmyard manure for the soil health focused practices. They then went ahead and identified trial participants who acted as local suppliers for all participants. While the team took samples of the compost and farmyard manure ahead of the first experimentation cycle, these were only analyzed later in the cycle. Unfortunately, the samples revealed that the N and P contents were too low to have a meaningful effect on production. Ideally, the team would have needed to assess the quality of locally available materials before using them in the trials. Combined with an initial manure application rate that was too low, the effect of manure and compost application remained below set expectations.

The team also struggled with a common tension in research-in-development projects: how to reach a relevant scale while having limited resources, and while scale is not the main objective. As indicated in the previous section, the team proceeded in a highly methodical manner and selected trial participants jointly with the farmer groups whose representatives had been invited to the initial co-design workshops, focusing on participants' potential capacity to reach and train other group members. The team also ensured to include farmers from 15 groups, including both those that had previously worked with the ALL host centers and those that hadn't - a second consideration related to reaching a certain scale. Embedding the overall process in the ALL host centers was, of course, a third scale-focused and -relevant decision. The selection of government, extension, and local NGO, as well as known agroecology/organic farming promoters in the process was another deliberate aspect. As mentioned as well, a fifth aspect was the preparation of the practice-focused training manual. The team also used available data sharing forums and platforms, such as the Agroecology TPP COP, and participated in scientific conferences and ALL host center hosted activities for further visibility and exposure. While all these aspects are important, other activities could have been considered to strengthen adoption at scale that could have been integrated in the team's activities without requiring many resources. These include:

1. More deliberate engagement of trial participants in view of their lead farmer position, and strengthening of farmer-to-farmer outreach modalities
2. More deliberate engagement with local government extension mechanisms, and local government-led agricultural transformation processes
3. More deliberate engagement with local and national communications channels

At the same time, the broader impact of the co-design process (knowledge, skills, experience, etc.) seems to have been cascading to many more farmers than the farmers hosting trials, which should be documented more consistently. For example, in Makeni, the 30 farmers hosting trials belong to 27 groups, each group having 30 to 100 members.

Another element that deserves continuous attention is the relationship built with trial participants, and the expectations placed in them in terms of mobilizing their own assets and resources. Agroecology is a resource efficiency-focused approach that emphasizes farmers' agency and own resource use. Yet, it is important to differentiate between those farmers who are interested in improving their small-scale production by using their existing farm resources better and more efficiently, and those who might be interested in using less harmful inputs without necessarily being interested in producing them themselves. Being able to engage and support such farmers, who might typically operate larger land sizes, will be important going forward. A second aspect related to the same is the question of facilitation, or the paying of transport allowances to participants. While the team adopted uniform rates drawn from PELUM Kenya, the rates and payment modalities could be improved to reduce related tensions - both with participants, and more conceptually in relation to the role and ethical best practices of external actors in research-in-development processes.

Globally, the co-design process could be improved by providing more and clearer methodological guidance to the implementing teams- and their implications (also see the methodological considerations in section 4.1 in Fuchs et al., 2023b). While teams can opt to adapt such guidelines in line with their experience, skills, and preferences, having a uniform methodological guidance can help avoid simple mistakes. As indicated, it would be particularly useful to not only provide guidance, but to explicitly discuss the implications, potential results, or "so what" of different methodological approaches, of given tools, of a specific sequencing of tools, of a sequencing of sessions across time, of facilitation modalities, of trial participant selection modalities, etc. Beyond the initial co-design cycles, it will be important to guide implementing teams on how to graduate from one cycle to the next,

and help them gradually move to more comprehensive, more complex, and more ambitious co-designed practices that help to test and document more elaborate and innovative practices.

## **6.2 Reflections, lessons and recommendations on the agronomic / agroecological results**

The technologies being tested make sense in terms of agronomic performance and in terms of farmer assessment in both Kiambu and Makueni. However, differences between test agroecological technologies and the control are less pronounced in Kiambu, although the technologies were rated favorably by participating farmers. As mentioned earlier, the small differences recorded might be related to the fact that controls in both sites are themselves 'agroecological' (no synthetic input, etc.). Moreover, the nutrient contents (N, P) of applied manure and compost (data not reported) turned out to be too low to provide meaningful effects. To be able to assess the performance of the co-designed practices more comprehensively, it would be beneficial to include a 'conventional' control, at least in some of the trials, as many farmers in both Kiambu and Makueni are not practicing permaculture/organic farming, or apply manure/compost on quantities that supply N and P equivalency of recommended rates.

To ensure consistence and quality of the data collected, more closely controlled measurements could be made in fewer trials, and some in-depth variables added. The parallel work conducted on adjacent plots by several students attached to the Initiative could have been leveraged in that regard. It is also important that electronic forms used for data collection are thoroughly tested before deployment to avoid the resulting data being difficult to maneuver, requiring a lengthy data cleaning process, and challenging data analysis.

From a purely agronomic point of view, the selection of farms hosting trials could be more purposive, which would help to maximize the utility of the information collected. Geographic data could be used for that (many rasters are open access). A farm typology could also guide the selection of farms (data gathered through the HOLPA tool could potentially serve as a basis for such a typology).

During particularly wet years - which can be anticipated by weather forecast, mulching and other technologies aiming at harvesting water, should be discouraged and/or their application closely monitored. Tracking soil moisture in a few trials would also be very informative to better understand the impact of different technologies on water use efficiency (particularly terraces and mulching). It would also be interesting to collect data on costs, including labor, on a subset of trials. Other interesting analyses could include the routine analysis of the active ingredients of home-made ecological inputs, as well as the composition and nutritional value of the harvested crops.

Finally, it would be interesting to better connect agronomy trials to the work done on inclusive business models: in Makueni, that work focusses on mango production, and the team could explore if there are any production challenges that could be addressed by agronomy.

## **6.3 Generic or specific recommendations and plans for the next cycle of codesign**

The transdisciplinary co-design of knowledge is at the heart of agroecological innovation processes. The support and interest generated among AE-I partners and participants for the innovation process pays tribute to the centrality of maintaining methodical and structured innovation co-design in the Multifunction Landscapes Science Program.

As previously indicated, the Kenya WP1 team took a particular approach to innovation co-design in this initial engagement with the ALL stakeholders. Overall, the Kenya team prioritized three main things in the co-design activities in the first cycles of experimentation:

1. the identification and implementation of a suitable co-design process, which would allow co-designing options and knowledge through the purposive and sequential engagement of different knowledge types and holders
2. relationship building between the research team and the ALL host centers, farmers and other stakeholders
3. the development of farmer researcher skills among farmers, and the corresponding accompaniment modalities (training material, monitoring sheets, exchange modalities, personalized data reports etc.) that would allow the research team to support this

This also meant that the technologies themselves were fairly basic, and initially focused on single practices that were generally well known in the area, and often already practiced by participating farmers. It also meant maintaining farmers' current practice as control, rather than insisting on more uniform controls.

The very simple practices were maintained for two consecutive cycles to collecting and analyzing data in line with relevant agronomic data analysis protocols. In the third phase, the trial participants were invited to broaden their perspectives, which led to a more integrated farm design in Makueni, and a diversification of crops in Kiambu.

Going forward, it would be interesting to support a further development of the practices put under trial, and consider (1) farm-level integration of different practices to harness ecological processes more broadly, (2) considerations for landscape-level perspectives in which practices on different farms are "aggregated" for broader ecosystem service provision.

# 7. Conclusions

This report provides a summary overview of the innovation co-design process and its results in terms of the innovative practices put under trial in the Kenyan ALLs, as well as a scientific assessment of their performance. It concludes with adaptation and reflection sections, which outline what worked well, and what did not work well, and makes recommendations about how to proceed in the Multifunctional Landscapes Science Program. The abstract included provides a good summary of the main elements addressed in the report, which complements the detailed co-design report prepared by the WP1 Kenya team in 2023 (Fuchs et al., 2023b).

# Lists of documents produced by the country team related to codesign

Further information can be found in the specific outputs related to the co-design of innovative agroecological practices:

## Official outputs

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# Annex A: Summary overview of the co-designed technologies

(Site)	Specific technology being tested	Concrete Problem it is addressing	Cycles during which technology was tested	Domain (e.g. soil fertility, IPM, mechanization, "systemic")	Underlying agroecology principle(s)	Origin
<b>Kiambu</b>	Compost manure on spinach	Depleted soils	(1) Oct 2023-March/April 2024 (2) May 2024-Aug/Sept 2024	Soil health management	Recycling, input reduction, soil health, synergy	Co-design
	Mulch on spinach	Limited water holding capacity and retention in the soil; variable rainfall	(1) Oct 2023-March/April 2024 (2) May 2024-Aug/Sept 2024	Water management/conservation agriculture	Recycling, input reduction, soil health, synergy	Co-design
	Plant-based biopesticide (chili) on cabbage	Pests and diseases	(1) Oct 2023-March/April 2024 (2) May 2024-Aug/Sept 2024	IPM	Recycling, input reduction, soil health, synergy	Co-design
<b>Makueni</b>	Farmyard (animal) manure on maize-bean intercrop	Depleted soils	(1) Oct 2023-March/April 2024 (2) May 2024-Aug/Sept 2024	Soil health management	Recycling, input reduction, soil health, synergy	Co-design
	Terraces with planted edges on maize-bean intercrop	Limited water holding capacity and retention in the soil; variable rainfall	(1) Oct 2023-March/April 2024 (2) May 2024-Aug/Sept 2024	Water management/conservation agriculture	Recycling, input reduction, soil health, synergy	Co-design
	Plant-based biopesticide (neem) on maize-bean intercrop	Pests and diseases	(1) Oct 2023-March/April 2024 (2) May 2024-Aug/Sept 2024	IPM	Recycling, input reduction, soil health, synergy	Co-design

# Annex B: Summary overview of the established trials

<b>Trial #</b>	<b>Short Name of trial (ex: forage mixtures)</b>	<b>Cycle(s) during which trial was established</b>	<b>Name of villages / sites where trial was established</b>	<b>Number of farmers that established the trial</b>	<b>Number of treatments included by each farmer</b>	<b>Replications established by each farmer</b>
1	Compost	(1) Oct 2023- March/April 2024  (2) May 2024- Aug/Sept 2024	Ndeiya ward, Limuru sub-county, Kiambu County	(1) 12 (2) 19	1-2	1
2	Mulch	(1) Oct 2023- March/April 2024  (2) May 2024- Aug/Sept 2024	Ndeiya ward, Limuru sub-county, Kiambu County	(1) 12 (2) 19	1-2	1
3	IPM (chili)	(1) Oct 2023- March/April 2024  (2) May 2024- Aug/Sept 2024	Ndeiya ward, Limuru sub-county, Kiambu County	(1) 12 (2) 19	1-2	1
4	FYM	(1) Oct 2023- March/April 2024  (2) May 2024- Aug/Sept 2024	Mbumbuni market, Mbooni East sub- county, Makueni County	(1) 13 (2) 13	1-2	1
5	Terraces	(1) Oct 2023- March/April 2024  (2) May 2024- Aug/Sept 2024	Mbumbuni market, Mbooni East sub- county, Makueni County	(1) 10 (2) 10	1	1
6	IPM (neem)	(1) Oct 2023- March/April 2024  (2) May 2024- Aug/Sept 2024	Mbumbuni market, Mbooni East sub- county, Makueni County	(1) 14 (2) 14	1-2	1

Note. In the first cycle, 30 farmers implemented 35 trials in Kiambu, including 3 composite trials (1 mulching + compost; 1 IPM + compost; 1 IPM + mulching), alongside CSHEP that tested all three practices. In Makueni, 33 farmers implemented 34 trials, including 1 composite trial (IPM + manure), alongside DNRC that tested all three practices. In total, 73 individual trials were established in the first cycle.

# Annex C: Summary overview of the trial monitoring and evaluation approaches

<b>Trial #</b>	<b>Short Name of trial (ex: forage mixtures)</b>	<b>Key agronomic variables monitored or collected</b>	<b>Key socioeconomic variables monitored or collected</b>	<b>How many field days or exchange visits were held which included this trial?</b>	<b>Did farmers contribute to monitoring of this trial (Yes fully/ partly /no)?</b>
1	Compost	Number of leaves, number of spoilt leaves, leaf color, vegetable yield	Costs (inputs, labor, transport, value addition), cash income from sales	Intra-ALL, Inter-ALL, INALL; bi-weekly visits by ALL host center staff	Yes
2	Mulch	Number of leaves, number of spoilt leaves, leaf color, vegetable yield	Costs (inputs, labor, transport, value addition), cash income from sales	Intra-ALL, Inter-ALL, INALL; bi-weekly visits by ALL host center staff	Yes
3	IPM (chili)	Pest infestation, leaf damage, other pests, head famage, leaf color, weight, head size	Costs (inputs, labor, transport, value addition), cash income from sales	Intra-ALL, Inter-ALL, INALL; bi-weekly visits by ALL host center staff	Yes
4	FYM	Pest infestation, leaf damage, grain damage, leaf color, plant height, pod length and size, number of pods, yield, stover yield, crop health	Costs (inputs, labor, transport, value addition), cash income from sales	Intra-ALL, Inter-ALL, INALL; bi-weekly visits by ALL host center staff	Yes
5	Terraces	Pest infestation, leaf damage, grain damage, leaf color, plant height, pod length and size, number of pods, yield, stover yield, crop health	Costs (inputs, labor, transport, value addition), cash income from sales	Intra-ALL, Inter-ALL, INALL; bi-weekly visits by ALL host center staff	Yes
6	IPM (neem)	Pest infestation, leaf damage, grain damage, leaf color, plant height, pod length and size, number of pods, yield, stover yield, crop health	Costs (inputs, labor, transport, value addition), cash income from sales	Intra-ALL, Inter-ALL, INALL; bi-weekly visits by ALL host center staff	Yes

# Annex D: Sample photos of filled monitoring sheets

Name of Farmer		IPM					Control plot				
Practice implementing		Test Plot					Control plot				
Crop		Cabbage									
Parameter	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	
<b>Time 1</b>											
Pest infestation	0	1	2	4	4	1	5	1	1	4	
Leaf damage	0	3	3	7	3	0	13	3	3	3	
Other pests	0	1	1	1	0	0	5	1	2	3	
Plant Leaf color	3	4	4	4	5	5	4	4	5	4	
Number of leaves	15	13	14	15	13	14	13	15	14	11	
<b>Time 2</b>											
Pest infestation	0	0	0	1	0	1	0	0	0	2	
Leaf damage	0	5	5	3	5	5	1	5	5	5	
Other pests	0	1	0	1	0	0	0	0	0	0	
Plant Leaf color	4	5	5	5	6	5	6	5	5	3	
Number of leaves	15	16	17	17	15	10	15	16	17	17	
<b>Time 3</b>											
Pest infestation	0	0	0	0	0	0	0	0	0	3	
Leaf damage	0	5	5	1	1	1	1	1	1	7	
Other pests	0	0	1	0	0	0	0	0	0	0	
Plant Leaf color	4	3	6	3	5	3	5	5	5	2	
Number of leaves	15	14	16	13	13	12	14	16	17	16	
<b>Time 4</b>											
Pest infestation	1	0	0	0	0	0	0	0	0	0	
Leaf damage	5	5	1	1	1	1	1	1	5	5	
Other pests	0	0	0	0	0	0	0	0	0	0	
Plant Leaf color	5	6	4	3	5	4	5	5	4	2	
Number of leaves	12	12	7	9	11	15	12	13	14	9	
<b>At Harvest</b>											
Head size	48cm	49cm	37.5cm	36cm	49cm	40cm	40cm	34cm	25cm		
Weight	2.670	1.905kg	0.915	0.660	2.595	1.535	1.330	0.880	0.150		
Head damage	1	1	3	3	1	1	1	2	3		

Photo 1: Monitoring sheet for biopesticides on cabbage in the Kiambu ALL

Name of Farmer		Compost Spinach		
Practice implementing		Test Plot		Control Plot
Crop		Spinach		
Parameter				
<b>Time 1</b>				
Number of leaves per plot		398		235
Leaf color		1		1
Vegetable yield (kg) per plot		0.15 kg		0 kg
<b>Time 2</b>				
Number of leaves per plot		360		221
Leaf color		2		1
Vegetable yield (kg) per plot		2.5kg		1.70kg
<b>Time 3</b>				
Number of leaves per plot		523		421
Leaf color		3		2
Vegetable yield (kg) per plot		5.29 kg		4.26 kg
<b>Time 4</b>				
Number of leaves per plot		491		<del>431</del> 431
Leaf color		2		3
Vegetable yield (kg) per plot		3.54kg		3.21 kg
<b>Time 5</b>				
Number of leaves per plot		441		429
Leaf color		2		2
Vegetable yield (kg) per plot		1.77 kg		1.01 kg
<b>Time 6</b>				
Number of leaves per plot		530		457
Leaf color		2		1
Vegetable yield (kg) per plot		4.04kg		4.01 kg

Photo 2: Monitoring sheet for compost on spinach in the Kiambu ALL

# Annex E: Sample of the personalized soil data report



## CGIAR Initiative on Agroecology in Kenya Personalised soil report for trial participants

Peter Bolo<sup>1</sup>, Hezekiah Korir<sup>2</sup>, Beatrice Adoyo<sup>3</sup>, Anne Kuria<sup>3</sup>, Edith Anyango<sup>3</sup>, Lisa Fuchs<sup>1</sup>

<sup>1</sup> Alliance of Bioversity International and CIAT, Nairobi, Kenya

<sup>2</sup> International Institute for Tropical Agriculture (IITA), Nairobi, Kenya

<sup>3</sup> World Agroforestry Centre (ICRAF), Nairobi, Kenya

### 1. General information about the Agroecology Initiative

The Agroecology Initiative (AE-I) is a collaborative partnership of eight CGIAR entities, as well as CIFOR-ICRAF, and the French research institute CIRAD under the Agroecology Transformative Partnership Platform (TPP) project. The initiative is funded by the CGIAR System Council and is currently being implemented in eight countries, comprising five in Africa, two in Asia, and one in the Americas. The primary goal of AE-I is to promote the application of contextually appropriate agroecological principles by farmers and communities in various contexts, with support from other food system actors.

### 2. Farmer profile

Name	Farmer ID	ALL	Trial focus area	Trial practice
		KIAMBU	Water management	Mulch

### 3. Individual soil data report

Element (except pH, all units are in mg/kg unless specified)	Nutrient levels to guide the interpretation of results				Farmer's Results	Interpretation
	Low	Medium	High	Very High		
pH	4.5-5.5	5.6-6.5	6.5-7.5	>7.5	7.57	High
Soil Organic Carbon (%)	1-2 %	2.1-3%	>3%		1.46	Low
Total Nitrogen (%)	0.1-0.2 %	0.2-0.3%	0.3-0.4%	>0.4%	0.13	Low
Phosphorus (P)	10-20	20-40	40-100	>100	-	-
Potassium (K)	<150	150-250	250-800	>800	424.97	High
Calcium (Ca)	500-1000	1001-2000	>2000		3632.76	High
Aluminium (Al)	45	45-90	91-225	>225	1027.74	Very high
Magnesium (Mg)	20-60	61-200	200-1000	>1000	502.66	High
Sulfur (S)	5-10	11-25	>25		15.57	Moderate
Manganese (Mn)	30	30-150	150-300	>300	449.5	Very high
Zinc (Zn)	1.5-2.2	2.21-5.0	5.1-20	>20	-	-
Copper (Cu)	1.5	1.6-10	>10		3.79	Medium
Iron (Fe)	30-60	61-300	301-420	>420	143.21	High
Boron (B)	0.2-0.5	0.51-1	1-2	>2	0.82	Medium
CEC (cmol/kg)	5-10	11-20	>20		22.77	High

### 4. Soil data interpretation and recommendations guidance

- Liming is necessary when the pH is **low**. No liming is needed under high pH. Very high pH should be managed appropriately.
- When calcium is low, apply high calcium limestone. When both calcium and magnesium are low, apply dolomitic limestone.
- When **soil organic carbon** is low, apply organic matter, organic residues, compost/manure, mulch or plant green manure cover crops
- When the soil nutrient(s) is(are) low, address by applying organic matter, organic residues, compost/manure, mulching, planting green manure cover crops or leguminous crops; or apply the appropriate nutrient-based organic fertilisers
- The medium and high concentrations of nutrients are okay for moderate to optimum crop productivity. However, they need to be maintained by applying organic matter, organic residues, compost/manure, mulching, planting green manure cover crops or leguminous crops; or applying the appropriate nutrient-based organic fertilisers

**Note:** The nutrient concentrations in the soil should range from medium to optimum, and these may vary with crops. Very high concentrations of some nutrients may be toxic to plants.



**Lisa Elena Fuchs, Alliance Bioversity-CIAT, [L.Fuchs@cgiar.org](mailto:L.Fuchs@cgiar.org)**

**Hezekiah Korir, IITA, [H.Korir@cgiar.org](mailto:H.Korir@cgiar.org)**

**Peter Bolo (Alliance), [P.Bolo@cgiar.org](mailto:P.Bolo@cgiar.org)**

**Michael Sakha, IITA, [M.Sakha@cgiar.org](mailto:M.Sakha@cgiar.org)**

**Pius Gumo, IITA, [P.Gumo@cgiar.org](mailto:P.Gumo@cgiar.org)**

**Machio Mbelwa, IITA, [M.Mbelwa@cgiar.org](mailto:M.Mbelwa@cgiar.org)**

**Anne Kuria, CIFOR-ICRAF, [A.Kuria@cifor-icraf.org](mailto:A.Kuria@cifor-icraf.org)**

**Beatrice Adoyo, CIFOR-ICRAF, [B.Adoyo@cifor-icraf.org](mailto:B.Adoyo@cifor-icraf.org)**

**Edith Anyango, CIFOR-ICRAF, [E.Anyango@cifor-icraf.org](mailto:E.Anyango@cifor-icraf.org)**

**Nicholas Syano, DNRC, [ngali1973@gmail.com](mailto:ngali1973@gmail.com)**

**Esther Kiruthi, CSHEP, [cshepkenya@gmail.com](mailto:cshepkenya@gmail.com)**

**Frederick Baijukya, IITA, [F.Baijukya@cgiar.org](mailto:F.Baijukya@cgiar.org)**

**Frédéric Baudron, CIRAD, [frederic.baudron@cirad.fr](mailto:frederic.baudron@cirad.fr)**

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**Lisa Elena Fuchs, Alliance Bioversity-CIAT, [L.Fuchs@cgiar.org](mailto:L.Fuchs@cgiar.org)**

**Hezekiah Korir, IITA, [H.Korir@cgiar.org](mailto:H.Korir@cgiar.org)**

**Peter Bolo (Alliance), [P.Bolo@cgiar.org](mailto:P.Bolo@cgiar.org)**

**Michael Sakha, IITA, [M.Sakha@cgiar.org](mailto:M.Sakha@cgiar.org)**

**Pius Gumo, IITA, [P.Gumo@cgiar.org](mailto:P.Gumo@cgiar.org)**

**Machio Mbelwa, IITA, [M.Mbelwa@cgiar.org](mailto:M.Mbelwa@cgiar.org)**

**Anne Kuria, CIFOR-ICRAF, [A.Kuria@CIFOR-ICRAF.org](mailto:A.Kuria@CIFOR-ICRAF.org)**

**Beatrice Adoyo, CIFOR-ICRAF, [B.Adoyo@CIFOR-ICRAF.org](mailto:B.Adoyo@CIFOR-ICRAF.org)**

**Edith Anyango, CIFOR-ICRAF, [E.Anyango@CIFOR-ICRAF.org](mailto:E.Anyango@CIFOR-ICRAF.org)**

**Nicholas Syano, DNRC, [ngali1973@gmail.com](mailto:ngali1973@gmail.com)**

**Esther Kiruthi, CSHEP, [cshepkenya@gmail.com](mailto:cshepkenya@gmail.com)**

**Frederick Baijukya, IITA, [F.Baijukya@cgiar.org](mailto:F.Baijukya@cgiar.org)**

**Frédéric Baudron, CIRAD, [frederic.baudron@cirad.fr](mailto:frederic.baudron@cirad.fr)**

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