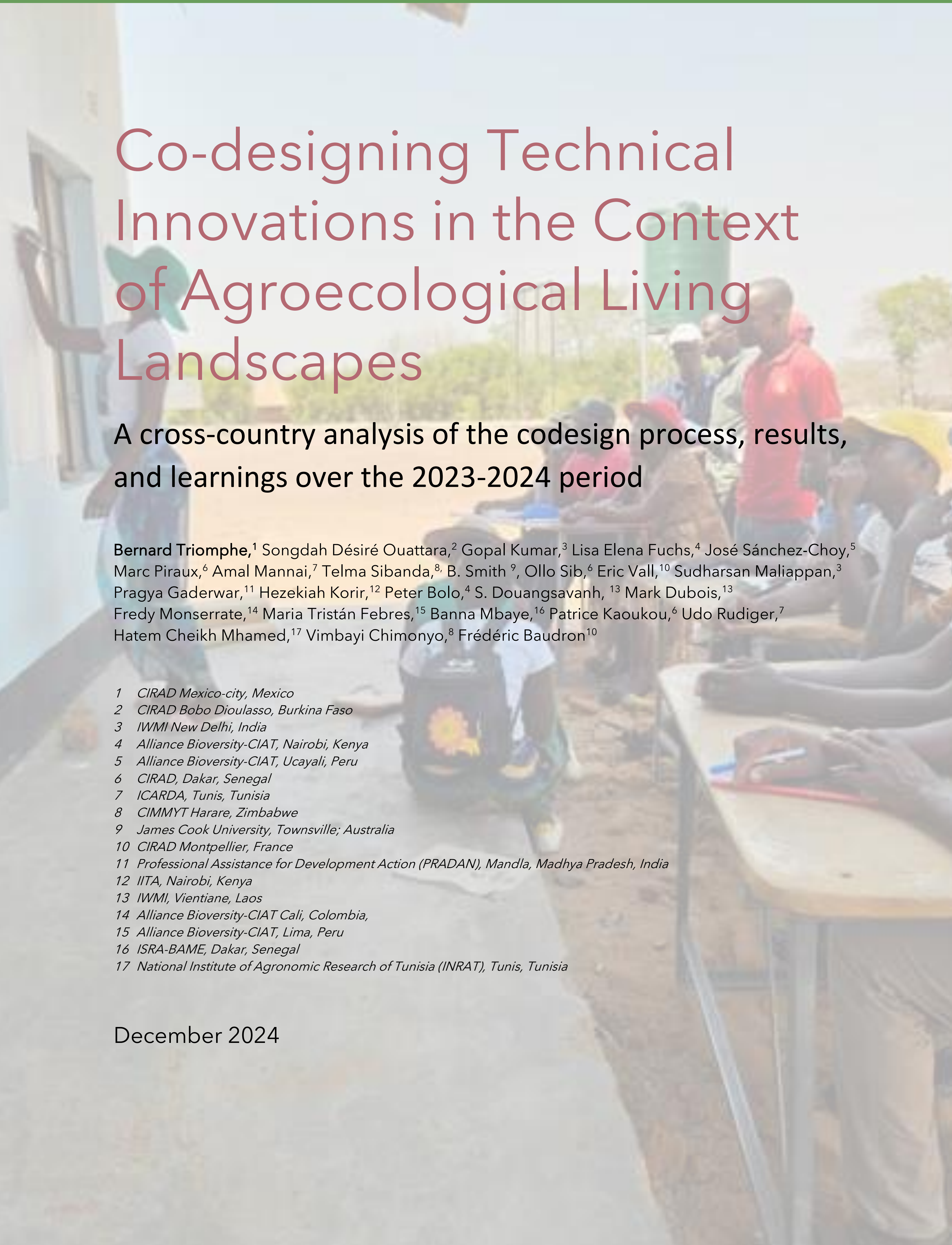


Co-designing Technical Innovations in the Context of Agroecological Living Landscapes

A cross-country analysis of the codesign process, results, and learnings over the 2023-2024 period

Bernard Triomphe,[1] Songdah Désiré Ouattara,[2] Gopal Kumar,[3] Lisa Elena Fuchs,[4] José Sánchez-Choy,[5]
Marc Piraux,[6] Amal Mannai,[7] Telma Sibanda,[8,] B. Smith [9], Ollo Sib,[6] Eric Vall,[10] Sudharsan Maliappan,[3]
Pragya Gaderwar,[11] Hezekiah Korir,[12] Peter Bolo,[4] S. Douangsavanh, [13] Mark Dubois,[13]
Fredy Monserrate,[14] Maria Tristán Febres,[15] Banna Mbaye,[16] Patrice Kaoukou,[6] Udo Rudiger,[7]
Hatem Cheikh Mhamed,[17] Vimbayi Chimonyo,[8] Frédéric Baudron[10]

1 *CIRAD Mexico-city, Mexico*
2 *CIRAD Bobo Dioulasso, Burkina Faso*
3 *IWMI New Delhi, India*
4 *Alliance Bioversity-CIAT, Nairobi, Kenya*
5 *Alliance Bioversity-CIAT, Ucayali, Peru*
6 *CIRAD, Dakar, Senegal*
7 *ICARDA, Tunis, Tunisia*
8 *CIMMYT Harare, Zimbabwe*
9 *James Cook University, Townsville; Australia*
10 *CIRAD Montpellier, France*
11 *Professional Assistance for Development Action (PRADAN), Mandla, Madhya Pradesh, India*
12 *IITA, Nairobi, Kenya*
13 *IWMI, Vientiane, Laos*
14 *Alliance Bioversity-CIAT Cali, Colombia,*
15 *Alliance Bioversity-CIAT, Lima, Peru*
16 *ISRA-BAME, Dakar, Senegal*
17 *National Institute of Agronomic Research of Tunisia (INRAT), Tunis, Tunisia*

December 2024

Co-designing Technical Innovations in the Context of Agroecological Living Landscapes

A cross-country analysis of the codesign process, results, and learnings over the 2023-2024 period

Bernard Triomphe,[1] Songdah Désiré Ouattara,[2] Gopal Kumar,[3] Lisa Elena Fuchs,[4] José Sánchez-Choy,[5] Marc Piraux,[6] Amal Mannai,[7] Telma Sibanda,[8,] B. Smith [9], Ollo Sib,[6] Eric Vall,[10] Sudharsan Maliappan,[3] Pragya Gaderwar,[11] Hezekiah Korir,[12] Peter Bolo,[4] S. Douangsavanh, [13] Mark Dubois,[13] Fredy Monserrate,[14] Maria Tristán Febres,[15] Banna Mbaye,[16] Patrice Kaoukou,[6] Udo Rudiger,[7] Hatem Cheikh Mhamed,[17] Vimbayi Chimonyo,[8] Frédéric Baudron[10]

1 *CIRAD Mexico-city, Mexico*
2 *CIRAD Bobo Dioulasso, Burkina Faso*
3 *IWMI New Delhi, India*
4 *Alliance Bioversity-CIAT, Nairobi, Kenya*
5 *Alliance Bioversity-CIAT, Ucayali, Peru*
6 *CIRAD, Dakar, Senegal*
7 *ICARDA, Tunis, Tunisia*
8 *CIMMYT Harare, Zimbabwe*
9 *James Cook University, Townsville; Australia*
10 *CIRAD Montpellier, France*
11 *Professional Assistance for Development Action (PRADAN), Mandla, Madhya Pradesh, India*
12 *IITA, Nairobi, Kenya*
13 *IWMI, Vientiane, Laos*
14 *Alliance Bioversity-CIAT Cali, Colombia,*
15 *Alliance Bioversity-CIAT, Lima, Peru*
16 *ISRA-BAME, Dakar, Senegal*
17 *National Institute of Agronomic Research of Tunisia (INRAT), Tunis, Tunisia*

December 2024

Contents

List of figures and tables

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 agricultural 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.

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 multi-stakeholder partnerships and collaboration in the designated ALLs (also referred to as "ALL establishment"), and the co-design of technological 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 across the various countries, 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.

The following people from the country teams are gratefully acknowledged for their contributions to the in-country work and reports on which this consolidated report is based:

Burkina Faso	Songdah Désiré Ouattara, Ollo Sib, Souleymane Sanogo, Étienne Sodre, David Berre, Eric Vall
India	Gopal Kumar, Sudharsan Maliappan, Ayan Samaddar, Md Shamim, Pragya Gadewar, Sahith Acharya, Alok Sikka, Bernard Triomphe and Vikash Vaibhav
Kenya	Lisa Elena Fuchs, Hezekiah Korir, Peter Bolo, Michael Sakha, Pius Gumo, Machio Mbelwa, Anne Kuria, Beatrice Adoyo, Nicholas Syano, Esther Kiruthi, Frederick Baijukya, Frédéric Baudron
Laos:	Bethany Smith, Somphasith Douangsavanh, Mark Dubois, Florine Degrune, Viengxay Xaydala, Ammala Chanthalath
Peru	José Sánchez, Fredy Monserrate; Víctor Gómez, María Claudia Tristán; Alex Correa, Atilio Huapalla
Senegal	Marc Piraux, Banna Mbaye, Raphael Belmin, Moussa N'Diénor, Patrice Kouakou, Marième Ba, David Berre, Etienne Delay, Jean-Pierre Muller
Tunisia	Amal Mannai, Aymen Frija, Udo Rudiger, Véronique Alary, Mourad Rekik, Ons Tebourbi, Zied Idoudi, Hatem Cheikh Mhamed, Salah Benyoussef, Khouloud Chetoui, Imen Hemissi, Amira Hachana, Hanen Arfaoui, Zoghlami Rahma Inès, Mohammed Annabi, Yassine Hidri, Ajmi Larbi, Mahdi Fendri, Hanen Zaeir, Ajmi Larbi, Anis Zaiem, Khalil Rahali, Bouthaina Abdi, Emna Ouerghi, Hanen Chaabani, Hanen Arfaoui
Zimbabwe	Telma Sibanda, Frederic Baudron, Dorcas Matangi, Christopher Gadzirayi, Vimbayi G. P. Chimonyo

The members of the WP1 global team are gratefully acknowledged for their contributions to the overall WP1 work on Agroecological Living landscapes (ALLs) and codesign, the agronomic assessment and the International Network of ALLs:

- Nadia Bergamini, Lisa Elena Fuchs, Fredy Monserrate, Frédéric Baudron, Angela Navarrete, David Berre

Executive summary

This report documents the processes, results, and key learnings from implementing co-design approaches for agroecological innovations across eight countries (Burkina Faso, India, Kenya, Laos, Peru, Senegal, Tunisia, and Zimbabwe) during 2023-2024, as part of Work Package 1 of the CGIAR Agroecology Initiative.

The participating countries demonstrated significant diversity in their co-design approaches, reflecting different contexts, farming systems, and priorities. Several countries like Kenya and Zimbabwe implemented structured, multi-cycle processes with systematic stakeholder engagement, while others like Peru focused on specific value chains such as organic cacao production. The co-design process typically progressed through several key phases: preparatory work to establish foundations and relationships, stakeholder engagement and visioning to develop shared understanding and goals, collaborative technology identification and design, systematic trial establishment, robust monitoring and evaluation, knowledge exchange through field days and farmer-to-farmer learning, capacity building, and iterative refinement based on results and feedback.

Stakeholder participation varied across countries but consistently involved farmers, international researchers, and extension services. Some countries achieved strong integration with national research organizations and private sector actors, though this remained a challenge in several locations. The process helped strengthen institutional collaboration and knowledge sharing between stakeholders while empowering farmers as active participants in innovation development. In Kenya, for example, the establishment of partnerships with farmer training centers as "host centers" created effective platforms for ongoing engagement and scaling.

Across the initiative, countries tested approximately 30+ distinct technologies spanning various domains. These included innovations in soil health management, such as Zimbabwe's conservation agriculture practices and Tunisia's biochar applications; integrated pest management approaches like Kenya's plant-based biopesticides and Peru's organic disease management for cacao; water management technologies including India's solar irrigation systems; and crop-livestock integration methods demonstrated by Burkina Faso's dairy production innovations. The scale of implementation was significant, reaching 300-350 farmers (data from six countries only), though the intensity of engagement varied. Most countries implemented 1 or 2 experimental cycles during this period, with some achieving three cycles based on local growing seasons.

Technology performance and adoption patterns showed strong context-dependency. Several technologies demonstrated significant potential for scaling, particularly where they aligned well with existing farming systems and provided clear economic benefits. Tunisia's forage intercropping systems showed marked improvements in soil health and animal nutrition, while Kenya's basic agroecological practices achieved widespread adoption through existing farmer networks. Burkina Faso's dairy management innovations demonstrated how integrated approaches could improve both productivity and resource efficiency.

Several critical success factors for technology adoption were identified, including secure land tenure, access to adequate labor and resources, and strong institutional support systems. Common challenges included high initial investment costs, intensive labor requirements, and the need for technical knowledge and training. Gender dynamics played a significant role, with some technologies showing different adoption patterns between men and women farmers.

Looking forward, the co-design experience generated valuable insights for future implementation. There is a clear need for standardized yet flexible methodological guidelines that maintain scientific rigor while allowing local adaptation. Future processes should better integrate activities across plot, farm, and landscape scales, while addressing multiple types of innovations including organizational and institutional ones. Enhanced mechanisms for inclusive participation, particularly of women farmers and diverse stakeholder groups, will be crucial for success.

These results provide a strong foundation for refining and scaling these approaches through the upcoming Multifunctional Landscapes program. The experiences demonstrate that well-structured co-design approaches can generate both immediate benefits and longer-term transformative change in agricultural systems, particularly when supported by robust knowledge sharing platforms and communication systems. Success will require continued attention to both technical and social dimensions while maintaining flexibility to accommodate local contexts and emerging opportunities.

Introduction

Agroecological Living landscapes operate across all the work packages of the Agroecology Initiative (AEI) and focus in developing innovations dealing with new agroecological production practices, value chain arrangements, business models, policy- and institution-enabling environments, and behavioral change strategies.

Work package 1 (WP1) for its part focuses on the codesign of technical agroecological innovations in the production sphere. This involves identifying, codesigning, testing, assessing, and eventually fostering the adoption and scaling of an array of technical AE innovations responding to the specific context and conditions and to the needs and objectives of farmers in each ALL. In 2022, ALLs were established and started functioning in seven countries. In 2023, most of the country teams were able to engage in two strategic activities under WP1: (1) developing a process eventually labelled "vision-to-action" (See Triomphe et al. 2024) allowing ALL stakeholders to identify a collective vision for a desirable future 10 to 15 years down the road and to specify the contribution of agroecology to this future, coupled with identifying transition pathways to go from the current state of agriculture in the ALL to this future (see corresponding report); and (2) engaging in a process of codesigning desirable technical agroecological innovations from the viewpoint of users (namely: farmers in the various ALLs), typically following an assessment of existing practices and innovations. In 2024, most country teams continued the codesign and experimentation process started in 2023, adding one or more cycles of adjusted experiments).

This report presents the results obtained over 2023 and 2024 with this second set of activities, i.e. the codesign process and associated technology portfolio for the eight country teams involved in the AEI, as reported with a variable level of details in the 2024 country reports. Developed with the help of Claude AI (see Annex 1), it builds on the initial codesign report published in December 2023 (Triomphe et al., 2023). It also presents key critical reflections, lessons and recommendations emerging out of two years of participatory engagement of AEI country and global teams with local and national partners and stakeholders.

As was already the case for ALL establishment, it was clear from the onset that codesign, being as much a set of principles as a specific approach, could not be implemented following a standard centralized approach. Instead, the different WP1 country teams went about codesign in a fairly decentralized manner, allowing each of them to determine and implement what they considered the most suitable approaches to codesign (see examples of specific approaches followed by some countries in Anne 2). This is in keeping with the highly contrasting and specific situations and contexts each country faces. Such contrasts include, among other aspects, **farming/cropping systems** (from cocoa-based systems in the rainy Amazon to crop-livestock systems in semi-arid regions of North and West Africa to cereal and vegetable production in a host of countries), **cropping calendars** and **prior trajectories and advances** each country had with agroecological farming practices, systems and related sustainable technologies (such as conservation agriculture), and the **profile and experience of the country team staff** with codesign and related participatory approaches. Another key reason for giving the country teams great autonomy is that the codesign process is by nature partly designed, decided and adjusted on the go, based on interactions and negotiations with national or local stakeholders in each ALL.

As a result of the interplay among these various factors, the codesign process varied greatly among countries, along with the set of technologies selected in a participatory manner for testing with each ALL and countries. The following snapshots per country illustrate such diversity (countries listed in alphabetical order):

- More than any other country perhaps, **Burkina Faso** tackled the whole farm scale for designing agroecology practices and dairy livestock systems, within the context of a dairy value chain which serve as its ALLs. TO this effect, it focused on a cascade of innovations including fodder crop production (cereals and legumes), improved manure facilities, and optimized cattle diets
- **India** started in earnest the codesign process in late 2023, after changing its main intervention site from Andhra Pradesh to Madhya Pradesh. Still, it managed to handle a structured codesign process and established a fairly diverse set of experiments dealing with a host of innovations, several of which being of a rather systemic / holistic nature such as Agroecological Homestead Models (AHM). The aim is to diversify the income and diet of smallholder tribal communities dedicated to paddy rice crop.
- **Kenya** invested a lot of effort in a systematic and participatory assessment of existing agroecology practices before engaging in codesign of new practices. The Kenya team was also especially careful to involve its two main local partners (the so-called "host centers") in every step of the codesign process in each one of the two ALLs established. It focused on enhancing the resilience of crops like maize, beans, spinach, and cabbage through improved soil fertility, water management, and integrated pest management.
- **Laos** consolidated a functional AEI team in late 2023. While Laos conducted a fair deal of diagnostic studies aimed at understanding the diversity of agricultural practices and systems or water management at the watershed level, with little still in the way of experiments with agroecology practices, it focuses the codesign efforts on technologies and options aimed at improving food security and income of poor households through solar pimping, integrated Rice-Fish Culture, red rice production, and vegetables during the dry season under the umbrella of a gender-sensitive sustainable wetland management approach.

- The **Peru** team has been dealing with cocoa-based systems, within the context of a certified export-oriented organic value chain in partnership with two farmers cooperatives. Cocoa being a perennial crop, and given the short-term horizon being of the AEI, Peru conducted experiments aimed at better controlling moniliasis, a major cacao fruit disease, as well at enhancing the tree nutrition, both technologies having to be compatible with organic certification.
- Although **Senegal** joined the AEI only in early 2023, it was able to build on activities and results related to codesign obtained under the related EU-funded DeSIRA FAIR Sahel project, which mobilizes a host of approaches that are in fairly original compared to what is being done within the context of the AEI or even the CGIAR in general, including scenario development, ideotyping of agroecological options at the cropping systems and territorial level. Within the framework of a very diversified ALL working at the scale of an entire department, it focused on enhancing groundnut production through intercropping with cowpea and the use of manure for fertilizing different crops
- **Tunisia** relied heavily for the codesign process on results and technological options developed in previous projects, while also paying attention to a wide diversity of conditions and farming systems across the communities and six farmers' groups that are part of its ALL. Through a collaboration with a host of national R&D partners, it focused on a diversity of technologies such as Sulla forage, forage mixtures (Vetch, Oat, and Triticale) which can help improve sheep fertility, and various ways of enhancing soil health in olive orchards and durum wheat fields and.
- **Zimbabwe** started codesign as early as late 2022. The Zimbabwe team was fairly autonomous in its approach to codesign. Within the framework of a diversified partnership involving extension services, NGOs, and private sector, it focused on improving maize and sorghum production through practices like push-pull, mulching and conservation agriculture, and biochar. It also developed a number of original digital tools for trial monitoring and assessment by farmers

To make sense of this diversity of experiences (which is documented in great details in the country reports focused on ALL emergence, codesign and other key activities implemented within the context of the AEI), yet provide an overall synthesis and draw some overall perspectives from the many results and achievements, this report focuses on the following aspects:

- Following this introduction, section 1 focuses on generic aspects related to how countries structured their respective codesign approach and process. It particularly looks at the technologies selected, the design of experiments, and the M&E systems put in place. Section 1 also includes some critical analysis of how things went and a photographic codesign journey through the eight countries.
- Section 2 briefly synthesized the main results of the agronomic and agroecological assessment conducted on the various technologies selected by the various countries with the help of WP1 global team members (a separate report provides details: see Monserrate et al. 2024)
- Section 3 looks at adaptation, adoption and scaling potential of the various innovations tested
- Section 4 outlines the main reflections, lessons and recommendations across countries with respect to the codesign process, both by looking at achievements and the way forward.
- The concluding section mentions several generic reflections, lessons and recommendations for future codesign efforts, which hopefully will inform the new SP2 / Multifunctional Landscape program from the CGIAR, or any similar types of interventions keen to implement a codesign approach.

Note: The detailed countries codesign reports on which this cross-country report is based are listed in the reference section whenever they were available at the time this report was submitted, along with other relevant resources countries produced

1. Process and steps followed for codesigning innovations

1.1 Main steps followed and activities organized as part of the codesign process

The main steps and activities followed across countries for implementing the codesign process are the following. Figure 1 and Figure 2 provide concrete examples of how Kenya and India implemented the codesign process.

Preparatory Phase

The preparatory phase focused on establishing foundations for the codesign work, mostly in the form of activities developed to allow ALL establishment. In Kenya, this involved initial assessments to identify potential host centers and building relationships with partners. Zimbabwe conducted national consultation meetings to identify potential sites and map existing agroecological activities followed by district-level kick-off meetings to introduce the initiative to local communities. India began with baseline surveys incorporating literature reviews and spatial databases to assess the context before initiating formal implementation.

Stakeholder Engagement and Visioning

After initial preparations, countries organized structured engagement with stakeholders, following the generic blueprint developed by WP1 and in particular the vision-to-action process. For example, Kenya conducted visioning workshops with women's groups, men's groups, and mixed groups including district officials and researchers. A key aspect across countries was the integration with existing mechanisms and institutions. For example, Burkina Faso built on existing dairy innovation platform. India worked through established self-help groups. Peru collaborated with existing cooperative structures.

Technology Identification and Design

The process then moved to identifying and designing specific interventions. In Kenya, after an initial assessment of existing practices and innovations, co-design workshops brought together farmers and researchers to identify and select innovations and develop experimental designs. Zimbabwe used participatory stakeholder mapping to document existing practices and case studies. Peru organized workshops where growers and technicians identified agroecological innovations focused on technologies compatible with organic certification. Tunisia for its part implemented stakeholder workshops to develop innovation packages tailored to local needs and priorities.

Trial Establishment

Experimentation typically consisted of establishing networks of field trials in farmers' fields. Zimbabwe established mother and baby trials across different sites. Kenya implemented parallel trials across multiple locations with simple protocols. Burkina Faso organized demonstration plots for forage production and supporting the construction of covered manure pits. Peru set up randomized complete block design trials across multiple cocoa plantations.

Monitoring and Evaluation Systems

Countries established systematic monitoring, including agronomic, socioeconomic and process dimensions. This included periodic visits to the trials by researchers or technicians to record technical data and gather farmer perspectives. While all countries conducted systematic monitoring, their approaches differed. Zimbabwe developed detailed protocols covering agronomic, socioeconomic, and environmental parameters. Kenya implemented multi-level monitoring involving researchers, ALL host centers, and farmers, while Burkina Faso created integrated tools for monitoring both production and value chain aspects. Tunisia created comprehensive evaluation systems tracking both technical and socioeconomic variables. Peru focused on precise technical measurements in controlled trial settings. The collected evidence supported a detailed analysis of trial and codesign results and was useful in contributing to learning and adjustments from one cycle to the next.

Knowledge Exchange and Adaptation

Besides the visits by researchers, the codesign process incorporated many **knowledge exchange activities** among farmers and between farmers, researchers and technicians. Kenya organized intra-ALL and inter-ALL exchange visits. Zimbabwe conducted seed fairs, farmer field days and feedback workshops. Tunisia facilitated farmer-to-farmer exchange visits to share experiences and insights. These exchanges informed ongoing adaptations to the technologies and approaches being tested.

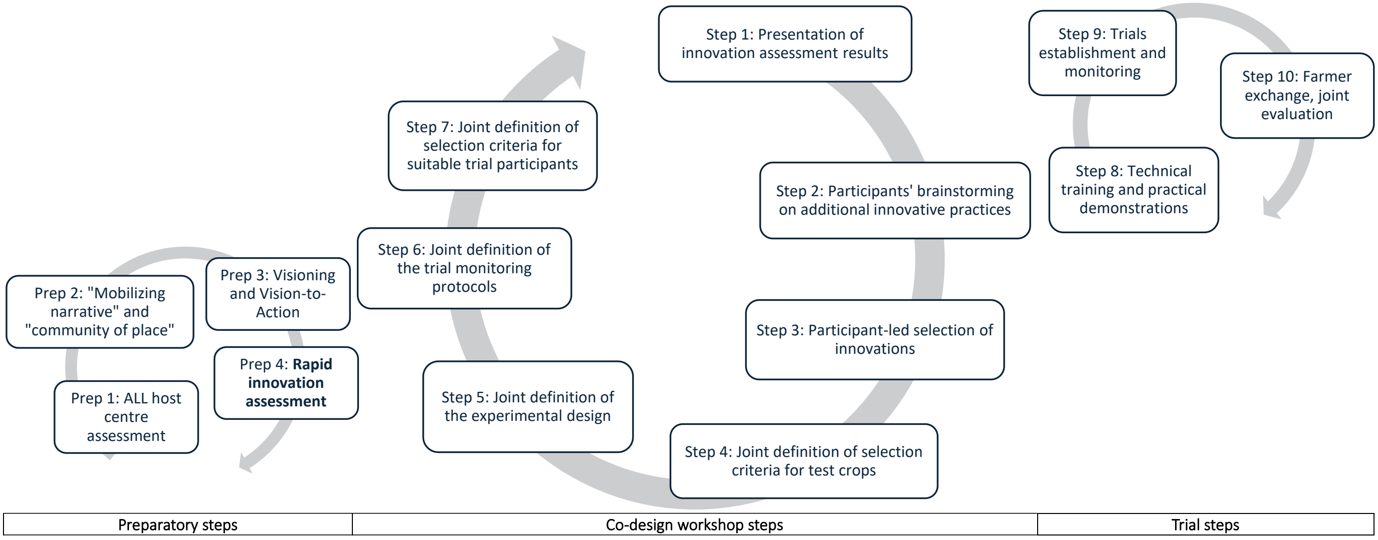


Figure 1. Steps in the broader co-design process followed by the Kenya team.

(source: Kuria et al. 2024)

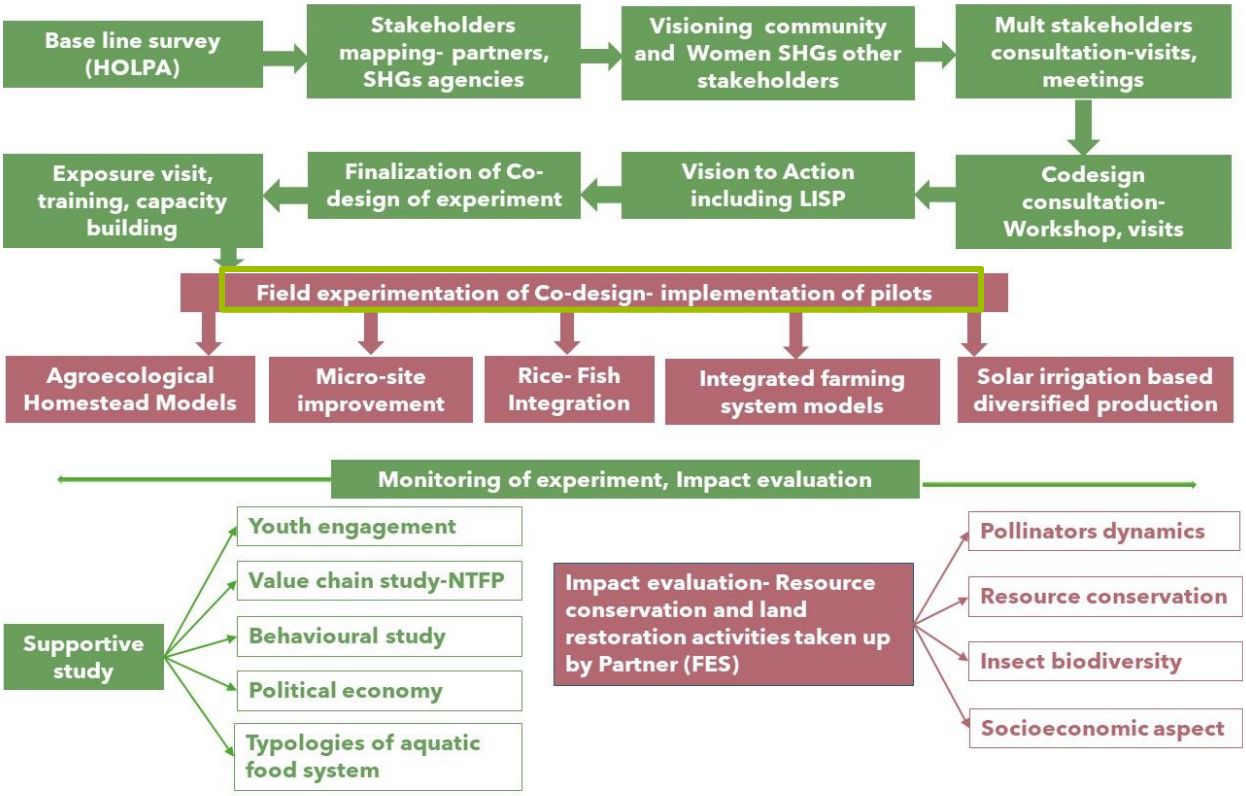


Figure 2. The broader steps followed for co-designing innovation, monitoring and impact evaluation by the India team

(source: India codesign report)

Capacity Building and Technical Support

Throughout the process, countries provided technical support and training. Burkina Faso conducted training on rationing tools and forage production. Zimbabwe organized seed fairs and technical training sessions. Kenya held technical training workshops before each implementation cycle. Most formal training directed to farmers seems however to have been more of a technical nature (related to the handling of the specific technologies being tested, and sometimes to the monitoring of the trials) rather than process-oriented (such as developing the ability of farmers to engage in codesign process as such).

Iteration and Refinement

The codesign process has been iterative in most countries (and continues to be, as several countries have started a new cycle of experimentation by late 2024, or are planning to do so during 2025), with successive cycles of implementation and refinement. This iterative process typically included initial testing, gathering farmer feedback, making adjustments, and conducting additional trials with improvements.

By mid-2024, Zimbabwe had already conducted two complete cycles of testing and adaptation since late 2022, following the mother-baby trial concept. It is in the process of implementing a third one for the 2024/2025 season. Owing to the specificities of its climate, Kenya implemented three successive cycles of trials since 2023 with modifications based on learning from previous cycles (the 3rd one is on-going). Peru, dealing with a perennial crop, completed one cycle in late 2024 and is in the process of implementing its second cycle with adjustments based on farmer feedback.

Local Adaptation of the generic Codesign Approach

Countries developed different ways of ensuring local adaptation. Kenya implemented a multi-tiered system of trials with varying levels of control over the trials depending on where the trial was implemented (host center vs. farmer fields). India emphasized the integration of traditional (tribal) knowledge with modern techniques. Owing to its close relationship with cooperative technicians in charge of providing technical assistance to farmers, Peru opted for formally designed trials (RCB with 2 repetitions).

Countries varied significantly in their implementation scale and technical focus. Zimbabwe, Tunisia, India and Kenya implemented broad agendas covering multiple crops and themes, while Peru focused specifically on organic cacao production systems. Burkina Faso concentrated on dairy value chains, demonstrating a more targeted sectoral approach.

Such adaptations partly respond to how available resources (human and financial) were allocated. Some countries, like Zimbabwe and Kenya, implemented extensive networks of trial sites, while others, like Peru, focused resources on intensive testing at fewer locations.

The above implementation steps demonstrate how countries adapted a generic codesign framework to their respective local contexts while maintaining core principles of participatory engagement and systematic learning. This structured yet flexible approach to codesign allowed for meaningful stakeholder involvement while ensuring scientific rigor in testing and evaluating agroecological innovations.

Evolution of the Codesign Process over Consecutive Cycles

Several countries implemented at least 2 cycles of codesign. Some countries such as India and Laos established their first experimental cycles in late 2023 or 2024 for a host of reasons, others like Senegal conducted several cycles as part of a related EU-funded project, the details of which were not necessarily reported within the framework of the AEI, while Peru deal with long experimental cycles of a perennial crop.

Zimbabwe and Kenya provided the most detailed accounts of the "evolutionary processes" taking place from one cycle to the next.

Zimbabwe's Evolution

Zimbabwe's codesign process demonstrated clear progression across successive phases. The initial cycle, implemented in 2022-2023, established foundational practices through mother demonstration trials. These trials compared three core treatments: conventional practices, conservation agriculture with dead mulch, and push-pull technology.

In the second cycle (2023-2024), Zimbabwe expanded the scope significantly. The program added three new treatments: biochar, traditional IPM practices, and conservation agriculture with live mulch. This expansion reflected learning from the first cycle and incorporated farmer feedback. A particularly significant development was the implementation of a mother-baby trial approach, where 83 farmers (64 in Murehwa and 19 in Mbire) selected preferred treatments from the mother trials for testing on their farms. This evolution illustrates increasing farmer autonomy in technology selection. Farmers could modify specific practices while maintaining core experimental parameters, demonstrating how the process became more flexible and locally adapted over time. The program also refined its monitoring systems, incorporating more detailed tracking of pest prevalence and yield parameters.

Kenya's Progressive Development

Kenya's codesign process evolved through successive cycles, with each phase building on previous learnings.

The first cycle, initiated in October 2023, established baseline trials testing specific and fairly basic practices in soil management, water management, and integrated pest management. During the second cycle (May 2024-August/September 2024), Kenya maintained the same core practices, but incorporated adaptations based on initial results. For instance, in Makueni, the program adjusted the specific bean sub-variety used, and increased the manure application rate based on first-cycle outcomes. The monitoring systems became more sophisticated, incorporating both technical measurements and farmer perceptions. The third cycle, started in late 2024, demonstrated further evolution. Farmers in Kiambu opted to maintain existing practices but diversified planting arrangements to include high-value crops like rosemary and pumpkins. In Makueni, the program evolved toward integrated farm designs combining multiple tested practices with new elements like contour planting and kitchen gardens.

Common Evolutionary Patterns across countries

Some patterns emerged in how the codesign processes evolved across countries:

- First, codesign typically started with relatively straightforward trials testing specific simple or at least already known component technologies, then progressed towards more complex, integrated approaches. This evolution reflected growing capacity among participants and deeper understanding of local contexts.
- Second, monitoring systems became more sophisticated over time. Initial basic measurements expanded to include more detailed parameters and better integration of farmer observations with technical data collection.
- Third, farmer participation increased in both scope and depth. Early cycles often featured more researcher-led activities, while later cycles showed greater farmer autonomy in decision-making and experimentation.
- Fourth, the countries demonstrated increasing flexibility in accommodating local variations while maintaining scientific rigor. This balance between standardization and local adaptation improved as the processes matured.

In the coming cycles, several countries plan on refining further their approach to codesign, and propose to go beyond the production at field / plot scale, by linking better innovations in production with marketing in some cases, or by addressing the whole farm and territorial scale.

Overall, the evolution of codesign processes demonstrates how iterative implementation can lead to more refined and locally appropriate innovations. The progression from basic trials to more complex, integrated approaches suggests that multiple cycles of implementation allow for valuable learning and adaptation, ultimately strengthening the effectiveness of agroecological interventions.

1.2 Stakeholders involved in the codesign process

Based on the country reports, the codesign processes across countries involved multiple stakeholder groups with distinct roles and contributions, as described below.

Farmers, farmers' organizations and other local actors

Farmers served as primary stakeholders of the codesign process across all countries, contributing local knowledge and practical experience as well as taking part in the M&E and various types of assessments.

In Zimbabwe, farmers participated in identifying feasible solutions and testing technologies in their fields. They provided valuable insights on existing challenges and helped ensure solutions were contextually appropriate. Farmer organizations, such as cooperatives in Peru helped coordinate activities and facilitate broader adoption of tested practices.

Community-based organizations and local institutions played important roles in implementation. Women's self-help groups in India helped mobilize community participation. These organizations provided crucial local context and helped ensure community buy-in.

International research Institutions

International research organizations played central coordinating and expertise roles in each country, albeit it was by design (they developed the AEI and were in charge of coordination and implementation in each country, controlling budgets, human resources and methodological development).

Across countries, they provided technical expertise and guidance on experimental design, protocol development and evaluation methods. They contributed scientific knowledge and experience while ensuring rigorous testing of innovations. They also facilitated knowledge and experience exchanges between farmers, scientists, technicians and other stakeholders.

In several countries, international researchers partnered with national researchers, students and in some cases academia representatives during the codesign process (this was especially the case in Tunisia, Senegal and Burkina Faso, but also in India and Laos). This was however not systematic as NARS partners have not been systematically or sufficiently integrated in the ALLs and whenever they have, funding made available by the AEI for their involvement remained limited. The AEI experience can serve as reminder that international research organizations should try to avoid "substituting" NARS, and contribute to the necessary capacity building of NARS, which is an essential component for ensuring sustainability of interventions beyond the usually limited time frame of projects and interventions such as the AEI.

Extension Services and development partners

Public extension workers served as critical intermediaries between researchers and farmers. In Zimbabwe, AGRITEX (Agricultural Extension Services) coordinated capacity-building activities and provided technical support to farmers. In Tunisia, the Livestock and Pastures office (OEP) provided much appreciated support on activities related to its mandate.

In Peru, this role was played by the partner cooperative technical teams, which helped design and implement trials and collect data. In Kenya, two NGOs were host centers of the ALLs, and played a similar role as public extension, including lending part of their own facilities for establishing trials. Similarly, NGOs played a strong role in Senegal and in India.

Altogether, extension and development stakeholders contributed to capacity building and helped establish linkages to broader innovation networks. They often brought experience from similar initiatives in other regions, enriching the local implementation process. They helped translate scientific concepts into practical applications while providing ongoing support to farmers.

Other government agencies

Government representatives contributed institutional support and policy alignment in some countries. In Zimbabwe, agencies like the Environmental Management Agency and Forestry Commission provided technical expertise and capacity building. They helped ensure innovations aligned with national agricultural and environmental policies while offering regulatory guidance and support.

Private Sector Actors

Private sector involvement, beyond farmers, varied by country but was relatively limited. When it happened, it generally included input suppliers, processors, and market actors. In Tunisia, private companies participated in testing and scaling innovations. Burkina Faso's program engaged dairy processors and collectors. These stakeholders helped ensure commercial viability and market integration of developed solutions.

National and local educational Institutions

In some cases, universities and agricultural training institutions contributed technical knowledge and research capacity. In Tunisia, they helped bridge theoretical knowledge with practical application while supporting capacity development.

Considering the importance of capacity building of all stakeholders and the need to prepare the future generation of R&D professionals, it would seem however that participation of national and local educational institutions in the codesign process remained fairly limited across countries. Their decisive involvement should be ensured in the next phase of the AEI, which will take place through the Multifunctional Landscapes Program of the CGIAR.

Variations in stakeholder engagement across countries

While farmers and international researchers had similar levels and types of engagement on codesign across countries, contributing actively to all steps of the codesign process, there were more variations with respect to the engagement of other stakeholders. For their part, extension and development partner participation showed were key players in some cases, while in other cases, they served primarily in their conventional role as technical advisors or resource providers. Participation of other government agencies (beside research and extension) varied from rather weak (case of Kenya) to very significant (case of Zimbabwe in particular). The same applies to the involvement of private sector actors across countries, mostly involved in input supply and market linkages, but hardly in codesign per se.

Coordination among stakeholders

The effectiveness of the contributions made by the various stakeholders was enhanced through structured coordination mechanisms as allowed by the establishment of ALLs in their diversity. Through them, countries established clear frameworks for permanent stakeholder interaction and integration of perspectives and resources, through regular meetings, field days, and joint planning sessions (see also Navarrete et al. 2025 Internal Governance report).

Altogether, the involvement of multiple stakeholder groups created synergies that strengthened the overall codesign process. Farmers' and other local actors' empirical, situational and practical knowledge combined with researchers' technical expertise led to more effective solutions. Extension services' facilitation role helped ensure smooth implementation, while private sector involvement supported what will hopefully soon become sustainable use and adoption of technologies and other innovations. This multi-stakeholder approach also contributed to building lasting capacity for continued collaboration (but see the caveats mentioned with respect to the involvement of NARS).

For their part, the observed variations in stakeholder participation reflect how countries adapted to local institutional contexts while attempting to maintain core principles of engagement (see Triomphe et al., 2022, principles of engagement). These differences demonstrate the flexibility of the codesign approach in accommodating various institutional arrangements while working toward shared objectives of sustainable agricultural development. Understanding these patterns can inform future efforts to optimize stakeholder engagement in agricultural innovation processes.

Our cross-country analysis demonstrates how successful codesign processes depend on meaningful engagement of diverse stakeholders, each contributing specific perspectives and capabilities while working toward shared visions and objectives of achieving sustainable agricultural development and in the specific case of the AEI, of agroecological transitions.

1.3 A cross-country focus on the technologies and the experiments established

The following analysis is based on the common tables developed across countries.

Technology selection process and outcome

Based on the country reports, the selected technologies across countries reflect both common themes and distinct local priorities. The selection processes typically considered multiple criteria including feasibility, scalability, and alignment with agroecological principles.

Selection Criteria and Process

The technology selection process typically involved multiple stages and considered several key criteria, in sync with agroecological principles:

- Technical Effectiveness: Technologies were evaluated based on their proven or potential effectiveness in addressing identified agricultural challenges. Zimbabwe's push-pull technology, for instance, was selected based on its demonstrated effectiveness in pest control and soil improvement.
- Local Appropriateness: Selected technologies needed to align with local farming systems, resources and priority needs. Burkina Faso's forage production system was specifically designed to integrate with existing dairy production practices and local feed resources.
- Economic Viability: The selection process considered implementation costs and potential economic returns. Peru's organic cacao management practices were chosen partly because they aligned with premium market opportunities for organic production.
- Environmental Sustainability: Technologies were evaluated for their environmental impact and contribution to agroecological principles. Kenya's selection of plant-based pest management approaches reflects this emphasis on environmental sustainability.
- Social Acceptability: The selection process considered local cultural practices and social norms. India's emphasis on traditional knowledge integration in their homestead models illustrates this consideration.

Differences in the selection process among countries

For one, the timeline and staging of selection differed among countries. Kenya implemented a phased approach with progressive identification and refinement of technologies across multiple seasons. Furthermore, the process followed in Kenya allowed substantial farmer input in technology adaptation. The same applies to how the India team proceeded in Mandla Pradesh. Other countries tended to maintain more centralized control over technical parameters in the experimentation. Zimbabwe began with controlled “mother” trials before expanding to farmer-managed “baby” trials. These variations reflect different vision and related approaches to relative farmer autonomy, managing risk and validating effectiveness.

Another difference lies with how countries chose to integrate new technologies with existing practices. India emphasized building on traditional (tribal) knowledge systems, while Tunisia focused on value chain integration. For its part, Peru decided to build on existing technical knowledge related to organic production and certification requirements held by cooperatives, illustrating the importance of external constraints (in this case: influence of export markets) in selecting and designing technologies.

Prioritization of technologies also varied among countries. Zimbabwe emphasized scalability and broader adoption potential. Kenya focused strongly on resource accessibility for small-scale farmers. Tunisia considered value chain integration opportunities more prominently. The weight given to economic factors versus environmental benefits varied among countries. Peru's focus on compatibility with organic certification reflected an unescapable market orientation typical of systems based on cash export crops, while other countries balanced multiple objectives more evenly.

Overall, this systematic approach to technology selection helped ensure that chosen innovations were both technically sound and practically applicable in local contexts. The process demonstrated how careful consideration of multiple criteria, combined with structured implementation approaches, can support effective agricultural and agroecological innovation. Our analysis also illustrates how countries adapted common principles to local contexts while maintaining core elements of participatory engagement and scientific rigor. Understanding in more detail these variations across countries can inform future efforts to develop generic approaches to optimizing the technology selection processes.

Diversity of the technologies eventually selected for testing

Based on the tables 1-3 below, developed by collating evidence found across country reports, there are emerging patterns in the technologies selected, revealing both commonalities and distinctions in how different countries approached agroecological innovation.

Core Technology Categories

Soil Health and soil fertility management emerged as a primary focus across multiple countries, though implementation approaches varied significantly. Zimbabwe implemented conservation agriculture with both dead and live mulch variants, while Tunisia focused on biochar application and organic amendments for olive orchards. Kenya chose to focus on traditional composting and manure management systems. These variations reflected different local soil challenges and resource availability (which, beyond the current experimentation, will need to be addressed at the farm and territorial level for scaling). In Peru, they chose to focus on the use of foliar organic fertilization.

Integrated pest management represented another common thread, though with distinct regional adaptations. Peru tested organic disease management options for cacao production, particularly focusing on moniliasis control. Kenya focused on plant-based biopesticide applications suited to local conditions and crops. Zimbabwe integrated pest management within broader system approaches, notably through push-pull technology that served multiple functions including pest control and soil improvement. These selections typically emerged from farmers' needs to reduce chemical inputs while maintaining crop protection.

Water management technologies showed perhaps the greatest variation, reflecting diverse environmental challenges. Kenya implemented mulching, and terracing systems with planted edges, creating multifunctional solutions for water conservation, pest management, and fodder production. Laos and India tested integrated solar irrigation systems linked to crop diversification, while other countries incorporated water management within broader soil conservation approaches.

Interestingly, various technologies tested are multi-purpose: such is the case of conservation agriculture as tried in Zimbabwe which addresses simultaneously soil fertility and water conservation.

Technological Complexity

The selected technologies demonstrated **different levels of complexity and integration**. Countries like Kenya began with relatively simple interventions before progressing to more complex, integrated approaches. India developed sophisticated homestead models that combined multiple technological elements, while Burkina Faso focused on integrated forage systems around dairy production.

The degree of technology adaptation also varied significantly. Some countries adapted existing technologies to local conditions, while others developed new approaches through the codesign process. Tunisia's work with olive waste management and biochar represented innovative combinations of existing technologies, while Peru's organic disease management systems built upon existing technical knowledge and recommendations combined with new insights.

Resource Requirements

The selected technologies showed varying requirements for external inputs and resources. Some approaches, like Kenya's biopesticide systems, emphasized locally available materials and minimal external inputs. Others, such as India's solar irrigation systems, required more significant initial investment but aimed for long-term sustainability.

Scale of Implementation

The scale at which technologies were tested varied considerably, which is tightly linked to their degree of maturity. Zimbabwe's mother-baby trial system allowed for both controlled testing and broader community implementation. Kenya developed technologies suitable for small-scale application by individual farmers, while Tunisia's approaches went from relatively large-scale demonstration plots to single researcher-controlled and replicated trial. They often considered broader landscape and value chain integration.

This analysis of technology selection patterns reveals how countries balanced common agroecological principles with local contexts and constraints. While core themes emerged across countries, the specific implementation approaches demonstrated considerable adaptation to local conditions, resources, and priorities. This suggests that successful agroecological innovation requires flexibility in technology selection while maintaining focus on fundamental principles of sustainability and local appropriateness.

Number of technologies, number of farmers

Total Technologies Tested

Across the 8 countries for which data was available (see Table 1), approximately 30+ distinct technologies were tested, though some technologies had multiple variants or were implemented in different ways across locations. The distribution was as follows (countries in alphabetical order):

- **Burkina Faso** tested 4 integrated technologies: dynamic forage production, co-product management systems, dairy production units, and covered manure pits. These reached varying numbers of farmers, with 65 farmers implementing fodder demonstration plots and 47 establishing manure pits.
- **India** implemented 5 technologies: agroecological homestead models, microsite improvement (Krishikund), solar irrigation systems, integrated farming systems, and homeopathic sprays in paddy cultivation. The number of participating farmers varied by technology, ranging from 5 to 27 farmers per intervention.
- **Kenya** tested 6 distinct technologies across its two ALLs: compost manure application, mulching systems, plant-based biopesticides (chili), farmyard manure application, terraces with planted edges, and plant-based biopesticides (neem). In the first cycle, 63 farmers established 73 trials.
- **Laos** tested solar pumping, rice-fish integration and improvement of red rice production. They also engaged in water management, even though this is not a technology per se.
- **Peru** tested 3 variants of organic-compatible technologies for cacao production, implementing trials with 13 farmers across different locations.
- **Senegal** tested 3 technologies involving legume mixtures with or without organic inputs, farm-level scenario modeling (which is not a technology per se) and regeneration of salty soils
- **Tunisia** implemented 6 technologies: forage intercrops, biofertilization with Rhizobium, green fertility management, biochar soil amendments, olive mill waste valorization, and agroforestry integration. The scale of implementation varied by technology, with some reaching 74 farmers (forage intercrops) while others were tested with smaller groups (down to one farmer for the biochar experiment).
- **Zimbabwe** implemented 5 core technologies: push-pull systems, conservation agriculture with live mulch, conservation agriculture with dead mulch, traditional practices, and biochar applications. These reached approximately 83 farmers through the mother-baby trial system.

Total Farmer Participation

In aggregate, the documented trials directly involved approximately **300-350 farmers** across the 6 countries and technologies for which information was available, though the exact number is difficult to determine precisely as some farmers participated in multiple trials and some reports did not specify exact numbers for all technologies.

The scale of farmer participation varied significantly across technologies and countries, ranging from trials with small number of farmers involved (3-5 farmers for some specialized technologies) to broader implementations reaching 70+ farmers for more widely applicable practices (akin to "demonstration plots" rather than "experiments").

This analysis highlights the variation in the scale of technology testing as a result of both the technology itself and its maturity (and hence its trajectory prior to the testing within the framework of the AEI) as well as the approaches selected by the various country teams, which also link with their prior experience

Key Problems addressed by the tested technologies

As shown in Table 1, the tested technologies across countries addressed several key agricultural challenges, among which the most common include the following.

Soil Degradation and Fertility Management

Soil-related challenges emerged as a primary concern across multiple countries.

For example, in Zimbabwe, technologies targeted reduced soil fertility and erratic rainfall through conservation agriculture approaches. Tunisia's biochar applications addressed soil degradation in semi-arid environments, particularly focusing on water retention and nutrient availability. India's microsite improvement technology specifically targeted the restoration of degraded land, demonstrating how different regions approached similar fundamental soil challenges through context-appropriate solutions. Kenya’s compost and farmyard manure treatments focused on soil health, while mulching and terraces focused on water retention.

Pest and Disease Management

Plant health challenges represented another significant focus area.

For example, Peru's technologies specifically addressed the loss of cacao due to moniliasis disease, which could affect up to 80% of production. Zimbabwe implemented push-pull technology to combat increased pest pressure, particularly from fall armyworm. Kenya developed plant-based biopesticide applications to address pest management needs while reducing chemical inputs.

Resource Use Efficiency

Many technologies targeted challenges related to resource availability and efficiency.

For example, India's solar irrigation systems addressed poor crop production linked to inadequate water access while simultaneously tackling the problem of fossil fuel dependence. Burkina Faso's technologies focused on improving the efficiency of crop-livestock integration, particularly addressing dry season forage deficits and high forage seed prices.

Production System Integration

Several technologies addressed challenges related to agricultural system integration.

For example, India addressed multiple dimensions through its Agroecology Homestead model. Tunisia's olive mill waste valorization technology tackled both waste management and soil fertility challenges simultaneously. Burkina Faso's approaches addressed poor management of farm co-products, demonstrating how technologies often targeted multiple related challenges within production systems.

Economic Viability

Economic issues and challenges frequently motivated technology testing, even though they often tended to be addressed simultaneously with environmental challenges.

For example, Peru's organic management systems addressed both production constraints and market access requirements. India's integrated farming system models targeted the need to enhance nutrition, soil health, and income simultaneously. These approaches demonstrated how technologies often needed to address both to be viable.

Climate Resilience

Climate-related challenges appeared consistently across countries.

For example, Zimbabwe's conservation agriculture technologies specifically addressed erratic rainfall. Tunisia's technologies targeted climate change impacts in semi-arid environments, particularly focusing on increasing temperatures and decreasing rainfall patterns. Kenya’s mulching and terraces focused on soil moisture retention, and broader water management.

Overall, the selected technologies often addressed multiple interconnected challenges simultaneously, reflecting the complex nature of agricultural production and improvement needs. The diversity of problems addressed also demonstrates the versatility of agroecological principles in responding to various agricultural challenges while maintaining focus on sustainable solutions. Understanding these patterns in problem-solving approaches can inform future efforts to develop more integrated, comprehensive and effective agricultural innovations that address both immediate challenges and longer-term sustainability goals.

1.4 Key features of the technologies tested across the AEI countries

Table 1. Key features of the technologies selected for testing as part of the codesign in agroecological technologies across AEI countries

Country	*Trial #*	*Specific technology being tested*	*Concrete Problem it is addressing*	*Cycles of testing*	*Domain*	*Underlying agroecology principle(s)*	*Origin*
Zimbabwe	1	Push-pull	Increased pest pressure (fall armyworm)	2022/2023 y 2023/2024	IPM	Input reduction, biodiversity, soil health, animal health	Previous research
Zimbabwe	2	CA (Live mulch)	Low livestock feed quality, low availability of biomass for mulch	2022/2023 y 2023/2025	Water management, productivity, livestock production	Synergy, animal health	Farmer innovation
Zimbabwe	3	CA (dead mulch)	Reduced soil fertility, rainfall variability	2022/2023 y 2023/2026	Water management, productivity	Soil health	Previous research
Zimbabwe	4	Traditional	High input (seed and pesticide) cost	2022/2023 y 2023/2027	IPM, productivity	Social values and diets	Farmer innovation
Zimbabwe	5	Biochar	High fertilizer cost	2022/2023 y 2023/2028	Soil fertility/amendments	Input reduction	Previous research
Kenya	6	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
Kenya	7	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 2025	Water management/ conservation agriculture	Recycling, input reduction, soil health, synergy	Co-design
Kenya	8	Plant-based biopesticide (chili) on cabbage	Pests and diseases	(1) Oct 2023- March/April 2024, (2) May 2024- Aug/Sept 2026	IPM	Recycling, input reduction, soil health, synergy	Co-design
Kenya	9	Farmyard (animal) manure on maize-bean intercrop	Depleted soils	(1) Oct 2023- March/April 2024, (2) May 2024- Aug/Sept 2027	Soil health management	Recycling, input reduction, soil health, synergy	Co-design
Kenya	10	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 2028	Water management/ conservation agriculture	Recycling, input reduction, soil health, synergy	Co-design
Kenya	11	Plant-based biopesticide (neem) on maize-bean intercrop	Pests and diseases	(1) Oct 2023- March/April 2024, (2) May 2024- Aug/Sept 2029	IPM	Recycling, input reduction, soil health, synergy	Co-design
Burkina Faso	12	Dynamic forage and seed production	Dry season forage deficit and high forage seed prices	June to November 2023	Forage production	Biodiversity, Participation, Co-creation of knowledge and Reduction of inputs	Research technology tested by the project team
Burkina Faso	13	Co-product management tool (*CoProdScope)*	Poor management of farm co-products	Review: June to May 2023 (year N); Board: June 2023 to May 2024 (year N+1).	Recycling farm co-products	Recycling, reducing inputs	Previous research?
Burkina Faso	14	Setting up dairy production units using the *Jabnde* tool	Lack of rationing skills among dairy farmers; Low cow productivity	December 2023 to April 2024	Animal feed; Milk production	Participation, knowledge co-creation and input reduction	Previous research?
Burkina Faso	15	Production of high-quality manure using covered manure pits	Soil poverty	December 2023 to June 2024	Soil fertility	Soil health	Research technology tested by the project team
Tunisia	16	Forage intercrop	Furnishing a quality forage crop as an advantageous alternative to oaten hay.	2022-2023 and 2023-2024.	Forage crops, quality intercrop forage, animal nutrition, rotation enhancement	Recycling, Synergies, Biodiversity, Economic diversification, Co-creation of knowledge - Fairness,	Previous R&D interventions (CANA, CLCA I and II)

Country	*Trial #*	*Specific technology being tested*	*Concrete Problem it is addressing*	*Cycles of testing*	*Domain*	*Underlying agroecology principle(s)*	*Origin*
						Land and natural resource governance	
Tunisia	17	Biofertilization with Rhizobium	Degradation of soil fertility and excessive dependence on chemical inputs, leading to declining crop yields, increased vulnerability to climate change, and negative impacts on the environment.	2023-2024	Soil fertility	Recycling, Input reduction, Soil health, Biodiversity, Co-creation of Knowledge	Researcher's technology
Tunisia	18	Using VOT forage mixtures to prepare sheep for mating and improve fertility and prolificacy	In semi-arid conditions, reproduction is affected by unfavourable conditions for sheep mating, inducing excessive use of supplementary feed.	Spring – Autumn of 2024	Crop-livestock integration	Recycling, Input reduction, Economic diversification, Animal health, Biodiversity, Synergies, Co-creation of knowledge	Previous R&D interventions through joint INRAT-OEP-ICARDA collaboration
Tunisia	19	Biochar as soil	High dependence on chemical fertilizers, Climate change and increasing temperatures/ decreasing rainfall, Low yields (depending on rainfall)	2023-2024	Soil fertility	Recycling, Input reduction, Soil Health, Economic diversification, Co-creation of knowledge	newly codesigned ones during the codesign process followed for the initiative
Tunisia	20	Agronomic valorization of olive pomace (Amendment of an olive-growing soil)	1. Limited farmer adoption due to insufficient knowledge and concerns about potential impacts on soil quality and crops., 2. Technical, economic, and logistical challenges hinder the efficient transport of olive pomace.	2023-2024	Soil fertility, Climate change mitigation, environmental impact	Recycling, Input reduction, Soil health, Co-creation of knowledge	The agricultural scientific research (a researcher's technology)
Tunisia	21	Agroforestry (Integration of intercropping in olive groves)	Soil degradation and climate vulnerability, - Low and undiversified income, - Loss of biodiversity	2023-2024 and 2024-2025.	Sustainable agriculture: agricultural practices adapted to marginal areas, Soil management and conservation of natural resources, Climate resilience, Income diversification, Interaction between biodiversity and agricultural productivity	Input reduction, Soil health, Animal welfare, Biodiversity, Synergies, Economic diversification, Co-creation of knowledge	Agricultural scientific research (a researcher's technology)
India MP	22	Agroecology Homestead Model	Enhancing nutrition, soil health and income of tribal farmers	Monsoon 2024	Systemic, (Soil fertility, Water management, Livestock management, IPM)	Recycling, Input reduction, soil health, animal health, Economic diversification, Synergy, social values and diets, land and natural resource governance	co-design process for improving existing technology
India MP	23	Microsite (*Krishikund*) for restoration of degraded land	Restoring degraded land	2024	Soil fertility, water management	Efficiency, Recycling, Soil health, land and natural resource governance, Synergy, economic diversification, Input reduction	co-design process
India MP	24	Solar irrigation-based crop diversification	Poor crop production, mono cropping, use of fossil fuel	2024 (on-going)	Water Management, Mechanization, -use of green energy, diversity, income	Economic diversification, Synergy,	Previous technology with new social dimension (women water user groups)
India MP	25	Integrated Farming System Model	Enhancing nutrition, soil health and income.	Monsoon 2024	Systemic- Soil fertility, Water management, Livestock management	Recycling, Input reduction, soil health, animal health, Economic diversification, Synergy, social	Existing research Technology adapted

Country	***Trial #***	***Specific technology being tested***	***Concrete Problem it is addressing***	***Cycles of testing***	***Domain***	***Underlying agroecology principle(s)***	***Origin***
						values and diets, land and natural resource governance	locally through co-design process.
India MP	26	Homeopath spray in Paddy cultivation	Poor productivity, insect pest damage	sept-24	IPM, Plant health, productivity	Input reduction per unit of output, productivity enhancement, Synergy	(unclear?)
India AP	27	Integrated Rice-fish cultivation	Poor nutrition and income	Since 2023- ongoing	Dietary and nutrition, water management, income	Recycling, soil health, Social value and Diets, economic diversification	Existing technology from other regions of India
Peru	28	Frequencies of application for a mixture of bio-inputs aimed at disease control	Loss of cacao fruits due to moniliasis	November 2023 – October 2024	IPM	Recycling, Input reduction, Soil health, Knowledge co-creation	previous tests by farmers coop
Peru	29	Frequencies of bio-fertilizers spray applications	Low nutrition of plants	January – October 2024	IPM	Recycling, Input reduction, Soil health, Knowledge co-creation	Previous tests by farmers coop + Farmers empirical experience
Peru	30	Types of different bio-inputs aimed at disease control	Loss of cacao fruits due to moniliasis	January - October 2024	IPM	Recycling, Input reduction, Soil health, Knowledge co-creation	Previous tests by farmers coop + Farmers empirical experience
Laos	31	Solar Pumping of Groundwater	water scarcity during dry season, high energy and input costs	2023-2024	Renewable energy, water management, dry season crops / productivity	Input reduction, economic diversification	Codesign
Laos	32	Rice-Fish System	low productivity, soil fertility decline, poor human nutrition	2024 -on-going	Integration crop-animal, resource efficiency, production, nutrition, soil fertility	Economic diversity, input reduction, biodiversity, diets	Co-design
Laos	33	Organic Red Rice Growing	low productivity, soil fertility decline, poor human nutrition, lack of diet diversity, limited access to lucrative markets	2023-2024	Productivity, soil health	Economic diversity, input reduction, diets	Co-design
Laos	34	Wetlands Management	Low sustainability of wetland systems, low participation	n.a.	Natural resource management	(Participation)	Not applicable
Senegal	35	Peanut-cowpea intercropping	Low soil fertility	?	Soil Fertility, crop rotations	diversification, biodiversity, soil health, participation	Codesign
Senegal	36	farm-scale scenario codesign & modelling	improve decision-making and innovation capacities of farmers	?	Systemic	Synergies, participation	Research
Senegal	37	Recovery of salty soils	Salinization, soil degradation	?	Soil fertility	recycling, participation	?

Table 2. Key features of the protocols of the experiments established as part of the codesign in agroecological technologies across 6 AEI countries (Senegal and Laos without information)

Country	Trial #	Short Name of trial	# of farmers with this trial	# of treatments per farmer	# Reps per farmer
Zimbabwe	1	Integrated pest management Mother trial	20	2	1
Zimbabwe	2	Conservation Agriculture mother trial	20	2	1
Zimbabwe	3	Soil fertility Mother trial	20	1	1
Zimbabwe	4	Integrated pest management baby trial	59	2	1
Zimbabwe	5	Conservation Agriculture baby trial	47	2	1
Kenya	6	Compost	12 (cycle 1), 19 (cycle 2)	1 or 2	1
Kenya	7	Mulch	12 (cycle 1), 19 (cycle 2)	1 or 2	1
Kenya	8	IPM (chili)	12 (cycle 1), 19 (cycle 2)	1 or 2	1
Kenya	9	FYM	13	1 or 2	1
Kenya	10	Terraces	10	1	1
Kenya	11	IPM (neem)	14	1 or 2	1
Burkina Faso	12	Forage and seed demo-plots	65	1	1
Burkina Faso	13	Assessment and advice on valorization of farm co-products with CoProdScope tool	10	1	1
Burkina Faso	14	Rationing dairy cows with Jabnde tool	20	1	1
Burkina Faso	15	Covered manure pits	47	1	1
Tunisia	16	Forage intercrops	74	1	1
Tunisia	17	Biofertilization with Rhizobium	30	3	1
Tunisia	18	Green Fertility	El Marja/Sers 11, El Abar/Sers 10, Rhahla 9	2	1
Tunisia	19	Activated biochar	1	7	3
Tunisia	20	Olive Mill Wastewater agricultural valorization	1	1	3
Tunisia	21	Agroforestry (Integration of intercropping in olive groves)	4	1	1
India MP	22	Agroecology Homestead Model	20	1	1
India MP	23	Microsite (*Krishi Kund*) for restoration of degraded land	16	4 (1)	Variable
India MP	24	Solar irrigation-based crop diversification	2 groups, 27 farmers total	1	1
India MP	25	Integrated Farming System Model	15 (10 new)	3	1
India MP	26	Homeopath spray in Paddy cultivation	10	1	2
India AP	27	Integrated Rice-fish cultivation	22	1	1
Peru	28	Aromatic - Moniliasis	4	4	2
Peru	29	CCN51 - Biol	5	4	2
Peru	30	CCN51 - Moniliasis	4	4	2

Table 3. Monitoring and Evaluation of experiments established as part of the codesign in agroecological technologies across AEI countries (Zimbabwe, Senegal and Laos sin information)

Country	*Trial #*	*Short Name of trial*	*Key agronomic variables monitored or collected*	*Key socioeconomic variables monitored or collected*	*Field days or exchange visits held (# if available)*	*Farmers involved in M&E?*
Kenya	**6**	Compost	Number of leaves, number of spoilt leaves, leaf color, vegetable yield	Costs (inputs, labor, transport, value addition), cash income from sales	Intra- and inter-ALL, INALL exchange; bi-weekly visits by ALL host center staff	Yes
Kenya	**7**	Mulch	Number of leaves, number of spoilt leaves, leaf color, vegetable yield			
Kenya	**8**	IPM (chili)	Pest infestation, leaf damage, other pests, head famage, leaf color, weight, head size			
Kenya	**9**	FYM	Pest infestation, leaf damage, grain damage, leaf color, plant height, pod length and size, number of pods, yield, stover yield, crop health			
Kenya	**10**	Terraces				
Kenya	**11**	IPM (neem)				
Tunisia	**12**	Forage intercrops	Forage yield, Final proportion of vetch and weeds, Competition index, Microbial activity of soils upon forage harvest	Production costs	37*	Yes
Tunisia	**13**	Biofertilization with Rhizobium	Plant emergence density, Vegetation cover density, Dry matter yield, Plant Nitrogen content, Soil chemical properties, total bacterial content	None	6	Yes
Tunisia	**14**	Green fertility	Forage and fallow yield (Initial and final), Nutritional value of grazed feed (Initial and final), Ewe body condition score (Initial and final), blood biochemistry parameters (BHB1 and NEFA2, Initial and final), Conception rate (Ultrasound pregnancy diagnosis), Lambing rate and date, Litter size	Workload	18	Yes
Tunisia	**15**	Activated biochar	Soil properties (chemical, physical), Soil Enzymatic activities, grain yield, spikes number /m², Nutrient use efficiency	Total revenue (grain and spikes), costs of inputs	16	Yes
Tunisia	**16**	Olive Mill Wastewater valorization	Soil quality, Nutritional status of the olive tree, yield parameters	Farmers' income, (formation of olive mill wastewater cooperatives)	15	Yes
Tunisia	**17**	Agroforestry (Integration of intercropping in olive groves)	Soil quality, nutritional status of the olive tree, yield parameters, yields	Economic variables (Implementation cost, income, opportunity cost, profitability), Social variables (Adoption and acceptability, Community engagement, Benefit distribution)	10	Yes
Burkina Faso	**18**	Forage and seed demo-plots	Technical itinerary, biomass yield, grain yield	Workload, expenses	5	Yes
Burkina Faso	**19**	Assessment and advice on valorization of farm co-products with CoProdScope tool	Quantity of livestock and crop co-products produced and purchased	---	2	Yes
Burkina Faso	**20**	Rationing dairy cows with Jabnde tool	Quantity of each diet ingredient distributed per day and daily milk production	Cost of milk production and sales	18	Yes
Burkina Faso	**21**	Covered manure pits	Quantity of livestock and crop co-products used for filling	Cost of setting up and running the pit and workload	7	Yes
India MP	**22**	Agroecology Homestead Model	Crop Yield, nutrient and pest management, Plant establishment and growth, insect load, pollinator diversity, soil moisture	Input cost, Gender equity, Market access	2	Partially
India MP	**23**	Microsite (*Krishikund*) for restoration of degraded land	Crop Yield, nutrient and pest management Plant establishment and growth, Soil moisture	Input cost, selling price, labor use	3	Partially

Country	***Trial #***	***Short Name of trial***	***Key agronomic variables monitored or collected***	***Key socioeconomic variables monitored or collected***	***Field days or exchange visits held (# if available)***	***Farmers involved in M&E?***
India MP	**24**	Solar irrigation-based crop diversification	Crop yield, acreage covered, pumping hours.	Production cost, Community participation, Gender equity, Pump running hours, charges collected	4	partially
India MP	**25**	Integrated Farming System Model	Yield/harvest from each component	Input cost, gross income, Dietary diversity,	3	Partially
India MP	**26**	Homeopath spray in Paddy cultivation	Crop yield, Insect and pest damage, Duration of greenness, Insect damage	Farm income, production cost, land holding	1	fully
India AP	**27**	Integrated Rice-fish cultivation	Rice yield, Fish yield, water quality, soil quality, fish quality	Farm income, dietary changes	2	fully
Peru	**28**	Aromatic - Moniliasis	% of healthy and diseased mature pods per tree, Incidence of moniliasis, External severity due to moniliasis, Cacao yield	Inputs and labor costs, labor use	13	Yes (3 out of 4)
Peru	**29**	CCN51 - Biol	% of healthy and diseased mature pods per tree, Cacao yield		12	Yes (3 out of 5)
Peru	**30**	CCN51 - Moniliasis	% of healthy and diseased mature pods per tree, Incidence of moniliasis, External severity due to moniliasis, Cacao yield		13	Yes (3 out of 4)

Agroecological principles represented in the technologies selected

Based on Table 1, several agroecological principles appear consistently across the selected technologies, though their representation varies in frequency and implementation approach.

Recycling and Input Reduction

The most frequently cited principle across countries was recycling, often paired with input reduction. This emerged particularly strongly in soil fertility management technologies. Zimbabwe's conservation agriculture approaches emphasized recycling of residue for soil improvement. Burkina Faso through its use of a co-product management toll, or Tunisia's olive waste management system directly addressed recycling of agricultural by-products. Kenya's composting and manure management systems similarly focused on recycling organic materials while reducing external input dependencies.

Soil Health

Soil health appeared as another dominant principle, referenced explicitly in many technologies. This principle manifested through various approaches, from Zimbabwe's mulching systems to Tunisia's biochar applications. The emphasis on soil health was often integrated with recycling principles, demonstrating how selected technologies often addressed multiple agroecological objectives simultaneously.

Biodiversity and Synergy

Biodiversity enhancement and synergistic relationships featured prominently, particularly in more integrated technological approaches. Zimbabwe's push-pull technology exemplified this by combining pest management with soil improvement and fodder production. India's homestead models explicitly incorporated biodiversity through integrated farming approaches. Kenya's terracing systems with planted edges demonstrated how technologies could create synergies between soil conservation and productive functions.

Economic Diversification

Economic diversification emerged as a significant principle, particularly in technologies designed to enhance farm resilience. India's solar irrigation systems linked technological innovation with income generation opportunities. Peru's organic cacao management system connected ecological principles with market opportunities (in this case, certified organic ones). This principle often appeared alongside others, suggesting its role in making agroecological innovations economically viable.

Knowledge Co-creation

The principle of knowledge co-creation, inherent to the codesign approach, appeared frequently in the country reports. This was evident in how countries integrated traditional / local knowledge with scientific approaches, particularly in India's homestead models, Kenya, Zimbabwe and Peru's disease management systems. The principle influenced not just the technologies selected but the processes through which they were developed and adapted.

Less Frequently Represented Principles

Some agroecological principles appeared less frequently in the explicit description of selected technologies. **Animal health and welfare**, while present in some systems like Burkina Faso's dairy innovations, received less direct attention. **Social values and diet-related principles**, while implicit in some approaches, were not as prominently featured in the technical descriptions, with the exception of Laos.

This analysis of principle representation reveals how countries tended to prioritize certain foundational agroecological concepts while perhaps giving less explicit attention to others. The emphasis on recycling, soil health, and biodiversity suggests these principles may offer particularly practical entry points for agroecological innovation. The consistent appearance of economic diversification alongside ecological principles demonstrates recognition of the need to balance environmental and economic objectives in agricultural development.

Understanding these patterns in principle representation could inform future efforts to develop more comprehensive agroecological interventions that might address a broader range of principles while maintaining practical feasibility in local contexts.

Origin of the technologies tested

Table 1 reveals several key categories of technological origin, with many technologies building on previous research while others emerged through various development pathways.

Research-Based Technologies

A significant proportion of the tested technologies originated from previous research and development interventions. In Tunisia, several technologies, including forage mixtures and crop integration practices, emerged from earlier research projects such as CANA and CLCA. In Zimbabwe, conservation agriculture and push-pull technology similarly built upon established research findings, demonstrating how existing scientific work informed technology selection.

Farmer Innovations

Some technologies originated directly from farmer innovations and traditional practices. Several technologies related to pest and disease management fall in this category, be it in Kenya, Zimbabwe or to a lesser degree Peru. This recognition of farmer-originated technologies highlights the value of traditional / local knowledge in contributing to codesign.

Co-Designed technologies

Several technologies emerged specifically through the codesign process itself. India's homestead model or microsite improvement technique (Krishikund), various of the technologies tested in Kenya represent clear examples of co-designed technology developed or at least adapted from existing ones through participatory engagement. These technologies often combined elements of existing practice with scientific insights, creating hybrid approaches suited to local conditions.

Adapted Technologies

Many technologies represented adaptations of existing practices. Peru's organic disease management systems, for instance, built upon established organic farming practices while incorporating specific local modifications. These adaptations often involved customizing known technologies to address particular regional challenges or resource constraints.

Research-Practice Integration

Some technologies emerged through deliberate integration of research findings with practical farming experience. Burkina Faso's dairy management systems exemplified this approach, combining scientific understanding of animal nutrition with practical knowledge of local farming systems. This integration produced technologies that balanced scientific rigor with practical applicability.

The analysis of technology origins reveals that successful agroecological innovations often involve combining multiple sources of knowledge and experience. Rather than relying solely on any single origin, the most effective approaches typically drew upon both formal research and practical experience, creating integrated solutions that addressed local needs while ensuring scientific soundness. This carries important implications for future transition efforts. It suggests that effective innovation requires maintaining openness to multiple sources of knowledge while creating frameworks that can effectively integrate these different origins into coherent technological solutions.

A closer look at experimental protocols

Number of treatments and replications that each farmer established in the various experiments

Se Table 2

Zimbabwe tended to use simple treatment structures, with farmers implementing 1-2 treatments each in both mother and baby trials. The mother trials had 20 farmers per trial testing 1-2 treatments each, while baby trials had 47-59 farmers implementing 1-2 treatments each.

Kenya also maintained a straightforward approach with 1-2 treatments per farmer across all six trials. Their trials involved 10-14 farmers in Makueni and 12-19 farmers in Kiambu, each implementing either one or two treatments.

Tunisia showed more variation. While most trials had farmers implementing just 1 treatment each, the biochar trial stood out with 7 treatments implemented by a single farmer. The forage intercrop trial had 74 farmers selecting one treatment out of 4 possible options.

Burkina Faso maintained consistency with just 1 treatment per farmer across all four types of trials, though the number of participating farmers varied significantly from 10 to 65.

India's treatment structure was relatively simple, with most trials involving 1-3 treatments per farmer. The Microsite (Krishikund) trial was notable for having 4 treatments per farmer.

Peru implemented a uniform design across their three trials, with all participating farmers (4-5 per trial) implementing 4 treatments each, with 2 replications per treatment.

In summary, most countries favored simple treatment structures with 1-2 treatments per farmer and a single replication, likely to ensure manageable experimental conditions for participating farmers. Tunisia's biochar trial and Peru's trials stand *out for implementing more treatments and 2-3 replications per farmer. Such more complex protocols allowed closer monitoring and more controlled conditions.*

Number of sites or villages where the various experiments were established

In Zimbabwe, the experiments were concentrated in two main districts - Mbire and Murehwa but the specific number of villages in each district / ALL is not explicitly stated.

In Kenya, trials were established in two main sites: Ndeiya ward in Limuru sub-county (Kiambu County) and Mbumbuni market in Mbooni East sub-county (Makueni County).

Tunisia's experiments were distributed across multiple governorates and sites. The trials were established in Siliana (including locations like Chouarnia and Rhahla), Le Kef (including Sers and Elles), and specific sites like Hammam Biadha. The forage intercrop trial alone was implemented across three main regions.

In Burkina Faso, the experiments were spread across nine villages including Dafinso, Yégueresso, Kouakoualé, Bobo-Dioulasso, Satiri, Belle-ville, Farakoba, Bama, and Bana.

India's experiments were distributed across multiple villages in different regions. The Agroecology Homestead Model was implemented in 4 villages, the Microsite (Krishikund) trial in 12 villages, solar irrigation in 2 villages, Integrated Farming System Model in 5 villages, homeopath spray trial in 2 villages, and the rice-fish cultivation in 3 villages in Andhra Pradesh.

Peru's experiments were more geographically concentrated, being established in specific areas of Ucayali, including Neshuya, Campo Verde, Huipoca, A. Von Humboldt, and Curimaná.

The differences in geographic distribution reflect different approaches to experimental design, with some countries opting for concentrated implementation in fewer sites, probably for easier monitoring, while others chose broader distribution to capture diverse agroecological conditions. The variation in site numbers also appears to be influenced by the nature of the experiments, local agricultural contexts, and logistical considerations.

Data and information most frequently collected across experiments

Table 3 shows that there were clear patterns in data collection across experiments, with certain types of measurements appearing consistently while others were more context specific.

Agronomic Performance Metrics

Unsurprisingly, **yield measurements** emerged as the most universally collected data point across experiments. Countries consistently tracked crop yields, though the specific parameters varied by context. Zimbabwe measured both grain and biomass yields, while Peru tracked healthy versus diseased pod counts in cacao production. Kenya collected detailed yields for different crop types (from horticultural to cereals).

Plant health indicators represented another frequently collected dataset. Disease incidence and severity were commonly monitored, with particular attention to specific local challenges. Peru implemented detailed monitoring of moniliasis in cacao, while Zimbabwe tracked fall armyworm and other pest pressures. These measurements often included both qualitative assessments and quantitative scoring systems.

Soil-related measurements appeared frequently, especially in countries with experiments focused on soil health improvement. These included various physical and chemical soil properties, though the specific parameters varied by country and technology type.

Resource use efficiency metrics were used more sparingly, usually for water and input use. Kenya tracked water use efficiency in their trials, while Zimbabwe monitored input use efficiency across different technological packages.

Interestingly, few countries seem to have paid detailed attention to the monitoring of overall production practices by farmers such as planting dates and densities, germplasm, weed control, even though these often have a strong influence on productivity.

Economic Variables

Production costs appeared consistently in monitoring protocols across countries. This typically included tracking input costs, labor requirements, and associated operational expenses. Labor use emerged as a particularly common measurement, with several countries tracking both the quantity and distribution of labor across different activities.

Income and revenue data were fairly frequently collected, though the *specific metrics* varied. Some countries tracked gross income, while others monitored net returns or profit margins. Kenya specifically tracked income from sales and value addition opportunities, demonstrating attention to market integration.

Participation and use / adoption

Participation and adoption / use metrics were commonly collected across countries. Countries tracked farmer engagement levels, technology use and adoption rates, and modifications made to recommended practices. Zimbabwe's mother-baby trial system specifically monitored how farmers adapted and implemented technologies in their own fields.

Social and Behavioral Data

While less standardized than technical measurements, many countries collected data on farmer perceptions and preferences. This often-included structured feedback on technology performance and implementation challenges. Kenya specifically tracked gender-related aspects of technology adoption and use.

This analysis reveals how countries did their best within their particular context and resource constraints to balance the need for rigorous technical and for simultaneous farmer assessments while also considering practical considerations. The focus on selected core agronomic and economic measurements (yields, costs) confirms their fundamental importance in evaluating technologies.

However, the lack of, or rarity of other key measurements (e.g. production practices) suggest there is room for improvement of the M&E protocols, which will become all the more necessary as country teams increasingly focus on systemic innovations at the farm or even territorial scale, which address several dimensions and objectives at the same time.

1.5 Main challenges and key lessons related to the codesign process,

Based on experiences reported by the various countries, the codesign processes implemented across countries encountered several significant challenges while also generating valuable lessons.

Key challenges

Participation and Representation

The countries faced difficulties maintaining consistent stakeholder engagement throughout the process. In Zimbabwe, inconsistent representation at meetings and activities posed challenges for continuity. Peru reported that some farmers could not fully participate in monitoring activities due to competing demands on their time, such as managing other agricultural plots or engaging in alternative income-generating activities.

Technical Implementation

Countries encountered various technical challenges in implementing their codesign and experimental activities. Zimbabwe experienced issues with communication barriers that affected the coordination of activities. In Peru, the accurate assessment of disease symptoms in cacao required careful training and standardization of observation methods. Kenya faced challenges in adapting practices to diverse local conditions across different agroecological zones.

Resource Constraints

Resource limitations affected implementation in several countries. Tunisia reported challenges related to the cost and logistics of transporting organic materials for soil amendments. In some cases, farmers faced difficulties acquiring necessary inputs or implementing labor-intensive practices without additional support.

Data Collection and Monitoring

Maintaining consistent and accurate data collection proved challenging across multiple countries. Peru noted that some farmers preferred recording data in their own notebooks rather than using standardized forms, creating potential inconsistencies in data collection. The complexity of monitoring multiple parameters while ensuring data quality required significant coordination effort.

Key Lessons Learned

Importance of flexible Design

The experience demonstrated the value of maintaining flexibility in implementation while preserving scientific rigor. Successful countries allowed for adaptation to local conditions and farmer preferences while maintaining core experimental principles. This flexibility proved essential for sustaining farmer engagement and ensuring practical relevance of the innovations.

Value of iterative Implementation

The multi-cycle approach adopted by several countries proved valuable for refining both technologies and processes. Zimbabwe's progression from basic trials to more sophisticated mother-baby arrangements demonstrated how iterative implementation allows for valuable learning and adaptation. Each cycle provided opportunities to incorporate lessons and improve outcomes.

Critical Role of Local Knowledge

Countries found that effectively integrating local knowledge with scientific expertise strengthened outcomes. Zimbabwe's experience showed how farmer insights helped identify feasible solutions and adapt technologies to local conditions. This integration of knowledge systems proved essential for developing practical, sustainable innovations.

Importance of Strong Institutional Frameworks

Countries that established clear coordination mechanisms and institutional support structures generally achieved better implementation. Kenya's use of ALL host centers and Zimbabwe's multi-tiered coordination system demonstrated how strong institutional frameworks can support effective stakeholder engagement and program implementation.

Need for Comprehensive Support Systems

Successful implementation required more than just technical support. Countries needed to address various farmer needs, including access to inputs, marketing support, and capacity building. This comprehensive approach helped ensure sustained participation and successful adoption of innovations.

These challenges and lessons suggest several important considerations for future codesign initiatives:

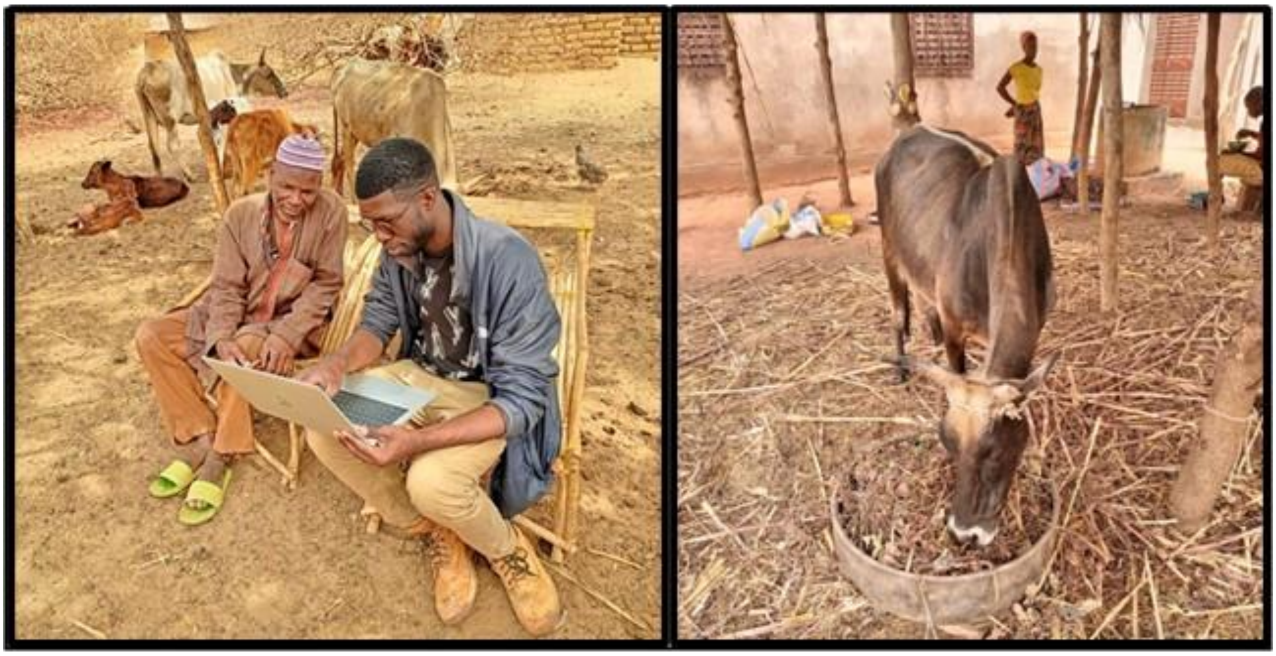
- The need to balance standardization with local adaptation, maintaining scientific rigor while accommodating local conditions and needs.
- The importance of developing robust but practical monitoring systems that can capture necessary data while remaining manageable for farmers and technical staff.
- The value of building strong institutional partnerships and support systems to sustain engagement and ensure effective implementation.
- The benefit of maintaining flexibility in implementation while preserving core scientific principles and objectives.

(Section 4 on "Reflections, recommendations and lessons" presents the detailed recommendations derived from such challenges and lessons)

1.6 A photographic journey illustrating of the codesign process and experiments established across eight countries

Illustrations 1-14 give a glimpse of key moments and places where codesign activities were implemented across countries.

Burkina Faso



Ration co-design session in a dairy production unit

mucuna plot sorghum plot

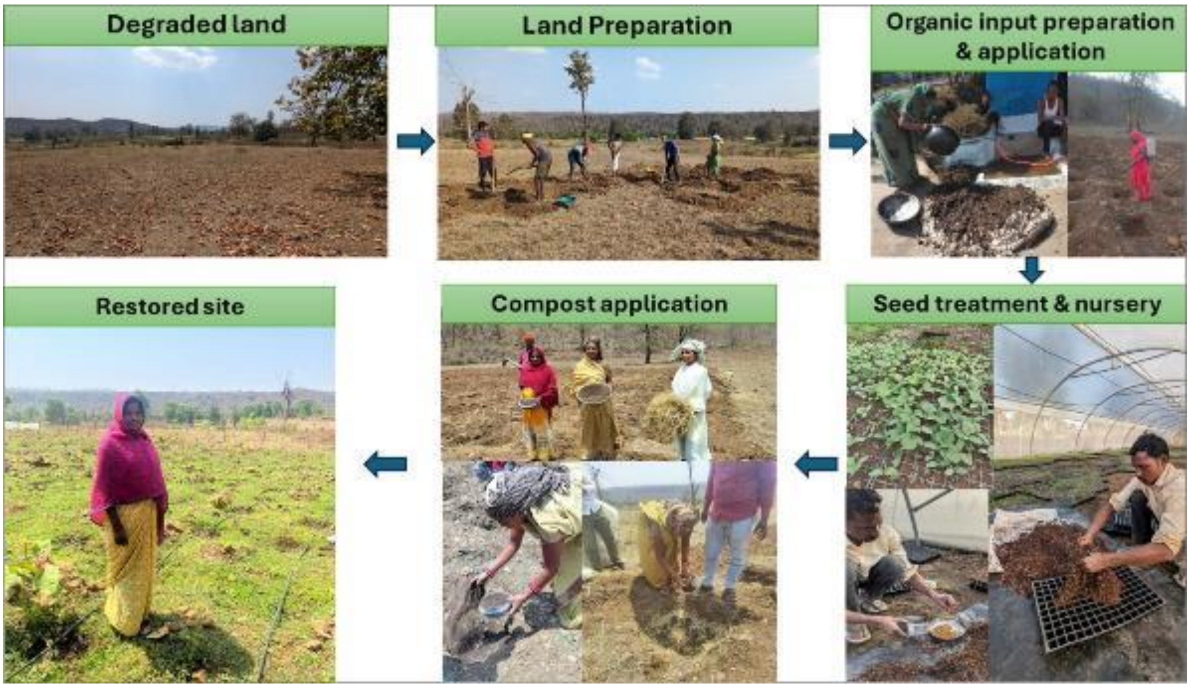
cowpea plot maize plot

Views of four forage crops in the Fodders Demo-Plots

Illustration 1. Various aspects of the codesign process and trials implemented in Burkina Faso.

Agroecology Homestead model in Mandala ALL, India

Solar irrigation system installed at Chimkatola is being tested by members of women Water user group



Steps involved in improving the degraded sites under the microsite improvement

Illustration 2. Various aspects of the codesign process and trials implemented in India.

Kenya


© Hezekiah Korir/IITA

INALL visit with Zimbabwe team and Kiambu youth to DNRC in the Makueni ALL, Kenya


© Lisa E. Fuchs/CIAT

A youthful trial participant from the Kiambu ALL sharing discussion results during the inter-ALL exchange visit and co-design workshop in April 2024, Kenya

Illustration 3. Various aspects of the codesign process and trials implemented in Kenya.

Bokashi production at CSHEP in the Kiambu ALL in Kenya.

Illustration 4. Various aspects of the codesign process and trials implemented in Kenya.


Learning about terraces during technical training, Makueni, August 2023. © B. Adoyo


Learning about mulching during technical training in Kiambu ALL, August 2023. © B. Adoyo.

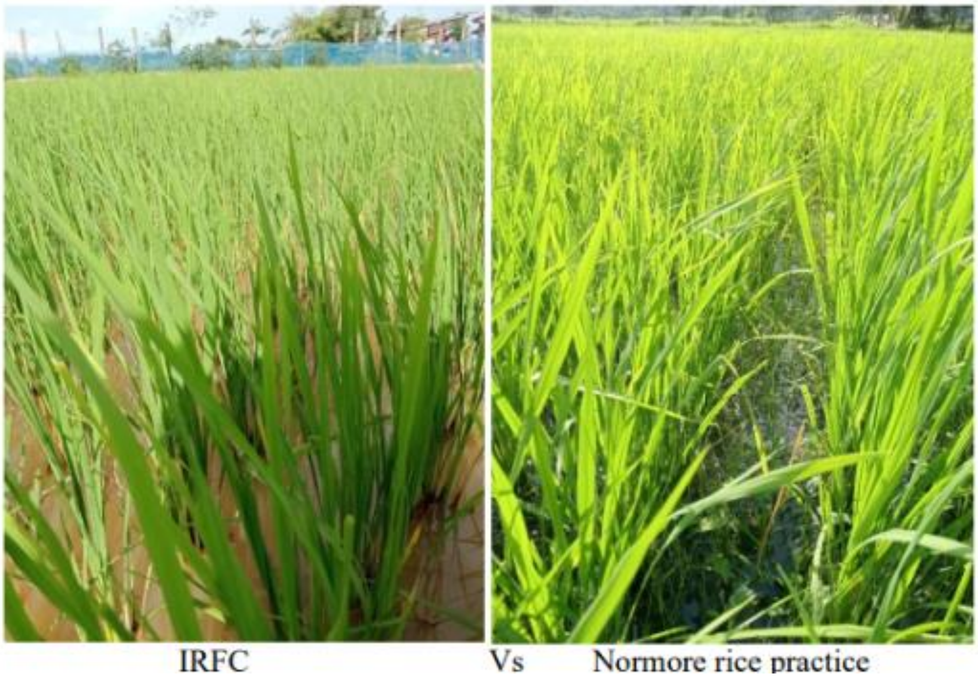

Farmer monitoring the growth of her intercropped beans in her experiment, Makueni, **December 2023.** © H. Korir


Spinach harvest in a farmer mulching test plot, Kiambu, December 2023. © H. Korir

Illustration 5. Various aspects of the codesign process and trials implemented in Kenya.

Laos

Visioning exercises attended by Attapeu ALL stakeholders during the inter-provincial consultation workshop co-hosted by NAFRI, the 1CG team and the Laos Farmers Network in Attapeu region



Differences between rice-fish culture systems and monoculture rice production

Illustration 6. Various aspects of the codesign process and trials implemented in Laos.


Field visit to assess potential site for rice-fish culture.


Codesign workshop on infrastructure for rice-fish culture.

Illustration 7. Various aspects of the codesign process and trials implemented in Laos

Peru

© José Sanchez/CIAT

Workshop at Colpa de Loros cooperative headquarters for socializing results of the main harvest season 2024 and modifying the design of the trials

© José Sanchez/CIAT

Exchange of experiences among technicians, producers, and researchers.

Illustration 8. Various aspects of the codesign process and trials implemented in Peru.

Harvest in an experimental plot for controlling moniliasis using sulfur-lime solutions.
Source: Victor Hugo Gomez/CIAT

Labeling of cacao trees for the evaluation of bioinput application for monilia control.

Illustration 9. Various aspects of the codesign process and trials implemented in Peru.

© Raphael Belmin/CIRAD

Illustration 10. Group work during the workshop on codesign of ideotypes of agroecological cropping systems, held in Ndiop, Senegal, August 2022.


© Raphael Belmin/CIRAD

Visit to an experimental plot in Koussanar, testing cropping association/organic fertilization as part of the Fair Sahel Project.


© Raphael Belmin/CIRAD

An experimental plot combining groundnuts and cowpeas.

Illustration 11. Codesigned experimental work on agroecology implemented in Senegal.

Illustration 12. Various aspects of the codesign process and trials implemented in Tunisia.

Codesign workshop held in June 2023 with different national and ALL stakeholders.

Researchers from the Olive Institute discussing with a farmer the co-experiment/protocol for growing forages between olive trees.

Illustration 13. Various aspects of the codesign process and trials implemented in Tunisia.

Zimbabwe

Zimbabwean ALL farmers in a group discussion as they co-design innovations that they want to continue with in the next season

CIMMYT staff monitoring demos and scouting for pests in a farmer field in Zimbabwe

Farmers understanding more about the push-pull treatment at a field day in Mbire, as they prepare for their rating and ranking session

Mother demo plot holder in her push-pull and sorghum conservation agriculture plot

Illustration 14. Various aspects of the codesign process and trials implemented in Zimbabwe.

2. Agronomic and agroecological assessment of the technologies tested: a brief overview

The information presented in this section is directly extracted from the **synthesis of the agronomic assessment across AEI countries conducted by the WP1 Agronomy team** and synthesized in Monserrate et al. 2024, which itself is based on detailed Individual country reports.

The various technologies selected for testing as part of the codesign process (cf. Table 1 in section 1) can be grouped in 5 categories by type of technologies as shown in Table 4 below.

Table 4. Main technologies tested, by topic, country and commodity

TOPICS	COUNTRIES	COMMODITIES	SPECIFIC TECHNOLOGIES	TRIALED[†]
Crop-livestock integration	Burkina Faso	Livestock (Cattle)	Fodder crops (cereals and legumes) and Manure	Yes[‡]
	Senegal	Groundnut/Millet	Horse manure and Cowpea intercropping	Yes
	Tunisia	Livestock (Sheep)	Fodder crops (Vetch-Oat-Triticale)	Yes
	Kenya	Maize/Bean	Farmyard manure	Yes
	India	Vegetables	Farmyard manure and poultry manure	No
	Peru	Cacao	Manure use to produce bio-inputs	No
	Lao	Rice	Integrated Rice-Fish Culture	Yes
Bioinputs	Kenya	Maize/Bean	Neem-based biopesticide	Yes
	Kenya	Cabbage	Chili-based biopesticide	Yes
	Zimbabwe	Maize, Sorghum	*Lantana*, *Maerua*, chili (biopesticides)	Yes[‡]
	Zimbabwe	Maize, Sorghum	Biochar	Yes[‡]
	Peru	Cocoa	Organic compatible fungicides to control *Moniliasis*	Yes
	Peru	Cocoa	Foliar biofertilizers	Yes
	Tunisia	Olive	Wastewater valorization as soil amendment	Yes
	Tunisia	Sulla, Wheat	Rhizobium	Yes
	Tunisia	Wheat	Biochar	Yes
	India	Vegetables	Mixtures (based on cow urine, neem, etc.)	No
Diversification	India	Rice	Agroecological homestead models (AHM)	Yes[‡]
	Lao	Rice	Red Rice	Yes[‡]
	Lao	Rice	Dry season vegetables	No
	Lao	Rice	Integrated Rice-Fish Culture	Yes[‡]
	Burkina Faso	Livestock (Cattle)	Fodder crops (cereals and legumes) and Manure	Yes[‡]
	Senegal	Groundnut/Millet	Horse manure and Cowpea intercropping	Yes
	Tunisia	Livestock (Sheep)	Fodder crops (Vetch-Oat-Triticale)	Yes
	Zimbabwe	Maize & sorghum	Landraces cropping	Yes[‡]
Soil-water conservation	Kenya	Maize/bean	Terraces	Yes
	Kenya	Spinach	Mulching	Yes
	Zimbabwe	Maize, sorghum	Dead and live mulch	Yes[‡]
Crop associations	Zimbabwe	Maize, sorghum	Push-pull (cowpea and *Brachiaria*) with Sorghum in Mbire or with Maize in Murehwa	Yes[‡]
	Zimbabwe	Maize, sorghum	Mucuna as a live mulch for Sorghum or Maize	Yes[‡]
	Senegal	Groundnut	Groundnut-cowpea intercropping	Yes
	Lao	Rice	Rice-legume intercropping	No
	India	Vegetables	Agroecological homestead models (AHM)	Yes[‡]

2.1 Crop-Livestock Integration

Fodder crops to boost livestock productivity

The inclusion of fodder crops, including cereals and legumes, in Sahelian mixed crop-livestock systems has generated remarkable benefits. In Bobo-Dioulasso, Burkina Faso, the availability of cattle feed increased fivefold through fodder crop production compared to traditional foraging. Research by CIRAD, CIRDES, and INERA came up with balanced diets based on these crops to enhance milk production. Additionally, in Tunisia's El Kef-Siliana transect, ewes grazing a mix of vetch, oat, and triticale led to a 20% increase in flock fertility. Moreover, although not directly linked with livestock productivity, the Tunisia experience, led by ICARDA, OEP, INRAT, and ISA-CM, also doubled soil microbial activity in soils under this sort of grazing, supporting the soil health improvement under mixed systems. These findings underscore the advantages of diversifying crop components in mixed farming systems.

Animal manure: a key resource for agroecological innovations

Animal manure plays a crucial role in agroecological systems, serving as organic fertilizer, soil conditioner, and input for bio-inputs. In Kenya (research conducted by IITA, Alliance Bioversity & CIAT, CIFOR-ICRAF, DNRC, and CSHEP), maize yields increased by 18%, and bean yields by 25%, when fertilized with 10 tons/ha of manure. However, applying 4 tons/ha of manure did not significantly increase spinach yields. Furthermore, cattle manure in Burkina Faso and horse manure in Senegal effectively boosted groundnut and millet production. For example, in Senegal, manure increased groundnut and cowpea yields as sole crops by 23% and 36%, respectively. These findings highlight the importance of manure as a strategic resource. However, achieving sustainable impacts requires a thorough understanding of its nutrient composition, availability, and optimal application rates for specific crops and contexts.

Key messages from the crop-livestock integration

- Crop-livestock integration is primarily driven by livestock manure use and the production of fodder crops.
- Livestock manure is used in seven out of the eight countries of the AEI. Given the multiple and significant roles of livestock manure, several key questions arise regarding the upscaling of these innovations at the landscape level, particularly those relying on manure use:
  - Manure availability: As highlighted by the Senegal team, addressing manure availability at the landscape level is critical for successful upscaling. In Laos, limited manure availability is a constraint for paddy rice growers, as it is for farmers in India. This challenge suggests that the availability and distribution of manure should be a key consideration in scaling efforts.
  - Manure quality and management: The Senegal team also emphasized the need for in-depth analyses of manure quality, composition, and best practices for handling and storing. In this regard, the Burkina Faso team is monitoring the composition and use of cattle manure based on their manure pits innovation, but the results have not been reported yet. However, beyond compositional aspects, understanding the influence of manure on soil biochemical and microbiological processes is equally essential to maximize its benefits and effectiveness.
  - Cattle diet and residue management: As noted by the Peru team, cooperatives avoid using manure from cattle grazed on herbicide-treated pastures due to potential residual effects that could jeopardize the organic certification of cacao. This underscores the importance of considering livestock diets in the broader context of manure use.
  - Environmental impacts: Environmental considerations must be integrated into the upscaling of livestock manure use in crop-livestock systems. Best practices for manure management to mitigate greenhouse gas emissions (Petersen et al., 2013) and prevent nitrogen leaching into subsoil (Wang et al., 2023) should be identified and implemented. Furthermore, evaluating manure's effects on soil nitrogen mineralization and other soil microbiological processes is essential for sustainable and environmentally sound practices (Eghball et al., 2002).
- The innovations involving fodder crop production offer a sustainable alternative for increasing biomass production for livestock feed.
- Across three countries testing the effect of fodder crop innovation on the performance of the crop-livestock systems, innovations included legumes such as groundnut and cowpea in Senegal, mucuna and cowpea in Burkina Faso, and vetch in Tunisia. The inclusion of these legumes had positive effects on biomass productivity. Further analyses are needed to quantify their impacts on soil health and productivity of both sub-systems (crops and livestock), tailored to the specific conditions of each ALL in the initiative.
- The production of fodder crops in Tunisia demonstrated an improvement in soil microbial activity, supporting the soil heath because of an agroecological innovation.
- Additional results may provide further insights and enable more comprehensive comparative analyses. However, some experimental outcomes are still in progress, or the country teams have yet to report them.

2.2 Bioinputs

Biopesticides to keep pests in check

Plant-based biopesticides derived from neem and chili extracts have proved effective in reducing pests' incidence. In Kenya, neem-based biopesticides reduced fall armyworm incidence in maize by 5.2% and aphid incidence in beans by 22% (Figure 3). Similarly, chili-based biopesticides lowered brassica aphid incidence in cabbage by 5%. These trials, conducted by IITA, the Alliance of Bioversity & CIAT, CIFOR-ICRAF, DNRC, and CSHEP, revealed promising trends, though pest pressures were lower than typical conditions. Further testing under diverse climatic conditions and pest pressures is needed to confirm their efficacy in supporting integrated pest management (IPM) in diverse environments. Additionally, neem and chili biopesticides are being trialed in Zimbabwe and India, but results are still pending. Comprehensive data collection and analysis are crucial to validate the effectiveness of these biopesticides and ensure their optimal use in IPM across diverse agroecological systems.

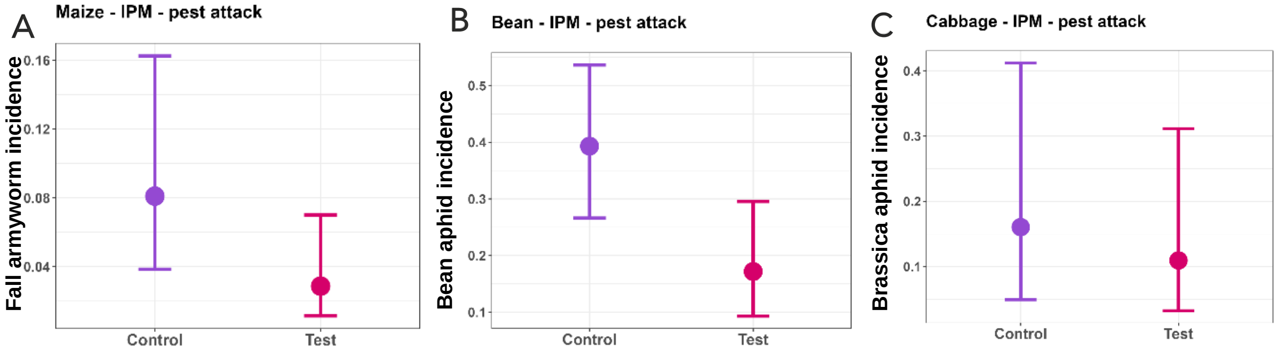


Figure 3. Predicted pest incidences for mother trials at the Makueni ALL for maize (A) and bean (B), and at the Kiambu ALL for cabbage (C), Kenya.

Note. Test treatments at the Makueni ALL involved the use of neem-based biopesticides, while at the Kiambu ALL, chili-based biopesticides were used. The control treatment represents conventional pest management practices at each ALL. Points indicate predicted means derived from mixed model outputs pooled across two observation seasons, with whiskers representing the 95% confidence intervals. A treatment's predicted value differs significantly from the control when the corresponding dot and whiskers are colored pink; no significant difference is indicated by purple coloring.

(Source: Monserrate et al., 2024)

Cultural practices: simple, yet effective

Trials in organic cacao orchards at the Pucallpa ALL in Peru, co-designed by the Alliance Bioversity & CIAT with the Colpa de Loros and Banaqui-Curimana cooperatives, highlighted the vital role of cultural practices in managing cacao fruit diseases. Regularly harvesting diseased fruits proved the most effective strategy, keeping moniliasis incidences below 5% in well-managed orchards, compared to nearly five times higher in orchards neglecting this practice, regardless of biofungicide use. These findings underscore the agroecological value of reducing disease pressure through simple, low-cost practices rather than relying solely on external inputs. Although unusually warm and dry conditions during the 2023–2024 season contributed to low disease levels, the trials demonstrated that cultural practices could safeguard production even in favorable conditions for disease suppression. This evidence underscores the need to prioritize cultural practices as key components of sustainable and agroecological disease management in cacao production systems.

Revitalizing soils in semi-arid agriculture through rhizobium and biochar

In Tunisia, ICARDA and INRAT led research to improve soil health and plant productivity in the semi-arid El Kef-Siliana transect. Rhizobium inoculation significantly enhanced biomass production in both durum wheat and the melliferous fodder sulla plant. In sulla, inoculation doubled plant height and boosted biomass to over 7.5 tons/ha, compared to 3.8 tons/ha for non-inoculated plants. Similarly, inoculation in durum wheat doubled biomass, which is used as a high-protein fodder crop under semi-arid conditions. Additionally, combining biochar with chemical fertilizers nearly doubled durum wheat grain yield compared to treatments without biochar, highlighting biochar's role in optimizing fertilizer efficiency (Figure 4). These findings demonstrate the potential of integrating rhizobium inoculation and biochar to enhance soil health, improve biomass, and maximize grain production, offering a sustainable approach to farming in semi-arid regions undergoing agroecological transition. In this regard, in Zimbabwe biochar is also being tested in maize and sorghum.

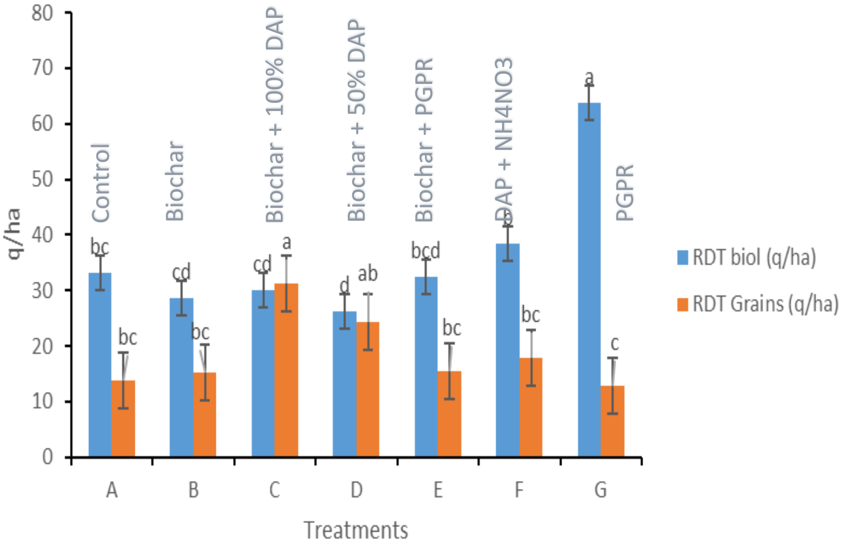


Figure 4. Biological (Blue) and grain (Orange) yield of durum wheat crop after different soil amendments in Tunisia.

Note. A: unamended soil, B: soil amended with olive-derived biochar (10ton/ha); C: soil amended with olive-derived biochar combined with 100% DAP, D: soil amended with olive-derived biochar combined with 50% DAP; E: soil amended with biochar combined with biofertilizer (PGPR); F: soil fertilized with 100% DAP and ammonium nitrate; G: soil amended with biofertilizer (plant growth-promoting rhizobacteria- PGPR). The letters represent the significant differences from one-way ANOVA analysis (n=3) at the 5% significance level.

(Source: Monserrate et al., 2024)

Key messages from the bioinputs use

- The IPM approach using biopesticides represents a promising agroecological strategy. However, further experimentation under diverse environmental conditions is necessary, especially considering the increasing impacts of climate change and extreme weather events. Additionally, data aggregation in country reports and the status of experimentation limited a deeper understanding of the effects of plant-based bioinputs such as neem and chili extracts.
- The use of organic-compatible fungicides in Peru during the main cacao harvest season of 2024 did not significantly reduce the incidence of fruit diseases. Dry and warm weather conditions likely minimized the prevalence of pathogens, such as those causing Moniliasis. These findings emphasize the importance of considering environmental conditions during experiments and adopting an IPM approach that integrates cultural practices with bio-input applications.
- Observations from cacao trials highlighted the critical role of cultural practices, such as regular removal of diseased fruits. This agroecological-compatible practice proved effective in reducing pathogen incidences, even under conditions unfavorable for disease expression. Although this practice is a standard recommendation across farming systems, the results support its broader promotion to enhance disease management.
- The use of bioinputs for improving plant nutrition yielded the most promising results of bioinputs use across different countries. These bioinputs not only enhanced biomass and yields in various crops but also improved soil nutrient status and increased the efficiency of mineral fertilizers. Notably, rhizobium demonstrated the ability to optimize mineral fertilizer use in durum wheat, underscoring its role in transitioning toward more sustainable cropping systems.
- The application of olive mill wastewater (“margines” in French) offered a promising circular economy solution aligned with agroecological principles. However, a landscape-scale approach is needed to assess its broader environmental impacts and risks, including nitrogen leaching and the effects of bioinputs on water resources. Such considerations should extend to other bioinputs, including livestock manure, as previously discussed in the crop-livestock integration section.

2.3 Diversification and crop associations:

Diversification of traditional paddy rice crops in Asia: producing more with the same resources.

Agroecological innovations in India and Laos, co-designed by IWMI, partners, and local communities, aimed at diversifying traditional paddy rice monocropping systems. In India, 46% of households adopting multilayer crop systems on small plots (approximately 1000 m²) experienced increased income compared to rice cultivation on the same area. These systems, integrating up to 15 crops (Figure 5), were implemented by women self-help groups from tribal communities with support from PRADAN, targeting enhanced income and improved nutrition. In Laos, as part of an integrated wetland management approach, rice-fish culture is being promoted to further diversify paddy rice systems. These efforts collectively seek to strengthen food security, provide year-round income, and reduce reliance on rice monoculture while fostering agroecological practices.

Figure 5. Number of crops by village, family and layer at the multilayer Agroecological Homestead Models (AHM) in the Mandla ALL, India.

(Source: Monserrate et al., 2024)

From increased productivity to pest biocontrol: the multiple benefits of crop associations

Crop associations have proven highly beneficial in the AEI across various countries. A trial in Fatick, Senegal, conducted by ISRA, CIRAD, and ENDA, demonstrated that millet grain productivity increased 30-times and the biomass four times when grown after groundnut and cowpea rotation, compared to millet grown without the legume's rotation. Similarly, CIMMYT, government agencies, and development partners, in collaboration with local communities, implemented push-pull intercropping systems of maize or sorghum with beans or cowpea, reducing fall armyworm damage by 22%. In India, multilayer cropping systems boosted income and food security, while rice-legume rotations in Lao PDR are looking to enhance soil fertility. These examples underscore the versatile roles crop associations play in improving productivity, resilience, and sustainability. By using synergies among crops, agroecological systems can address critical challenges such as pest management, soil health, and food security, making them vital for sustainable agricultural landscapes.

Key messages from the diversification innovations

- In Asia, diversification innovations were co-designed to diversify the traditional paddy rice crop. However, these innovations are still in the very early stages of implementation, limiting the scope of analysis thus far.

- Despite the early stage of implementation of diversification innovations in both countries, these innovations show potential for preserving local germplasm. Additionally, field visits highlighted the need for careful attention to agronomic practices and data management aspects of the intervention.
- The inclusion of different species of fodder crops was identified as an innovative approach with promising results for crop-livestock integration technologies. The germplasm used was generally improved crop varieties.
- Data aggregation in Zimbabwe limited the scope of this analysis. This aggregation was justified by the local team to avoid conflicts with ongoing publications.

2.4 Soil-Water conservation: keep productive resources in situ

In Kenya, the use of vegetated terraces (i.e., planted with Napier grass) led to an increase in bean productivity of 25%. On these fragile tropical soils, these terraces are also likely to sustain productivity on the long term, though this could not be measure over few seasons. Mulching on vegetable production in Kenya and conservation agriculture on cereals in Zimbabwe have also been trialed, but short-term impact on productivity is not yet clear. However, a reduction of 22% in the severity of fall armyworm damage on cereals thanks to conservation agriculture was recorded, due to increased abundance of natural enemies.

Key messages from the soil-water conservation innovations

- Mulching and terracing were the two innovations co-designed in this regard. The data reported did not reveal a productivity advantage, however, the data aggregation limited the scope of this assessment.
- It is recommended to monitor the soil moisture dynamics to assess the effects of these technologies on soil water balances and yield.

2.5 Agroecological assessment of technologies

An assessment of the agroecological performance of the technologies and innovations included as part of the codesign was conducted in 7 countries out of the 8 analyzed in this report, except for Tunisia. To this effect, the Tool for Agroecology Performance Evaluation (TAPE) was used. TAPE was developed by FAO (Mottet et al., 2020), to assess the effectiveness of agroecological practices, aiming to develop a robust evaluation framework. TAPE provides a standardized method for evaluating the extent to which agricultural systems embody agroecological principles and contribute to sustainable development goals. The TAPE framework includes three stages, (1) the Characterization of Agroecological Transitions (CAET), based on the 10 elements of agroecology adopted by FAO (diversity, synergies, efficiency, recycling, resilience, culture & food traditions, co-creation & sharing of knowledge, human and social values, circular & solidarity economy, responsible governance), (2) the core criteria performance, and (3) the validation of results from previous stages.

In the current agronomic assessment, country teams were involved in constructing the CAET assessment by comparing the ratings of different elements for the control (or current non-agroecological practice) against the co-designed agroecological practices. These comparisons were based on their ongoing experiences with trial implementations. Seven country teams completed the assessment (Tunisia did not). Two countries, Burkina Faso and Senegal, developed assessments only for the four primary elements, which are typically evaluated at the plot or farm level. Peru conducted the assessment on nine elements, excluding Culture & Food Traditions, while India, Kenya, Laos, and Zimbabwe completed assessments for all ten elements.

Figure 6 provides an example of the CAET assessment for agroecological innovations in Kenya related to on vegetables, maize and in Zimbabwe related to sorghum and maize.

Figure 7 for its part provides a graphical summary of the sub-elements within the first four elements rated in the CAET assessment across the seven countries. The results ranged from the most contrasting ratings, observed in the Diversity element within ALLs focused on crop-livestock integration (upper-left boxes in the first three ALLs), to the more uniform ratings, represented by consistent horizontal colors, seen in the ALLs in Kenya and Zimbabwe.

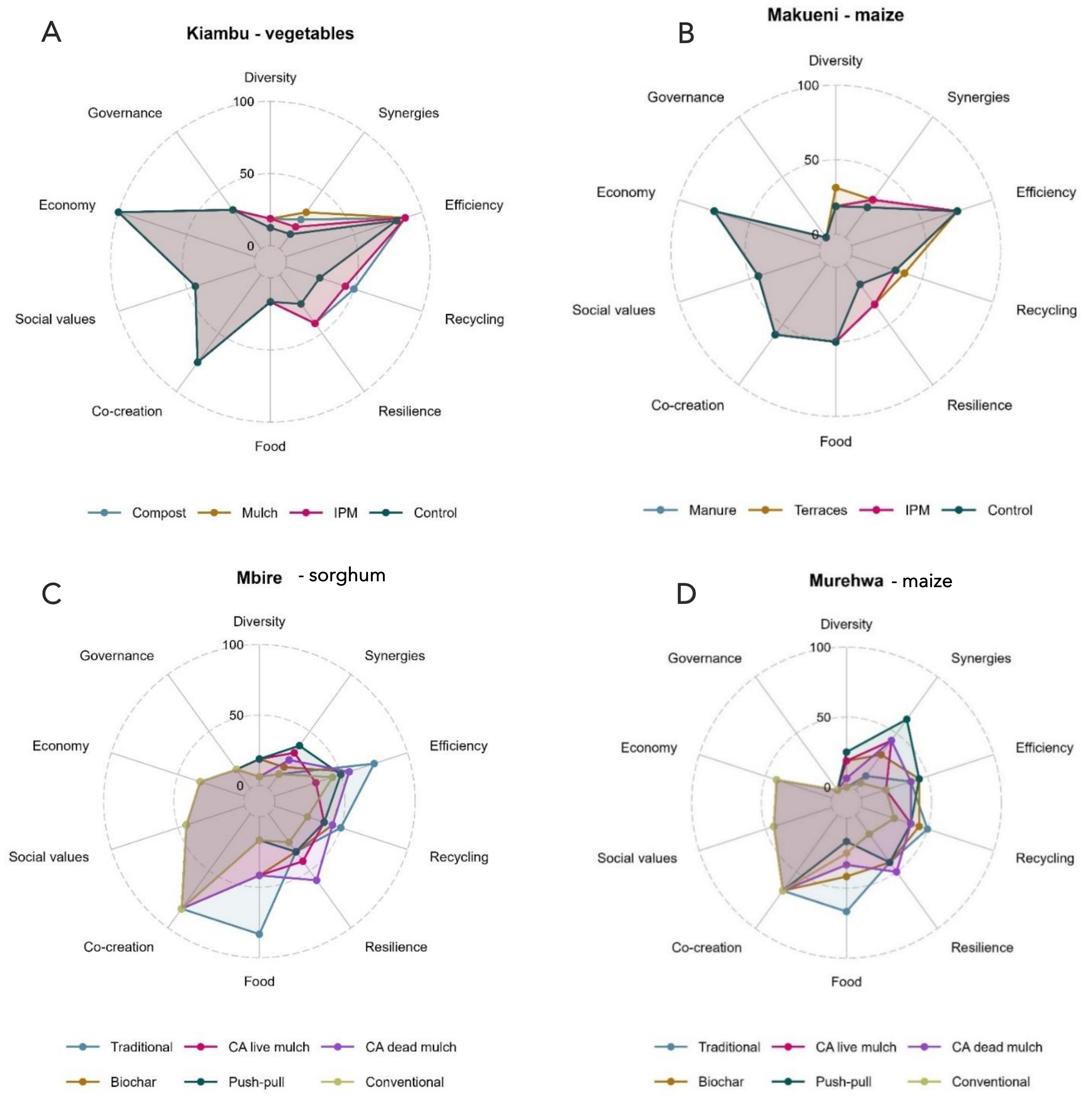


Figure 6. CAET assessment for agroecological innovations in Kenya (A and B) and Zimbabwe (C and D).

Note. (A) innovations on vegetables at Kiambu ALL, (B) innovations on Maize at Makueni ALL, (C) innovations on Sorghum at Mbire ALL, (D) innovations on Maize at Murehwa.

(Source: Monserrate et al., 2024).

2.6 Key recommendations emerging from the agronomic and agroecological assessment

A number of recommendations were developed on the basis of the results of the agronomic and agroecological assessments in the various countries. They were organized into four key themes: (1) improving the process of co-design of trials, (2) addressing agronomic aspects, (3) enhancing data management and evidence generation, and (4) promoting landscape integration. While the recommendations were broadly framed to accommodate diverse contexts, their relevance may vary depending on the specific progress and unique characteristics of each context. We are not covering in this report about the details related to agronomic aspects, or data management and reporting; they are of course critical to the success of future

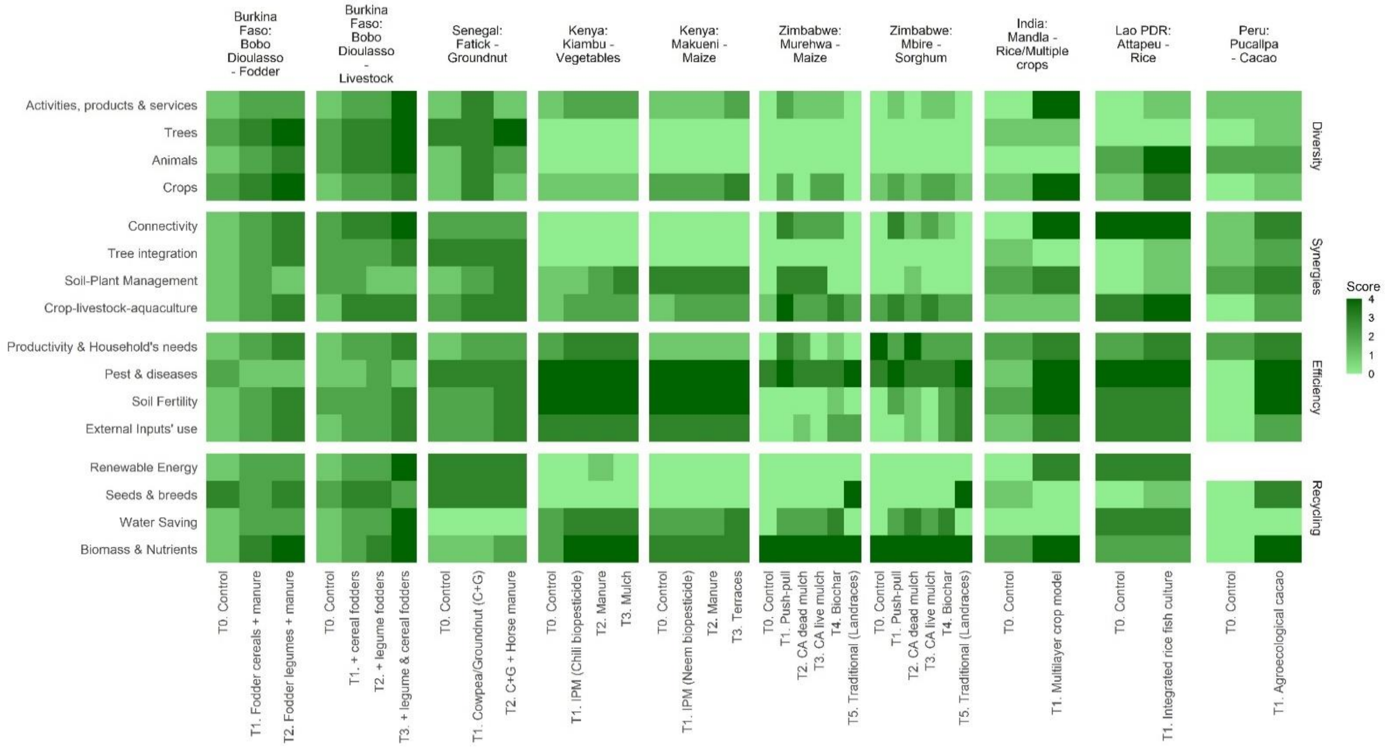


Figure 7. Heatmap of scores for each sub-element of the first four elements (Diversity, Synergies, Efficiency, and Recycling) in the CAET assessment across seven countries participating in the Agroecology Initiative.

Note. Each assessment compares the T0 (control) treatment or current non-agroecological practice with the co-designed innovations tested in each ALL. Ratings range from 0 (no agroecological transition) to 4 (full agroecological transition). A 100% transition in an element is achieved when all scores for that element are rated at 4.

(Source: Monserrate et al., 2024)

cycles of agronomic experimentation: See Monserrate et al 2024. We will only reproduce below, without entering into details, issues identified with respect to themes 1 and 4, as they overlap with issues and recommendations identified in Section 5 and based on a more complete set of reflections about the codesign process across the eight AEI countries, namely

1. Codesign of trials process

- Strengthening farmers' leadership roles in co-design cycles:
- Broadening Stakeholders' Representation
- Refining different technical aspects related to the co-designed treatments, such as
  - Timely implementation of treatments
  - Establishment of non-agroecological control treatments
  - Evidence-based recommendations during the second cycle of co-designing treatments
  - Evidence generation and monitoring

2. Landscape integration

- Assessing inputs and resources availability
- Addressing environmental impacts
- Strengthening natural resource governance
- Foster cross-sectoral collaboration

3. Potential adaptation and adoption of technologies tested

Beyond experimenting, the need to facilitate adaptation, use, adoption and scaling of tested technologies

3.1 Actual or potential benefits, challenges and drawbacks of various technologies

Based on the documentation provided, the key benefits, challenges, and drawbacks of the tested technologies across countries, organized by major themes, are as follows.

See Annex 3: Cross country Technology Evaluation Matrix, for detailed tables by technology presenting the information countries gathered about these same issues

Soil Health and Fertility Technologies

The rhizobial biofertilization technology in Tunisia demonstrates significant benefits for soil improvement and crop production. Farmers have observed enhanced nitrogen fixation, improved crop growth, and increased harvests. The technology also enriches soil with organic matter and improves soil structure. An important benefit is the reduced reliance on chemical fertilizers, leading to cost savings. However, the technology faces challenges related to performance variability based on local conditions, including soil type and climate. Some farmers require extensive support to adopt agroecological practices effectively, and the initial investment may deter adoption despite long-term cost reductions.

In Zimbabwe, conservation agriculture practices have shown benefits in addressing soil degradation and improving resource use efficiency. However, practices requiring higher labor or resource investments, such as cover cropping and mulching, face adoption challenges, particularly in regions like Mbire where resource scarcity and limited access to inputs create significant barriers.

Livestock and Forage Management

Tunisia's forage intercropping technology demonstrates multiple benefits, including higher nutritional value compared to conventional oaten hay and improved soil fertility through nitrogen fixation. The technology provides ecosystem services such as disease barriers and pollinator support. Farmers benefit from reduced crop failure risk due to diverse mixtures and lower input requirements for water, nitrogen, and herbicides. However, challenges include the availability of quality seeds during planting seasons and farmers' limited knowledge of management techniques for mixtures.

In Burkina Faso, the implementation of covered manure pits has enabled farmers to produce quality manure that improves soil fertility and increases fodder yields. However, the technology involves a significant workload, particularly in construction and mature manure removal. The gender implications of this workload have affected adoption patterns, with the technology being more readily adopted by men due to labor requirements.

Disease Management Systems

Peru's bio-input systems for cocoa disease management show promise in reducing disease incidence through preventive applications. Farmers can generate their own bio-inputs, providing cost advantages and autonomy. However, challenges include determining optimal application frequencies and the need for consistent cultural practices like removing diseased fruits. Not all producers know how to prepare mineral broths, and long cocoa harvest periods create favorable conditions for disease presence.

Water Management and Irrigation

India's Solar Irrigation Systems demonstrate benefits in providing affordable and sustainable water access, enabling increased cropping intensity and diversity. The systems contribute to women's empowerment through water user groups and reduce dependency on fossil fuels. However, the technology faces significant challenges related to infrastructure costs (approximately USD 10,000) and maintenance requirements. Limited technical knowledge for maintenance presents an ongoing challenge.

Integrated Farming Approaches

India's Integrated Farming Systems show potential for improving productivity and resource use efficiency while diversifying income streams and enhancing resilience to climate shocks. The systems improve soil and animal health while enhancing dietary diversity. However, the complexity of managing multiple components and the significant technical knowledge required present substantial challenges for implementation.

Cross-Cutting Challenges

Several challenges appear consistently across different technologies and contexts:

- Financial constraints often limit adoption, particularly for technologies requiring significant upfront investment. This challenge is especially prominent in technologies like solar irrigation systems and infrastructure-heavy soil management practices.
- Knowledge and training requirements present significant barriers, particularly for complex systems requiring integrated management approaches. This challenge appears in various contexts, from bio-input preparation in Peru to integrated farming systems in India.
- Labor availability and workload implications affect adoption patterns, often with gender-specific impacts. This is particularly evident in technologies requiring intensive physical labor or regular maintenance.
- Infrastructure and Resource Access: Access to necessary resources and infrastructure consistently influences technology effectiveness. This includes physical infrastructure for storage and processing, access to quality inputs, and availability of technical support systems. The absence of these supporting elements often limits the potential benefits of otherwise promising technologies.

Overall, while many technologies offer significant potential benefits, their successful implementation often depends on addressing multiple interconnected challenges. The most successful cases tend to be those where benefits clearly outweigh the combined impact of challenges and drawbacks, and where appropriate support systems are in place to help farmers overcome initial adoption barriers.

3.2 Level of maturity or readiness of the tested technologies for their use and adoption by farmers

Technologies which seem more or less ready

Evaluation Criteria and Considerations

Across countries, several common indicators have been used to assess technology maturity:

- Demonstrated effectiveness under varied conditions
- Ease of integration with existing farming practices
- Availability of necessary inputs
- Farmer ability to implement independently
- Evidence of spontaneous adoption beyond test groups
- Integration into existing training and extension systems

Forage and Livestock Management Technologies

Tunisia's forage intercropping technology stands out as one of the most mature innovations. The technology has several indicators of readiness: mixture seeds are readily available in the market, farmers recognize their nutritional benefits, and the positive impact on soil fertility has been demonstrated. Large state farms have already adopted forage mixtures as an alternative to traditional oaten hay, indicating market validation.

In Burkina Faso, the dynamic forage and forage seed production system has shown strong maturity indicators, with a 90.28% acceptance rate among volunteer farmers during the 2023/2024 campaign. The system's success is evidenced by high implementation rates - 97% of mother farmers and 76% of baby farmers implemented at least one forage crop independently, without requiring intensive monitoring from the research team.

Soil Management and Fertility Technologies

Rhizobial biofertilization in Tunisia has demonstrated sufficient maturity for farmer adaptation. The technology has been successfully tested across various agroecological contexts, shows compatibility with existing practices, and delivers direct benefits in terms of increased yields and improved soil health. The ease of application has facilitated its integration into current farming systems.

In Zimbabwe, several conservation agriculture practices have reached maturity, particularly in Murehwa district. The high adoption rates of practices such as crop rotation (81%), compost or manure use (79%), and tree retention (73%) indicate these technologies are well-established and ready for broader implementation. However, it's worth noting that adoption rates vary significantly between regions, with Mbire showing lower adoption rates for some practices.

Bio-Input Technologies

In Kenya, basic agroecological practices selected for initial testing have reached maturity. These were deliberately chosen for their familiarity, affordability, and ease of implementation. The practices' maturity is evidenced by their broad adoption and integration into regular training schedules at farmer training centers.

Water Management Technologies

India's Solar Irrigation Systems (SIP) have demonstrated reliability in providing sustainable water access for crop diversification. While the core technology is mature, its broader adoption is primarily constrained by infrastructure costs rather than technological readiness.

Farm-level resource Management Tools

In Burkina Faso, the Jabnde tool for cattle diet management has reached a functional level of maturity, with 100% of volunteer farmers reporting improved milk production after using the tool.

However, the current version requires technician support, and hence does not offer farmers autonomous use.

Overall considerations

Technology maturity often varies by context and user group. For instance, Zimbabwe's conservation agriculture practices show different maturity levels between Murehwa and Mbire districts, highlighting how local conditions influence technology readiness for adoption.

Additionally, some technologies may be technically mature but face adoption barriers unrelated to their readiness. These barriers might include high initial costs, labor requirements, or the need for supporting infrastructure or advice. Understanding these distinctions is crucial for developing appropriate scaling strategies.

Overall, while many technologies show promise, those that have reached true maturity tend to be ones that build on existing practices, require minimal additional infrastructure, and deliver clear, immediate benefits to farmers. The most successful cases often involve technologies that have been refined through multiple seasonal cycles and have established support systems for implementation.

Technologies which do not seem ready

Based on the documentation provided, several technologies across the participating countries require further development before they can be considered ready for widespread farmer adoption. Here is a synthesis of these technologies and the key factors limiting their readiness.

Cocoa Disease Management Technologies in Peru

The bio-input systems for controlling moniliasis in both aromatic and CCN51 cocoa varieties in Peru have not reached sufficient maturity. Two main factors have impeded their readiness: first, adverse weather conditions in 2024 hindered disease development, preventing the collection of statistically significant results about treatment effectiveness. Second, as cocoa is a perennial crop, multiple experimental cycles are necessary to validate the technology's long-term impact. The formulation and application frequency of bio-inputs were initially determined through empirical observation rather than data-driven analysis, necessitating further scientific validation.

Additionally, the foliar biofertilizer applications in Peru, while showing promise, lack clarity regarding optimal application frequencies for maximum impact on pod yield and disease control. The technology requires a second experimental cycle to determine these crucial parameters.

Biochar Applications in Tunisia

The biochar technology in Tunisia shows varying levels of maturity across different agricultural systems. While the underlying benefits are well-understood, widespread adoption readiness is limited by several factors. The technology requires improvement in traditional production methods and enhanced farmer training. Economic and technical challenges need addressing to maximize benefits. The technology's success appears highly contextualized, with adoption occurring primarily under specific conditions influenced by biomass availability, climate, and support from NGOs or research programs.

Digital Management Tools in Burkina Faso

The CoProdScope tool for managing farm co-products in Burkina Faso's dairy sector, while useful, faces significant implementation challenges. The current Excel version is not sufficiently ergonomic for farmer use, and the absence of farm registers complicates data collection.

As noted earlier, the Jabnde tool for cow diet management, despite showing positive results, requires technician presence for operation, limiting farmer autonomy.

Both tools need further development into more user-friendly formats, with a mobile application version of CoProdScope currently under development.

Complex Integrated Systems in India

Several technologies in India require additional development:

- The Krishi-Kund land restoration technology needs additional validation over longer cycles despite showing early promise in rehabilitating degraded lands. The technology's effectiveness in improving productivity by 2.39 to 5.71 times requires further confirmation across different contexts and seasons.
- The Integrated Farming Systems (IFS) in tribal areas of Mandla are still in early implementation stages. While the underlying concept is well-researched by the National Agricultural Research System, its application in specific tribal contexts requires additional refinement. The complexity of managing multiple components and the significant technical knowledge requirements currently limit its readiness for widespread adoption.
- The homeopathic formulations for crop productivity enhancement remain in the exploratory phase. Despite showing promising results in paddy cultivation, the technology faces several readiness challenges, including limited understanding of its scientific mechanisms, farmer skepticism, and the need for systematic validation of both effectiveness and potential side effects.

The key role of institutional Support Systems

A common theme across these technologies is the need for supporting systems to reach full readiness. For instance, in Zimbabwe, practices requiring higher labor or resource investments show lower adoption rates in regions like Mbire, indicating that technology readiness must be considered alongside resource availability and institutional support.

Further research needed

Many of the technologies tested so far in the context of the AEI codesign processes followed by the various countries require additional research in specific areas:

- Long-term effectiveness validation
- Cost-benefit analysis under various conditions
- Optimization of application methods and frequencies
- Development of user-friendly implementation tools
- Assessment of contextual factors affecting success

Overall, technology readiness often depends not just on technical effectiveness, but on a complex interplay of factors including ease of use, resource requirements, supporting infrastructure, and local context. Successfully bringing these technologies to readiness will require addressing both technical and systemic challenges while ensuring appropriate support systems are in place for farmer adoption.

3.3 Current evidence of use and scaling of the tested technology

Activities and strategies implemented so far (up to end of 2024) to share, diffuse and scale the various technologies?

Based on the provided documentation, the specific strategies and activities implemented across countries to share, diffuse and scale innovations can be synthesized up to the end of 2024.

Kenya's experience

Kenya implemented one of the most structured approaches to scaling, embedding scaling considerations into their entire co-design process from the beginning. Their strategy involved deliberate engagement with national networks, particularly PELUM Kenya and the Inter-Sectoral Forum on Agrobiodiversity and Agroecology. They established partnerships with existing farmer training centers as ALL host centers, which played multiple roles including farmer mobilization, providing physical meeting spaces, delivering training, and monitoring trials.

The Kenyan team carefully structured their participant selection process to promote scaling. In each ALL, they invited participants from 15 farmer groups, deliberately mixing groups that had previous experience with the host centers and those that had not. They co-designed participant selection criteria focused on identifying farmers with the potential to become effective lead farmers who could train others. The approach empowered farmer groups to designate their representatives based on established criteria.

Kenya also emphasized experiential learning through structured exchange visits within and between ALLs, fostering collective learning and maintaining farmer engagement. They developed technical manuals for trial establishment and involved diverse stakeholders from government, extension services, NGOs, and the private sector in co-design and testing.

Tunisia's Experience

Tunisia focused on building partnerships between research institutions and agricultural cooperatives. They organized field days in northern Tunisian governorates to demonstrate forage technologies and conducted training sessions for technicians on biofertilizer design and management. The country developed informative materials on forage production techniques and supervised student research on forage associations.

Their approach included establishing demonstration plots for hands-on observation of benefits and facilitating field visits for experience sharing among farmers. They collaborated with agricultural cooperatives and local groups for broader dissemination and distributed rhizobial biofertilizers to encourage adoption.

Zimbabwe's Experience

Zimbabwe emphasized the development of innovation bundles, combining complementary technologies like push-pull systems, conservation agriculture, and drought-resilient varieties. They established farmer field schools and implemented peer learning approaches alongside the co-design process. The country organized farmer field days, fairs, and evaluations to foster interaction among farmers and Food System Actors.

The strategy included leveraging community-based organizations to create localized experimentation and knowledge exchange opportunities. They particularly focused on participatory capacity-building through hands-on demonstrations and enhanced local seed fairs to improve access to diverse, resilient varieties.

Burkina Faso's Experience

Burkina Faso concentrated on technical support and demonstration. For their forage demonstration plots, they achieved 90.28% acceptance among volunteer farmers during the 2023/2024 campaign. They implemented the CoProdScope tool with 30 farmers and planned to use the Jabnde tool with 20 farmers during the 2024/2025 experimentation campaign.

The country focused on supporting farmers in establishing forage crops and developing cooperative systems for sharing forage seed. They also worked on creating more user-friendly versions of their digital tools to facilitate broader adoption.

Peru's Experience

Peru transformed their participatory experimental plots into learning centers where various stakeholders could gather to learn about implemented technologies. They organized sporadic exchanges between technicians and farmers in experimental plots and conducted two formal dissemination sessions - one aimed at organization technicians and another at farmers.

Their approach introduced experimentation-based learning rather than solely relying on demonstration, representing a significant shift from traditional demonstration plot approaches in the region.

India's Experience

India focused on developing partnerships with government stakeholders and financial institutions. They organized training programs and exposure visits for women's self-help groups and explored integrating technologies into broader rural development schemes. They established demonstration sites in collaboration with National Agricultural Research System partners and worked on developing detailed training modules.

Common elements Across Countries

Several common elements emerge across these different approaches:

- The establishment of demonstration sites or plots
- Structured training and capacity building programs
- Partnerships with existing institutions and organizations
- Peer-to-peer learning mechanisms
- Integration with existing agricultural support systems

Overall, while countries have adopted different specific strategies based on their contexts, successful scaling approaches typically combine multiple elements and engage various stakeholders while building on existing institutional frameworks and social networks.

Evidence of use and scaling of the tested technologies by farmers who were not directly involved in the experiments

Based on the provided documentation, the evidence of technology adoption and scaling can be synthesized beyond the direct experiment participants across the different countries.

Evidence from Kenya

Kenya demonstrates some of the strongest evidence of broader technology adoption. The co-designed practices have spread through three main pathways: farmer-to-farmer extension, ALL host center training, and adoption by other stakeholders who champion the practices. The host centers have incorporated the co-designed practices into their regular training curricula, expanding reach beyond initial participants. Additionally, the 30 farmers hosting trials in Makueni belong to 27 groups, each with 30 to 100 members, suggesting significant potential for broader impact through existing social networks.

Evidence from Burkina Faso

In Burkina Faso, the dynamic forage and forage seed production system shows promising signs of broader adoption. The mid-term follow-up revealed that 97% of mother farmers and 76% of baby farmers implemented forage crops independently, without rigorous monitoring from the research team. This high level of implementation suggests the technology's potential for organic scaling. The program attracted 135 volunteer farmers for the 2024/2025 season, exceeding the initial target of 130, indicating growing interest beyond the original participant group.

Evidence from Tunisia

Tunisia presents evidence of market-driven scaling, particularly with forage mixture technologies. Local seed providers are selling forage mixture seeds to various projects and NGOs, indicating adoption beyond the initial test groups. Large state farms have adopted forage mixtures as an alternative to traditional oaten hay, demonstrating institutional-level scaling. Farmers who witnessed the technology's benefits during demonstrations have independently adopted rhizobial biofertilization on their plots.

Evidence from Zimbabwe

In Zimbabwe, following the 2023 mother trials, 83 farmers (64 in Murehwa and 19 in Mbire) selected treatments like conservation agriculture and push-pull for adaptation in their fields, showing early adoption momentum. However, the documentation doesn't provide specific evidence of adoption beyond these directly connected farmers.

Evidence from Peru

In Peru, the cooperatives' technical teams promote tested practices among their broader membership. One cooperative extends its bio-input promotion to its 400+ members, though the effectiveness still requires validation with data and statistical analysis. The other cooperative promotes practices among its 70 members, indicating institutional-level scaling, albeit within structured networks rather than completely independent adoption.

Evidence from India

India reports varied levels of spontaneous adoption. Some farmers outside the co-design experiments have expressed interest in Solar Irrigation Systems, though lack of resource support limits actual adoption. For Integrated Farming Systems, neighboring farmers have shown interest in specific components like composting and fodder cultivation, suggesting partial technology adoption rather than complete system implementation.

Factors Influencing Spontaneous Adoption

The documentation reveals several factors that appear to facilitate spontaneous adoption:

- Strong institutional frameworks, as demonstrated by Kenya's success with training centers and farmer groups, create pathways for natural scaling.
- Market availability of necessary inputs, such as Tunisia's seed providers, enables independent adoption by making resources accessible.
- Clear and observable benefits, particularly in technologies addressing urgent needs or providing visible results, encourage spontaneous uptake.

Limitations in Current Evidence

The documentation suggests some limitations in tracking “spontaneous“ adoption. Kenya acknowledges that outcomes of both farmer-based and center-based outreach have not been captured in a structured manner. Many countries focus on describing potential for scaling rather than documenting actual cases of independent adoption.

Future Implications

The evidence suggests that technologies with the following characteristics show the strongest potential for spontaneous adoption:

- Those that build on existing practices and knowledge
- Those with clear economic benefits
- Those supported by strong institutional frameworks
- Those requiring minimal external support for implementation

Overall, while there is evidence of technology adoption beyond direct participants, much of this scaling occurs within structured networks rather than through completely independent adoption. The strongest cases of spontaneous adoption appear in contexts with robust institutional support systems and clear market mechanisms for accessing necessary inputs.

Profiles of farmers who have been using / adopting the various technologies or seem more likely to adopt them?

Based on the provided documentation, the key patterns can be synthesized regarding which types of farmers are adopting or most likely to adopt the various technologies across countries.

Resource Access and Land Tenure

Land tenure consistently emerges as a critical factor influencing technology adoption across multiple countries. In Zimbabwe, farmers with secure land tenure show higher adoption rates for conservation agriculture practices. Similarly, in Peru, land tenure significantly influences farmers' willingness to invest in cocoa management technologies. This pattern suggests that farmers with secure land rights are generally more inclined to implement technologies requiring longer-term investment or soil improvement practices.

Farm Size and Scale of Operations

The relationship between farm size and technology adoption varies by technology type. In Tunisia, farmers with mixed farming operations, regardless of size, show strong adoption potential for forage intercropping technology. However, in India, the Agroecological Homestead Models are particularly attractive to marginal landholders, while Solar Irrigation Systems appeal more to farmers with larger operations who can manage the substantial initial investment.

Labor Availability

Family labor availability significantly influences technology adoption patterns. In Peru, the availability of family labor emerges as a crucial factor for adopting various cocoa management practices. Burkina Faso's experience with covered manure pits demonstrates how labor requirements can shape adoption patterns, with the technology being more readily adopted by farmers who can manage the intensive labor demands.

Gender Dimensions

Gender plays a significant role in technology adoption patterns across countries. In India, women-led self-help groups show particular success with Agroecological Homestead Models due to their alignment with women's roles in household nutrition management. In Burkina Faso, gender influences technology adoption through labor allocation patterns, with some technologies being more readily adopted by men due to physical labor requirements.

Kenya's approach specifically considered gender in its participant selection process, deliberately structuring the program to promote adoption across gender lines. This strategic approach has helped ensure more equitable access to and adoption of technologies.

Economic Status and Market Access

Farmers' economic status and market connections influence their adoption patterns. In Tunisia, farmers with existing market connections and the ability to manage initial investments show higher adoption rates for rhizobial biofertilizers. In Peru, cocoa farmers' adoption of new technologies correlates strongly with market prices, with higher adoption rates observed when cocoa prices are favorable.

Age and Innovation Orientation

The relationship between age and technology adoption varies by context. In Peru, youth is not a determining factor for adopting certain cocoa management innovations. However, in Tunisia, younger farmers show more openness to innovation when provided with proper training. This suggests that age itself may be less important than factors like access to training and support systems.

Technical Knowledge and Training Access

Farmers with access to training and support systems consistently show higher adoption rates across technologies. In Kenya, farmers connected to training centers demonstrate stronger adoption of agroecological practices. Similarly, in India, farmers with access to technical support show greater success with complex systems like integrated farming approaches.

Location and Environmental Context

Geographic location and environmental conditions influence adoption patterns. In Zimbabwe, adoption rates for similar technologies vary significantly between Mbire and Murehwa, reflecting different environmental and socio-economic contexts. Farmers in areas with specific environmental challenges, such as degraded lands in India, show particular interest in relevant restoration technologies.

Organizational Membership

Membership in farmer organizations or cooperatives appears to facilitate technology adoption. In Kenya, farmers connected to existing farmer groups show higher adoption rates. Similarly, in Tunisia, farmers involved in agricultural cooperatives demonstrate greater capacity to implement and maintain new technologies.

Future Adoption Potential

The documentation suggests several farmer categories with high potential for future adoption:

- Small and medium-scale farmers with mixed farming systems show strong potential for integrated approaches
- Women farmers, particularly when technologies align with their existing roles and responsibilities
- Farmers with access to supportive institutional frameworks and markets
- Farmers in areas where environmental challenges create clear incentives for adoption

This analysis reveals that successful technology adoption often depends on a combination of factors rather than single characteristics. The most successful adoption patterns typically emerge when farmers have appropriate resources, knowledge access, and supporting institutional frameworks, regardless of their specific demographic characteristics.

3.4 Future plans for sharing, diffusing and scaling technologies

Based on the provided documentation, the future plans for sharing, diffusing, and scaling innovations across the different countries can be synthesized, highlighting how these approaches differ from current strategies.

Kenya's Evolution Toward Deeper Integration

Kenya plans to continue their existing successful approaches of collaboration with host centers, co-design processes, and exchange visits. However, they have identified several areas for enhancement that represent a shift from current practices. They aim to strengthen their engagement with trial participants specifically regarding their lead farmer position and improve farmer-to-farmer outreach modalities. The country plans more deliberate engagement with local government extension mechanisms and agricultural transformation processes. Additionally, they intend to increase their use of local and national communications channels, representing a new focus on broader media engagement.

Tunisia's Expansion of Current Framework

Tunisia's future plans build upon their current foundation while introducing new elements. For biochar technology, they plan to establish more demonstration fields specifically focused on sustainable soil improvement and residue management practices. This represents an expansion of their current demonstration approach with a more targeted focus. The country aims to develop monitoring systems to evaluate impact on productivity and sustainability, indicating a more systematic approach to assessment than currently exists.

Peru's Shift to Systematic Exchange

Peru plans to implement a significant change in their approach by systematizing a rotational exchange system in experimental plots. This new system will focus on specific themes determined collaboratively with farmers and technical teams, representing a more structured approach than the current sporadic exchanges. Following the completion of their second experimental cycle, they plan to design a comprehensive scaling strategy that will adapt successful technologies to various farmer profiles within organizations, considering both agronomic and economic outcomes. This represents a more systematic approach to scaling than their current methods.

India's Enhanced Integration Strategy

India's future plans indicate a shift toward more comprehensive integration of their technologies. For Solar Irrigation Systems, they plan to develop complete business models and integrate them more fully into agroecological frameworks. They aim to develop strategies to use surplus solar energy for rural transformation beyond irrigation, representing an expansion of the technology's scope. For their Integrated Farming Systems, they plan to enhance community sensitization and promote group adoption for more efficient use of tools and common resources, indicating a shift toward more collective approaches.

Zimbabwe's Focus on Systemic Support

Zimbabwe's future plans emphasize strengthening systemic support for their technologies. They intend to develop more robust innovation bundles and enable support systems to enhance both uptake and resilience. This represents an evolution from their current approach by focusing more on the enabling environment for technology adoption.

Burkina Faso's Technical Enhancement

Burkina Faso plans to focus on technical improvements to their existing tools. They are finalizing a mobile application version of the CoProdScope tool to make it more user-friendly, representing a significant technical evolution from the current Excel-based version. They also plan to co-design with farmers diets adapted to groups of homogeneous cows, moving away from the current individual diet approach of the Jabnde tool.

Common Trends in future Approaches to diffusion and scaling

Several common trends emerge in how countries plan to evolve their scaling strategies:

- Moving from individual to collective approaches: Many countries are shifting toward more community-based and group-oriented scaling mechanisms.
- Increased focus on systematic assessment: Future plans often include more structured monitoring and evaluation components than current approaches.
- Enhanced integration with existing systems: Countries are planning stronger connections with government programs, extension services, and local institutions.
- Technology refinement: Several countries plan to improve their existing tools and technologies based on initial implementation experiences.
- Broader stakeholder engagement: Future plans often include expanded engagement with diverse stakeholders, particularly government entities and financial institutions.

Overall, while countries generally plan to build upon their current successful approaches, they are also introducing more systematic, integrated, and technologically advanced elements to their scaling strategies. The future approaches appear more deliberate and structured, with greater emphasis on sustainable, long-term impact through institutional integration and community engagement.

3.5 Overall synthesis about technology adaptation and adoption across the participating countries

Based on the comprehensive documentation provided, the key patterns and insights about technology adaptation and adoption across the participating countries are as follows.

Technology Maturity and Readiness

The maturity of tested technologies varies significantly across countries and interventions. Several countries report a mix of mature and emerging technologies:

In Tunisia, forage intercropping technology is considered mature and ready for scaling, with available market seeds and demonstrated benefits. Similarly, rhizobial biofertilizers have been successfully tested across various agroecological contexts. In contrast, technologies like olive mill wastewater valorization require further research and infrastructure development.

Kenya took a deliberate approach by starting with basic, familiar practices to build trust and capacity before introducing more complex innovations. This strategic choice facilitated broader initial adoption while laying groundwork for more sophisticated interventions in future cycles.

In Peru, several technologies related to cocoa production are still in early experimental stages, requiring multiple cycles to validate their effectiveness due to the perennial nature of the crop. The adverse weather conditions in 2024 have further extended the evaluation period needed.

Common benefits

The technologies generally support improved resource efficiency and reduced input costs. For instance, Tunisia's forage intercropping and India's solar irrigation systems both demonstrate significant resource optimization. Multiple countries report enhanced soil fertility benefits, particularly through technologies involving organic inputs and residue management.

Common challenges

- High initial investment costs, particularly for infrastructure-heavy technologies like India's Solar Irrigation Systems and Krishi-Kund land restoration
- Labor intensity of certain practices, exemplified by Burkina Faso's covered manure pits and Zimbabwe's conservation agriculture practices
- Technical knowledge requirements, especially for complex systems like India's Integrated Farming Systems and Peru's bio-input preparation

Adoption Patterns

Several interesting patterns emerge regarding technology adoption:

- Gender dynamics play a significant role. In India, women-led self-help groups show particular success with Agroecological Homestead Models. Kenya deliberately structured its participant selection to promote gender-inclusive adoption. In Burkina Faso, the workload implications of manure pit technology affect gender-based adoption patterns.
- Resource access significantly influences adoption potential. For example, Tunisia's forage intercropping technology is most readily adopted by farmers with animal flocks, while India's solar irrigation systems require access to perennial water sources and government subsidies.
- Land tenure consistently appears as a critical factor across multiple countries, including Peru, where it influences the adoption of cocoa-related technologies, and Zimbabwe, where it affects conservation agriculture implementation.

Scaling Strategies

Different countries have developed varied approaches to scaling:

- Kenya implemented a comprehensive scaling strategy from the outset, embedding the co-design process within national networks and establishing structured partnerships with farmer training centers. Their approach includes systematic participant selection and regular exchange visits.
- Tunisia has focused on building partnerships between research institutions and agricultural cooperatives, complemented by field demonstrations and training sessions. They've also worked to integrate technologies into existing government programs.
- Zimbabwe emphasizes innovation bundles, combining complementary technologies like push-pull systems and conservation agriculture to create synergistic benefits. They utilize farmer field schools and peer learning approaches for dissemination.
- India has adopted a more gradual approach, focusing on demonstration sites and capacity building while working to secure government support and develop sustainable business models for technologies like solar irrigation systems.

These different approaches reflect local contexts and institutional capacities, while sharing common elements of demonstration, training, and partnership building. Most countries face similar fundamental challenges in technology adoption and scaling. The most successful approaches appear to combine technical innovation with strong social and institutional support systems.

4. Reflections, lessons and recommendations

4.1 How useful / effective has the codesign process been?

Looking at codesign from the viewpoint of three different stakeholders

Based on the country reports, the codesign process has offered distinct value and presented different challenges for each major stakeholder group (international researchers, national and local R&D partners and farmers.

International Researchers' Perspective

International researchers found the codesign process and the ALL framework in which it developed very valuable for identifying, validating and adapting technologies in real-world contexts. The process enabled them to better understand the complexities of local farming systems, including climate vulnerabilities and socioeconomic constraints that affect technology adoption. In India, researchers gained crucial insights into how tribal farming communities integrate new practices with traditional methods. However, many researchers expressed concern about the need for more rigorous data collection frameworks to ensure scientific validity while maintaining practical relevance.

National and ALL-Level Partners' Perspective

National research organizations and development partners particularly valued how the codesign process strengthened institutional collaboration and local capacity building. In Zimbabwe, agricultural extension services found that participatory tools like mother-baby trials enhanced their ability to validate technologies while maintaining strong farmer engagement. Kenya's experience demonstrated how codesign approaches could improve knowledge sharing and co-creation between research institutions, local institutions (the host centers) and farming communities. These partners appreciated the systematic integration of scientific knowledge with local practices, though many noted challenges with time and resource constraints affecting implementation schedules.

Farmers' Perspective

The codesign process represented a significant shift for farmers, moving them from passive recipients to active contributors in agricultural innovation. They highly valued practical training and peer learning opportunities and appreciated having their knowledge and experience respected and considered.

In Burkina Faso's dairy innovation platform, farmers valued their ability to directly influence technology adaptation based on their practical experience. Tunisia's experience with mixed forage systems showed how farmer participation in design decisions enhanced both adoption rates and local adaptation of technologies.

However, some farmers, particularly those with limited resources, struggled with the technical aspects of trials or the high initial investments required for certain innovations.

Cross-Cutting Benefits and Challenges

The codesign process created valuable opportunities for knowledge exchange, sharing and co-creation between all three main groups of stakeholders. Structured interaction among them enhanced understanding and innovation for all stakeholders. The process seemed to work best when a good balanced and integration was found between scientific knowledge and rigorous methodological approach and farmers’ knowledge, involvement and needs.

However, time constraints and coordination challenges sometimes limited the depth of engagement in codesign of the various partners, and proper multi-dimensional evaluation of short-term and longer-term effects and their implications.

These varied perspectives highlight how codesign processes can generate meaningful benefits for different stakeholder groups while requiring careful attention to their distinct needs and constraints. Success depends on balancing scientific rigor with practical implementation while maintaining strong communication channels between all participants.

A critical analysis of what worked well, and what worked less well

Based on the country reports, several aspects of the codesign process proved particularly successful across different contexts and stakeholder groups.

What worked well

Participatory Tools and Methods

As noted already previously, the implementation of **mother-baby trials** in Zimbabwe and also in Burkina Faso, and with another label ("Central field" and "Satellite trials", an approach used by CIRAD scientists since the late 1990s) in Senegal, demonstrated high effectiveness in combining scientific rigor with practical farmer needs. It allowed researchers to maintain controlled conditions in mother trials while enabling farmers to adapt technologies to their specific circumstances in baby trials, o to access difficult-to-source forage seed (case of Burkina Faso). Such approach seems especially valuable for farmers who can experiment with innovations under their own conditions while still benefiting from systematic research support. In **Tunisia**, the network of mixed forage trials empowered farmers to design their own crop mixtures and formulate concrete research questions. **Kenya's** experience with **personalized feedback** for soil data and during agronomic result workshops created strong engagement from both farmers and research teams. It also helped translate complex technical information into actionable recommendations, benefiting farmers through improved decision-making while providing researchers with valuable feedback on technology adoption and adaptation.

Use of digital tools

Zimbabwe's implementation of digital tools like KoBo Collect and QR codes significantly improved data accuracy and reduced inconsistencies in farmer records. This methodological innovation particularly benefited research teams by streamlining data collection while helping farmers maintain better records of their agricultural activities. In Burkina Faso, digital advisory tools enhanced dairy production management, supporting farmers in optimizing their resource use while providing researchers with valuable data on technology adoption.

Knowledge sharing through the functioning of the ALLs and network of trials

Across the AEI countries, the activities implemented at the level of the ALLs and the periodic organization of field visits and other interchange events strengthened the links between stakeholders and created effective knowledge-sharing and learning spaces between farmers, extensionists, researchers and other stakeholders involved in the ALLs. In particular the trials established as part of the codesign process, provided farmers with hands-on learning opportunities while enabling researchers to better understand local adaptation processes. Approaches that combined scientific inputs and methods with local knowledge and contributions while maintaining or developing farmer ownership proved most effective.

More generally, ALLs and the activity linked to the network of trials established in farmers' fields proved particularly successful in fostering mutual learning and innovation adaptation, and enhancing capacity of local organizations and research teams, leading to a series of positive early outcomes as documented elsewhere (see Blundo Canto et al. 2024 for Kenya for example).

Women's Empowerment

While different countries focused on women, India's experience with Women Self-Help Groups proved particularly effective in managing homestead models and bio-input preparation or in developing irrigation opportunities for women' groups through solar pumps. This approach proved particularly effective in empowering women farmers while ensuring the sustainability of agroecological innovations. The groups provided women with both technical skills and social support, enhancing their role in agricultural decision-making. Laos also emphasized the importance of women learning and empowerment.

These successes demonstrate how well-designed codesign processes; embedded in strong multistakeholder collaboration through the ALLs can generate benefits across different stakeholder groups while advancing agroecological transitions. The experiences highlight the importance of combining technical innovation with social empowerment while maintaining strong institutional support systems through the ALLs. Future activities in the AEI countries and ALLs or in new contexts can build on these successful generic components while adapting them to specific local contexts and needs.

What worked less well

Based on the country reports, several key challenges emerged in the codesign process that affected different stakeholder groups in distinct ways.

Operational and Logistical Challenges

Time constraints, logistical issues and delayed implementation created significant difficulties across multiple countries. In Kenya for example, delays in soil analysis prevented farmers from receiving timely feedback for planning their next trial cycle. The research team there struggled to maintain the planned schedule of activities, which in turn affected farmer participation and result quality. These delays particularly impacted resource-poor farmers who had allocated limited land and resources to the trials.

Technical Implementation Issues

Data collection and quality control posed significant challenges for several research teams. Kenya's experience with electronic monitoring forms showed how limited testing before deployment could create difficulties in data management and analysis. These technical challenges particularly affected field staff who needed to collect and manage data while maintaining engagement with farmers.

Infrastructure and resource Limitations

Many countries faced challenges related to inadequate infrastructure and resource constraints. Zimbabwe's experience with demonstration plot placement illustrated how site selection affected both trial results and farmer engagement. In Burkina Faso, the lack of suitable infrastructure for fodder conservation and storage prevented farmers from properly preserving their trial outputs. In some cases, the high initial investment costs (capital, labor, inputs, etc.) implied by some innovations (e.g. agroecological homestead models, solar pumps but also conservation agriculture) also created challenges. This is especially important as in many cases, financials services available to resource-poor farmers (the vast majority of those the AEI worked with across countries) are limited and hence they depend a lot of the external interventions such as the AEI to solve access issues, at least in the short-term.

Constraints related to stakeholder participation

Limited engagement from certain stakeholder groups emerged as a common challenge. In Tunisia, women's participation was constrained by household workload demands, while youth showed little interest in agricultural activities. The private sector's inconsistent engagement restricted opportunities to address systemic challenges like market access and financial services. These participation gaps particularly affected marginalized groups who could have benefited from more inclusive innovation processes.

Communication and knowledge sharing & diffusion

Language barriers and difficulties in translating scientific concepts into practical knowledge affected knowledge sharing effectiveness. Peru's experience with cocoa farmers showed how technical language could create barriers to understanding and implementation. This challenge particularly impacted farmers with limited formal education who struggled to engage with more technical aspects of the trials.

Coordination among partners and stakeholders

Weaker-than-desirable coordination between research institutions and local implementing partners created inefficiencies at certain times. In Kenya, organizational and logistics delays at times hampered the smooth implementation of planned activities. These coordination challenges particularly affected local partners who needed to manage relationships with both research teams and farmer groups.

These challenges demonstrate the complexity of implementing codesign processes in diverse agricultural contexts. The experiences across countries highlight the importance of addressing both technical and social dimensions while ensuring adequate support for all stakeholder groups. Future initiatives will need to develop specific strategies for overcoming these challenges while maintaining strong stakeholder engagement throughout the process.

4.2 How did the codesign of innovations (process, results) contribute to agroecological transitions?

Based on the country reports, the codesign process has made several significant contributions to agroecological transitions and stakeholder visions for the future.

System-Level Transformations

The codesign process has catalyzed important system-level changes across multiple countries. In Burkina Faso, the integration of dairy production, fodder cultivation, and manure management has strengthened crucial agriculture-livestock interactions. This systems’ approach has improved milk production while enhancing nutrient cycling and resource efficiency and improving fodder production sustainability, and building farmer capacity in agroecological techniques. It also strengthened links between producers, collectors, and processors. The process helped stakeholders envision and implement more integrated farming systems that align with agroecological principles. Similarly, system level effects although at the cropping systems level are being obtained in Zimbabwe by combining push-pull systems, while in Tunisia mixed forage systems enhanced both biodiversity and soil health

Knowledge Integration and Capacity Building

The codesign process has contributed greatly to effectively bridging scientific and traditional & local knowledge systems, as already reported previously. The establishment of ALLs created valuable spaces for knowledge exchange and cross-learning between farmers, extensionists, and researchers. This integration has enhanced the cultural relevance of innovations while building local capacity for continued adaptation.

Stakeholder Empowerment and Vision Development

The codesign process has empowered stakeholders to take active roles in shaping their agricultural futures. In Tunisia, farmers moved beyond being passive recipients of technology to become active participants in developing regional brands for their products. This transformation has strengthened their sense of agency and ownership in the transition process. India's experience with women's self-help groups showed how participatory approaches could enhance both technical capacity and social empowerment.

Policy and Institutional Alignment

The codesign process has helped align stakeholder visions with broader institutional frameworks. In India, government stakeholders have shown increased willingness to support scaling through existing programs, demonstrating how codesign can influence policy implementation. Senegal's use of modelling at different scales has helped stakeholders visualize transition pathways and align them with institutional support mechanisms.

Market System Development

Codesign processes have contributed to more sustainable market systems. As noted earlier, Burkina Faso's dairy innovation platform has strengthened links between producers, collectors, and processors, creating more stable value chains. This market system development has provided economic incentives for maintaining agroecological practices while ensuring broader distribution of benefits.

Environmental Sustainability Enhancement

The process has advanced environmental sustainability goals across different contexts. Zimbabwe's mother trials demonstrated important synergies between push-pull systems and conservation agriculture, enhancing both productivity and ecosystem services. Tunisia's work with intercropped forage systems has improved biodiversity while maintaining productive capacity.

Social Learning and Innovation

The codesign process has fostered important social learning and innovation dynamics. Peru's experience with cocoa farmers showed how participatory approaches could generate contextually appropriate solutions while building local innovation capacity. This social learning process has strengthened farmers’ individual and collective ability to continue adapting and improving their farming systems.

Long-term Vision Development

The process has helped stakeholders develop more comprehensive long-term visions for their agricultural systems. Senegal's integration of modelling approaches has enabled stakeholders to better understand potential transition pathways and their implications. This enhanced understanding has strengthened commitment to agroecological transitions while identifying crucial support needs.

These contributions demonstrate how codesign processes can facilitate meaningful progress toward agroecological transitions while strengthening stakeholder capacity and commitment. Experiences across countries show that well-structured codesign approaches can generate both immediate benefits and longer-term transformative change.

4.3 Specific suggestions and recommendations for engaging in codesign in the future

Based on the country reports and further thinking at the WP1 global level, several key recommendations emerge for future codesign processes within the context of intervention geared at fostering agroecological transitions and probably other types of transitions as well.

Generic / standardized methodological guidelines

The experiences across countries demonstrate the need for standardized (generic) methodological frameworks and concrete guidelines that provide clear structure, sequences and tool suggestions for engaging in codesign while maintaining flexibility for local adaptation. (NB: some of the guidelines developed and used in AEI are already integrated in the Agroecological living landscapes toolkit: see Voss et al., 2024; the detailed V2A guidelines can be found in Triomphe et al., 2024).

The Zimbabwe team specifically called for frameworks that can capture interactions between different agroecological practices, while maintaining scientific rigor. Kenya's experience highlighted how methodological guidance should explicitly discuss the implications of different approaches, tools sequencing, and facilitation modalities. This type of guidance may help different teams navigate the progression from initial engagement through implementation and evaluation phases.

Among the aspects such guidelines should cover, it will be important to include improved economic and social indicators at the various scales needed (see below), also able to track cumulative effects on a host of ecosystem services (i.e. beyond those related to production and soil health). Considering its power, participatory modelling of different kinds and at various scales may become an important tool for supporting codesign as illustrated by its use in Senegal or Burkina Faso, but this will require specific attention, investments, adaptation and calibration to each local context and hence may need specific guidelines in the future.

We will now get into a number of specific details and themes related to what such overall methodological guidelines might entail.

Participatory monitoring and evaluation frameworks

The experiences from Kenya, Tunisia and Burkina Faso in particular demonstrate the importance and relevance of developing monitoring and evaluation frameworks that integrate both scientific metrics, farmer criteria and technical knowledge from the outset, including the use of traditional units of measurement and local soil classification systems. Also, capturing both quantitative data and qualitative insights provides a richer understanding of technology performance and adoption potential.

Doing the above, and combining it with systematic translation of scientific data into farmer-friendly formats (incorporating appropriate visuals) and with capacity building helps bridge the frequent gap in knowledge, understanding and communication between researchers and farmers. This integration also improves data quality while maintaining relevance for both groups.

This is further validated beyond WP1, for example by the experience in WP2 with HOLPA design and implementation for assessing the performance of agroecology (Jones et al. 2024).

Types of measurements / variables that are particularly useful as part of the M&E of the trials and codesign process?

Based on the country reports and experiences, several categories of measurements and variables emerged as particularly valuable for monitoring and evaluating agroecological trials and codesign processes. While not at all forming an exhaustive list, the following indicators seem particularly useful across countries as part of the MEL of a codesign process or a set of codesigned trials (even through any indicator should only be used if it makes sense in the local context and framework of the technologies being tested).

Agronomic and Ecological Indicators

- Pest incidence and severity
- Soil moisture and fertility
- Water use efficiency
- Biodiversity metrics

The measurement of pest incidence and severity proved especially important across multiple countries. Zimbabwe's experience with fall armyworm monitoring in push-pull technology trials demonstrated how tracking specific pest pressures could validate intervention effectiveness. Soil moisture and fertility measurements also emerged as critical indicators, particularly during dry periods, for evaluating water use efficiency and long-term effects of practices like biochar and conservation agriculture.

Tunisia's work with mixed forage systems showed the value of tracking biodiversity metrics to assess ecosystem functionality. Their experience demonstrated how these measurements helped evaluate both agricultural productivity and ecological resilience. Kenya's approach to soil analysis, though initially delayed, provided crucial data about the long-term impacts of different management practices. Obviously, assessing soil fertility / soil health relies on different dimensions, not all of them accessible via soil sampling and lab analysis, and then the issue of reliability of laboratories and costs can become very important.

Economic and Labor Measurements

- Production costs
- Labor requirements
- Input costs
- Market access indicators

The systematic collection of economic and labor data emerged as essential for understanding adoption potential. It has however to be done with a view to capturing the variability of such costs across different farms, which may require collecting and monitoring them outside of the experiments themselves. There are also specific methodological protocols and requirements.

Production costs and input requirements proved particularly valuable for assessing the practical feasibility of different interventions. Labor, disaggregated by gender is an especially key indicator as often times, agroecological technologies meant to reduce external input use may induce extra labor investment. Zimbabwe highlighted the need to track production costs and labor requirements as they directly influence adoption decisions. Burkina Faso's illustrated the importance of tracking labor requirements across all activities to validate farmer feedback about technology intensity. Peru's experience showed how tracking market access indicators and value chain relationships provided a crucial context for technology adoption decisions. Tunisia emphasized capturing gender-specific impacts and ensuring women's participation despite cultural and workload constraints.

Social and Participatory Indicators

- Farmer satisfaction rates
- Technology adaptation and adoption rates
- Gender-disaggregated participation
- Knowledge diffusion and transfer indicators

While it is listed, adoption rates are not necessarily an easy indicator to measure. In the short term, adaptation and use rates are probably more relevant than adoption rates per se, which tend to only become meaningful (and reliable) over the long-term, and outside of the experiments.

Gender-disaggregated participation data proved especially valuable for understanding technology accessibility and adoption patterns. Zimbabwe and Kenya's rating and ranking tools revealed how different age and gender groups valued distinct aspects of agricultural innovations. Tunisia's experience showed the importance of measuring both technical outcomes and stakeholder acceptance. Peru also suggested incorporating behavioral and attitudinal change indicators.

How increased knowledge and capacity or behavioral changes can be best assessed is by itself a topic that would require deep reflection. Just counting training events or participants in such events and proceeding to hot assessments on the heels of a training event or during an exchange visit is just one piece of evidence among the several that would be desirable to collect and analyze.

Monitoring the codesign process

- Events and practices timeline
- Local technical knowledge integration
- Implementation challenges

Documentation of events and practices throughout the implementation process emerged as crucial for understanding success factors and failures and for tracking how the codesign process is moving forward. Burkina Faso's comprehensive tracking system helped explain variations in results and informed future improvements. Also, the integration of local technical knowledge indicators in the MEL of the codesign, such as local measurement units and quality criteria, enhances the relevance of collected data.

Finally, proper documentation of implementation challenges is critical, as it is the interaction between plans and implementation that shapes the eventual quality, limitations and validity of the results obtained.

Digital Monitoring Tools

Zimbabwe's and Kenya's experience with KoBo Collect and QR codes demonstrated how digital tools (which can and should be refined further) could improve data accuracy, quality and accessibility and reduce inconsistencies in farmer records. It also helps with their analysis within short time frames. Again, investments are needed to develop generic digital tools and provide the keys, including through capacity building, to adapt them to specific needs and contexts.

These findings suggest that many valuable measurements used in the AEI countries combine scientific rigor and knowledge with practical relevance for farmers. Success requires careful selection of indicators that can track both immediate impacts in multiple dimensions and longer-term changes while remaining feasible to collect and meaningful for all stakeholders. Adopting such a balanced approach ensures that monitoring data serves both research needs, stakeholder continued engagement and motivation, and practical decision-making requirements at the individual and collective level.

Data Collection Frameworks

The experiences across countries highlighted the critical importance of well-structured and robust data collection protocols to track both immediate and long-term impacts. Interestingly, Zimbabwe's team found that focusing on fewer but more frequently and comprehensively monitored trials yielded better quality data. They recommended concentrating efforts on 5 trials per district with frequent, with measurements tracking key variables like soil moisture and pest incidence. Kenya's experience showed how geographic data and farm typology could guide more purposive trial site selection to maximize data utility. Burkina Faso emphasized monitoring events and practices throughout the process to understand success factors and failures. India recommended establishing clear protocols for documenting agronomic, financial, and environmental impacts systematically. Peru suggested incorporating behavioral and attitudinal change indicators to capture learning outcomes.

Quality Control protocols

Several teams emphasized the need for stronger quality validation procedures. Kenya's experience with delayed soil analysis highlighted how critical it is to validate input quality before trials begin. They found that late verification of compost and manure quality significantly impacted trial outcomes. Tunisia developed a systematic approach combining scientific measurements with farmer assessments, showing how quality control can integrate both technical and practical perspectives.

Synthesis about monitoring and evaluation recommendations

These detailed recommendations reflect the complexity of monitoring codesigned experiments and process while maintaining practical feasibility. Success requires careful attention to both technical rigor and stakeholder engagement, supported by systematic documentation and effective communication systems. The experiences across countries demonstrate how different approaches can be adapted to local contexts while maintaining consistent quality standards.

This structured approach to monitoring and assessment provides a foundation for generating reliable evidence about agroecological innovations and transition while ensuring results remain relevant and accessible to all stakeholders.

Integrating multiple scales and multiple types of innovations

Future codesign processes, especially as they are expected to contribute to scaling of agroecology, need to better integrate codesign activities and objectives across plot, farm, communities and landscape scales, and possibly across other relevant scales depending on the context and objectives: value chains, region, or national. They also need to **address explicitly the codesign of various types of innovations** including organizational and institutional ones (WP1's mandate in the AEI was limited to technological innovations, and furthermore narrowed in, perhaps without much explicit reflection about it, or for lack of staff with different experience and skills, on innovations related to agricultural production). Senegal's experience with **complementary modelling approaches** at various scales (farm, landscape, department) illustrates how different tools can address specific challenges while maintaining coherence across scales. Tunisia recommended **expanding stakeholder engagement** beyond farmer groups to include diverse actors such as unions, media, and financial institutions for a more holistic strategy

The transition from farm-level innovations to landscape-and superior level transformations will require careful attention to cross-sector issues and perspectives (agriculture, forestry, water, but also education, transport, health, etc.) and the corresponding stakeholder engagements at the various relevant levels, which will require explicit mapping efforts.

Enhancing Stakeholder Engagement

The country experiences emphasize the importance of more inclusive and sustained stakeholder engagement. Tunisia's recommendation to expand participation beyond farmer groups to include media, financial institutions, and other value chain actors reflects the need for broader systemic change. India's experience showed how a preparatory phase focused on trust-building and stakeholder alignment can strengthen subsequent implementation.

Another important issue is ensuring better representation of stakeholder diversity within a given stakeholder group. in terms of. This is especially true with respect to the vast but globally fairly undifferentiated stakeholder category “farmers”, used by most countries without providing much evidence of its diversity in terms of gender, age, wealth or objectives or also modes of organizations (formal or informal, grass-root vs. umbrella organizations, etc.).

In this respect, gender should be a key dimension to consider in terms of inclusion and empowerment (access to knowledge, to resources), as stressed particularly by the Laos team. Structured efforts in this direction started under WP5 and will be expanded in the MFL program.

Particular attention will need to be paid to ensuring stronger private sector participation, especially as the attention moves from improving production to strengthening the connection of farmers with markets, value chains and consumers

Ensuring sufficient space for local knowledge and innovators

Paradoxically, several countries acknowledged that limited room perhaps was given to local knowledge and experience during the codesign process. This needs to be addressed as a matter of coherence with Agroecology principles and equity. All the more so that several programs and networks, such as PROLINNOVA or also WOCAT, have documented the richness of farmer knowledge and innovations, frequently in complementary dimensions and themes compared to R&D-developed innovations.

Related to this, there seems to be a significant value in engaging in systematic innovation tracking approaches to identify poorly visible local innovations and innovators (expanding and adapting the approach used by Kenya in 2023 – see 2023 Kenya and global codesign reports and Kenya by incorporating methodological steps suggested by Salembie et al., 2021).

Codesign and participatory governance

Country team would also benefit from developing more inclusive governance mechanisms at the ALL level in which farmers and their organizations would have more say (and control) over the codesign process and the allocation of resources (see Navarrete et al. 2024). This would among others require international researchers to take a few steps back and focus perhaps more in the future on strengthening local capacities particularly at the process and analysis levels, and on facilitating and accompanying the codesign process rather than leading and (micro)managing it.

These insights can inform the design and implementation of future agricultural innovation programs, helping to strengthen their effectiveness and sustainability, starting with the implementation of the Multifunctional Landscape program.

Training and Capacity Building

Already mentioned as part of the M&E frameworks above, but it is worth singling it out as it has a strategic role (as also highlighted in the principles of engagement: see Triomphe et al. 2023). While researchers tend to think that it is mostly farmers and local technicians that need capacity-building, India's experience highlighted the importance of building capacity among both researchers and farmers for effective joint assessment. Their approach included training farmers in basic monitoring techniques while educating researchers about local farming practices and assessment criteria. This mutual learning process strengthened the quality of joint assessments.

More generally, training and capacity building should address technical capacity, managerial capacities and what some call innovation or transformative capacities, i.e. a set of soft skills related to understanding and navigating complex environments and situations, engaging in collaboration with other stakeholders, influencing policy, or being able to be reflexive and engage in experimentation (TAP 2017).

The synthesis of these experiences suggests that successful integration of researcher and farmer assessments requires careful attention to both technical rigor and practical relevance. Key success factors include establishing clear protocols for combining different types of quantitative and qualitative information and knowledge, maintaining regular engagement and communication, and creating spaces for joint learning and adaptation. This integrated approach helps ensure that monitoring and assessment results are both scientifically valid and practically useful for all stakeholders. Such findings provide guidance for future efforts to better combine researcher and farmer assessments of codesign process and results and in doing so, contributing to agroecological transition.

Knowledge and experience sharing, feedback and communication mechanisms

Future codesign processes should ensure robust, diverse, effective and periodic knowledge sharing and learning mechanisms (physical platforms such as the ALLs or similar, digital platforms, networks, knowledge exchange events, etc.) are in place from the outset, able to facilitate dialogue and understanding among diverse stakeholders, as well as co-creation of knowledge. Peru recommended rotational exchanges in experimental plots to deepen learning. Kenya suggested strengthening farmer-to-farmer outreach modalities and documentation of informal knowledge transfer. Tunisia's experience showed how involving farmers in data interpretation sessions helped develop a shared understanding and validation of results. Digital platforms, even as simple as WhatsApp exchange groups used in Kenya, when properly implemented and made accessible to diverse stakeholders, can support continuous engagement and real-time sharing and feedback throughout the process. Such digital platforms may become generalized even though they will not replace the need for face-to-face interactions, especially when it comes to ensuring participation of and contributions by local stakeholders without creating exclusionary barriers for stakeholders least able to access digital resources.

Systematization of experiences and learnings and their proper diffusion also need to be addressed by each country team, in part by developing stronger and truly multidimensional internal participatory MEL procedures and systems (i.e. at the various scales each country is working with farmers, communities, ALL & national levels), and without depending too much on external or centralized resources, approaches and plans for fomenting such learning.

Climate Resilience Integration

Given increasing climate variability, future codesign processes must better incorporate climate resilience considerations and strategies. For example, Zimbabwe's experience highlighted the importance of including water harvesting technologies and drought-resistant varieties in the innovation portfolio. More generally, M&E systems should be able track climate impacts and adaptation strategies more systematically.

Policy and Market Integration

The reports emphasize the need for stronger linkages and integration between experimentation, policy frameworks and market systems from the early planning stages. India's experience showed how alignment with government programs could leverage resources and create synergies for scaling. Senegal recommended using integrated landscape approaches to align agroecology with global frameworks on climate change, biodiversity, and land restoration.

Long-term Impact Assessment

Future processes need better frameworks and methods for capturing long-term impacts on system resilience and sustainability. Burkina Faso's experience with its dairy innovation platform illustrates the importance of tracking both immediate outcomes and longer-term systemic changes. India recommended establishing systematic protocols for documenting environmental and social changes over time. For its part, Senegal's experience with landscape-level modelling illustrates how longer-term impacts (for example: biomass availability at the territorial level) could be projected and monitored at different scales. Overall, assessing long-term effects and (potential) impacts requires careful attention to developing appropriate indicators and M&E systems.

Private Sector Engagement

Most countries identified the need for stronger and meaningful private sector participation from the outset. Zimbabwe's experience highlighted how private sector engagement can help address systemic challenges like market access and financial services. Tunisia suggested creating platforms that facilitate dialogue between agricultural stakeholders and private sector actors.

Overall concluding remarks on recommendations

These recommendations reflect increasing awareness, understanding and hands-on experiences with the many aspects and implications of fostering codesign processes for agroecological transition. Eventual success in achieving the desired changes requires careful attention to both technical and social dimensions while maintaining flexibility to accommodate local contexts and emerging opportunities.

Conclusions

This consolidated report provides a summary overview of the innovation co-design process and its results in terms of the innovative practices put under trial across the various ALLs established in seven countries within the context of the Agroecology Initiative. As this report has amply demonstrated and illustrated, codesign has been ongoing in all countries at a variable pace, and on a variable array of technologies, depending on circumstances and possibilities. At this stage, most countries have implemented one or two experimental cycles, and analyzed the corresponding results. How much was actually achieved reflects in part the specificities of the cropping systems and calendars in the different countries and other context-related implementation issues. More importantly, it was a direct consequence of the significant and at times challenging time investment required from each ALL and its supporting AEI team to be in a position to truly and knowingly negotiate with and agree among ALL concerned stakeholders on the content and form of what a desirable set of experiments should be about (such as type of technologies/innovations, experimental setups, monitoring and assessment criteria and methods, etc.).

This report illustrates the diversity of approaches that countries implemented in going about codesign, which is a tribute to the AEI teams' creativity, resourcefulness, and enthusiasm in engaging in and learning by doing what codesign and doing research differently entail and how this allows us to consider farmers' needs, experience, and knowledge, and attempts to give them a real voice as co-researchers in what is being researched / experimented / proposed. Indeed, in doing so, several teams have gone beyond what WP1 leadership had envisioned initially or was able to provide in terms of concrete methodological guidance and support. This diversity thus constitutes a great source of richness and further learnings across the AEI.

The approaches used, and the results obtained provide a clear and indeed welcome contrast with more conventional researcher-controlled approaches to technology development, which while seemingly more rigorous (at least, more quantitative) tend to take less time, but also have less potential for meeting farmers' needs and, in our specific case, for meeting farmers' and other stakeholders' vision with regard to where they want to go with agroecology. Codesign also offers a host of associated benefits, such as helping to strengthen the capacity of local stakeholders in developing innovations, creating a sense of ownership, and reshaping the interactions and hierarchies among actors.

Altogether, the multi-faced results obtained by end of 2024 illustrate the great value of codesign approaches in contributing to innovation testing, validation and use / adoption, and to agroecological transitions that meets ALLs stakeholder needs and vision. The way forward for each ALL and country team looks promising and the results and lessons obtained during the AEI cycle (2022-2024) provide a strong platform and many key avenues for deepening and improvements of the approaches used for the next phase, i.e. the start of the new Multi-Functional Landscapes (MFL) Science Program of the CGIAR. While not limited to the 8 countries of the AEI, or to agroecological transition, the MFL Science Program will continue with participatory, multistakeholder approaches such as the ones used in the AEI and in WP1 in particular.

The perspectives as they stand at the end of 2024 are many-fold:

- First, all countries are highly motivated and ready to continue with the codesign process they started or conducted in 2023-2024, including finalizing the ongoing cycle of experimentation and assessing the corresponding results and lessons, and planning and implementing new cycles if possible.
- In doing so, country teams will also need to put codesign results in perspective by assessing how they contribute to transition pathways and to the vision ALL stakeholders have identified for a desirable future and for agroecological transition in particular.
- Another major investment will be to systematize more fully the approaches, experiences, and results across countries, and identify or validate lessons of different kinds (be it regarding technologies, codesign processes, approaches, methods and tools, multi-stakeholder collaboration, etc.). For a start, the output of such systematization will inform the MFL Science Program of the CGIAR that is initiating in early 2025. It will also be shared widely and in different forms with the many relevant and interested research, R&D, and practitioners' communities and networks locally, nationally, and internationally (see for example Busse et al. 2023).
- The International network of ALLs that WP1 initiated and facilitated in 2024, along with the Agroecology TPP or the Agroecology Coalition constitute some of main choice arenas for contributing to wide sharing and exchanges on the issue of codesign of agroecological innovations. Another avenue will be to integrate the results and lessons synthesized in this report in an upcoming comprehensive and user-friendly methodological guide that will address key steps of codesign from the assessment of existing innovations to participatory monitoring and evaluation all the way to result analysis. It will also attempt to address the multiple scales at which codesign needs to take place will be one more avenue for transmitting the lessons and experiences, along with more classical academic articles.

The road to be travelled is still long but it is an exciting one. We sincerely hope that this road will take the AEI teams and their many national or local partners much beyond 2024, and towards successful AE transitions.

References

Global references

Busse, M., Zscheischler, J., Zoll, F., Rogga, S., & Siebert, R. (2023). Co-design approaches in land use related sustainability science–A systematic review. Land Use Policy, 129, 106623.

Mottet, A., Bicksler, A., Lucantoni, D., De Rosa, F., Scherf, B., Scopel, E., López-Ridaura, S., Gemmil-Herren, B., Bezner Kerr, R., Sourisseau, J.-M., Petersen, P., Chotte, J.-L., Loconto, A., & Tittonell, P. (2020). Assessing Transitions to Sustainable Agricultural and Food Systems: A Tool for Agroecology Performance Evaluation (TAPE). Frontiers in Sustainable Food Systems, 4. https://doi.org/10.3389/fsufs.2020.579154

Salembier, C., Segrestin, B., Weil, B., Jeuffroy, M. H., Cadoux, S., Cros, C., … & Meynard, J. M. (2021). A theoretical framework for tracking farmers' innovations to support farming system design. Agronomy for Sustainable Development, 41(5), 61.

TAP, 2017: Common framework on capacity development for Agricultura innovation Systems. Synthesis Document. CAB International, Wallingford, UK https://tapipedia.org/resources#tabs-0-contentmain1

WP1 and other WPs consolidated reports and methodological documents

Jones, S.; Sanchez, A. (2024) Holistic Localized Performance Assessment (HOLPA) tool for collecting evidence on the impact of agroecology. Presented 17 December 2024. 11 sl. https://hdl.handle.net/10568/168908

Monserrate, F.; Berre, D.; Triomphe, B.; Baudron, F. (2024) Synthesis of agronomic assessment for co-designed trials and recommendations. 35 p. https://hdl.handle.net/10568/169320 Navarrete Cruz, A.; ElDidi, H.; Piraux, M.; Fuchs, L.E.; Tristan, M.C.; Matangi, D.; Chimonyo, V.; Alary, V.; Idoudi, Z.; Frija, A.; Triomphe, B.; Bergamini, N. (2025): Governance structures and mechanisms of Agroecological Living Landscapes in five countries. 41 p.: https://hdl.handle.net/10568/169531

Navarrete Cruz, A.; Piraux, M.; Bergamini, N.; Triomphe, B. (2024): Reading note 2: Internal governance of living landscapes. Agroecology Initiative Reading Notes WP1 Global Team. 15 p. https://hdl.handle.net/10568/152191

Triomphe, B.; Bergamini, N.; Fuchs, L.E. (2022): Engaging with stakeholders for initiating agroecological transition in Living Landscapes: Six guiding principles. 30 p. https://hdl.handle.net/10568/127414

Triomphe, B.; Chimonyo, V.; Fuchs, L.E.; Rudiger,U.; Vall, E.; Mbaye, B.; Sanchez Choy, J.; Dubois, M. (2023): Co-designing technical innovations in the context of agricultural living landscapes. 61 p. https://hdl.handle.net/10568/138923

Triomphe, B.; Bergamini, N.; Fuchs, L.E.; Falk, T.; Blundo Canto, G.; Alary, V.; Rietveld, A. (2024): From Vision to Action (V2A) in agroecological transformation: Understanding and implementing principle-driven participatory action research in agroecological living landscapes. 48 p. https://hdl.handle.net/10568/169532

Voss, R.C.; Freed, S.; Fuchs, L.E.; Triomphe, B.; Bergamini, N.; Dickens, C.; Quintero, M. (2024): Agroecological living landscapes toolkit. 29 p. https://hdl.handle.net/10568/169255

Voss, R.C.; Freed, S.; Falk, T.; Rietveld, A.; Rahma, A.; Alary, V.; Beltran, M.; Braiki, H.; Frija, A.; Guettou Djurfeldt, N.; Hamrouni, D.; Idoudi, Z.; Jaouadi, R.; Lestrelin, G.; Mathenge, C.; Manjella Ndiwa, A.; Singh, S.; Tristan, M.C.; Zingwena, T. (2024): Agency and behavior change in agri-food systems transformation: Lessons from the CGIAR Agroecology Initiative. 44 p. https://hdl.handle.net/10568/141843

Country documentations

The below reference lists are as indicated in the country codesign reports, but may not be up-to-date as many country reports were submitted after this report was developed.

1. Burkina

Anon. 2023b. "Work Package 1. Formalization of the Burkina Faso Agroecological Living Landscape (Based on the Actors of the Local Dairy Value Chain). Bobo-Dioulasso, 28-30 March 2023". Monograph. CGIAR Initiative on Agroecology. 2023. https://agritrop.cirad.fr/607632/ .

Lecomte, Philippe. 2022. "Jaɓnde A software tool for cattle feed supplementation in pastoral and agropastoral dairy herds in sub-Saharan Africa".

Ouattara, Songdah Désiré, Ollo Sib, Souleymane Sanogo, Etienne Sodre, Eric Vall, and David Berre. 2024b. "Agronomic Assessment of Agroecological Technologies Codesigned and Experimented with the Dairy Farmers Members of the Agroecological Living Landscape of Burkina Faso". Monograph. CIRAD. 2024b. https://agritrop.cirad.fr/611298/ .

Ouattara, Songdah Désiré, Ollo Sib, Souleymane Sanogo, Etienne Sodre, Eric Vall, CIRAD-FRA, CIRDES-BFA, and INERA-BFA. 2024a. "Loop- and Cascade-Based Co-Design of an Agroecological Dairy Farming System in Burkina Faso". CIRAD; CIRDES-INERA. https://doi.org/10.18167/AGRITROP/20326 .

Ouattara, Songdah Désiré, Ollo Sib, Issouf Traore, Baba Ouattara, and Eric Vall. 2024c. "Training Sessions of Volunteer Dairy Farmers during the Workshops Launching the 2024 Campaign of Experimentation of Agroecological Technologies". Monograph. CIRAD. 2024c. https://agritrop.cirad.fr/611289/ .

Sib, Ollo, Valérie M.C. Bougouma-Yameogo, Mélanie Blanchard, Eliel Gonzalez-Garcia, and Eric Vall. 2018. "Dairy production in western Burkina Faso in a context of emerging dairies: diversity of breeding practices and proposals for improvement". Revue d'élevage et de médecine vétérinaire des pays tropicaux 70 (3): 81-91. https://doi.org/10.19182/remvt.31521 .

Sib, Ollo, Boko Michel Orounladji, and Songdah Désiré Ouattara. 2023a. "Work Package 1. Co-Designing an Agroecological Package with the Actors of the Burkina Faso Agroecological Living Landscape. Bobo-Dioulasso, CIRDES, May 11, 2023. Monograph. CGIAR Initiative on Agroecology. 2023. https://agritrop.cirad.fr/607635/ .

Vall E, Orounladji B M, Berre D, Assouma M A, Dabiré D, Sanogo S, and Sib O, 2023. Crop-livestock synergies and co-products recycling: major factors for agroecology in West African agro-sylvo-pastoral systems. Agronomy for Sustainable Development. 43:70. https://doi.org/10.1007/s13593-023-00908-6

Zoungrana, Sombénéwendé Rasmata, Djamilatou Saadatou, Ollo Sib, Alain Loabe Pahimi, Souleymane Ouedraogo, Valérie M.C Bougouma-Yameogo, and Eric Vall. 2023. "The CoProdScope: an assessment and advisory tool for crop and livestock co-product management designed to support agro-pastoral farms in their agroecological transition efforts". Revue d'élevage et de médecine vétérinaire des pays tropicaux, December, 10. https://doi.org/10.19182/remvt.37167

2. India

Malaiappan, S., Gadewar, P., Goverdhanam, S., Konwar, D., Kumar, G., Krishnan, S. & Sikka, A.K. (2024). Agroecological Homestead Model (AHM): Technical and Implementation report. International Water Management Institute (IWMI). AHM Technical - Implementation report_MS.docx

Malaiappan, S., Gadewar, P., Goverdhanam, S., Konwar, D., Krishnan, S., Kumar, G. & Sikka, A.K. (2024). Agroecology in Action: Empowering Tribal Communities in Mandla, India through trainings on Bio-fertilizer and Bio-pesticides. International Water Management Institute (IWMI). AE Report on AHM_TB.docx

Malaiappan, S., Gadewar, P., Goverdhanam, S., Konwar, D., Krishnan, S., Kumar, G. & Sikka, A.K. (2024). Microsite (Krishi kund) for restoration of degraded lands: Technical and Implementation report. International Water Management Institute (IWMI).

Kumar, G., Malaiappan, S., Sikka, A.K., Konwar, D. & Singh, S. (2024). Agroecology Homestead Model: Enhancing Nutrition, Soil Health, and Income for Tribal Farmers. In International conference on Tropentag 2024: Explore opportunities... for managing natural resources and a better life for all, Vienna Austria, September 11-13, 2024.

Malaiappan, S., Kumar, G. & Sikka, A.K. (2024). Krishi Kund for agroecological transition of degraded lands: Microsite for improved production and ecosystem services. In International conference on Tropentag 2024: Explore opportunities... for managing natural resources and a better life for all, Vienna Austria, September 11-13, 2024.

3. Kenya

Blundo Canto, G.; Owino, E.; Nekoye, H. (2024) Kiambu ALL Outcome Evidencing Report. 39 p. https://hdl.handle.net/10568/169711

Bolo, P.; Korir, H.; Adoyo, B.; Kuria, A.; Fuchs, L.E. (2024) Innovative agroecology practices improve maize and bean yields in nutrient-deficient sandy soils of Makueni, Kenya, Tropentag, September 11 - 13, 2024, Vienna. 1 p. https://hdl.handle.net/10568/168466

Fuchs, L.E., Adoyo, B., Orero, L., Korir, H., Sakha, M., Anyango, E., Ongus, E., van Dien, C., Kipkorir, L., Apondi, V., Ntinyari, W., Bolo, P., Mong'ina, D. (2023a) Transition pathways and vision-to-action in the Agroecological Living Landscapes (ALLs) in Kenya. https://hdl.handle.net/10568/138753

Fuchs, L.E., Korir, H., Adoyo, B., Bolo, P., Kuria, A., Sakha, M., Gumo, P., Mbelwa, M., Syano, N., Kiruthi, E., Orero, L., Ntinyari, W. Co-designing on-farm innovations in the Agroecological Living Landscapes (ALLs) in Kenya, 2023b. https://hdl.handle.net/10568/138714

Fuchs, L.E.; Bolo, P.; Staiger Rivas, S.; Korir, H.; Adoyo, B.; Kuria, A.; Orero, L.; Gumo, P.; Mbelwa, M.; Sakha, M. (2024a) Agroecological transformation in Kenya: partner organizations lead change. Rome (Italy): Bioversity International; Cali (Colombia): CIAT 4 p. https://hdl.handle.net/10568/141791

Fuchs, L.E.; Korir, H.; Bolo, P.; Sakha, M.; Gumo, P.; Mbelwa, M.; Kuria, A.; Adoyo, B.; Syano, N.; Kiruthi, E.; Baijukya, F.; Baudron, F. (2024b) Synthesis report on the co-design of agroecological innovations in the Agroecological Living Landscapes (ALLs) in Kenya. 50 p. https://hdl.handle.net/10568/169333

Korir, H.; Sakha, M.; Gumo, P.; Bolo, P.O.; Adoyo, B.; Mbelwa, M.; Kuria, A.; Mihindo, N.; Kiruthi, E.; Syano, N.; Kihoro, N.; Baijukya, F.; Fuchs, L.E. (2024a) Protocols for innovative agroecological soil, water and integrated pest management practices: Management techniques, trials establishment and monitoring. 48 p. https://hdl.handle.net/10568/152216

Korir, H.; Bolo, P., Sakha, M.; Gumo, P.; Mbela, M.; Kuria, A.; Adoyo, B.; Syano, N.; Kiruthi, E.; Baijukya, F.; Baudrin, F.; Fuchs, L.E. (2024b) Agronomic assessment of codesigned agroecological technologies and trials in Kenya. https://hdl.handle.net/10568/169333

Kuria, A., Bolo, P., Ntinyari, W., Orero, L., Adoyo, B., Korir, H., Syano, N., Kagai, E., Fuchs, L.E. (2023) Assessment of Existing and Preferred Agroecological Soil, Water, and Integrated Pest Management Practices in the Makueni and Kiambu Agroecological Living Landscapes, Kenya. https://hdl.handle.net/10568/137726

Kuria, A.W.; Bolo, P.; Adoyo, B.; Korir, H.; Sakha, M.; Gumo, P.; Mbelwa, M.; Orero, L.; Ntinyari, W.; Syano, N.; Kagai, E.; Fuchs, L.E., (2024) Understanding farmer options, context and preferences leads to the co-design of locally relevant agroecological practices for soil, water and integrated pest management: A case from Kiambu and Makueni agroecology living landscapes, Kenya. *Frontiers in Sustainable Food Systems* 8, 2024, https://doi.org/10.3389/fsufs.2024.1456620

4. Laos

Douangsavanh, Somphasith; Viossanges, Mathieu; Xaydala, Viengxay; Dubois, Mark. 2024. Sustainable water management: community-managed solar groundwater in Laos. Colombo, Sri Lanka: International Water Management Institute (IWMI). CGIAR Initiative on Agroecology. 4p. https://hdl.handle.net/10568/159567

5. Peru

Sanchez, J.; Gómez, V.H.; Monserrate, F.; Tristan, M.C. (2024) Codiseño de innovaciones agroecológicas en cacao: Reporte de ensayos experimentales. WP1: Reporte de ensayos experimentales. 28 p. https://hdl.handle.net/10568/168305

Sanchez, J.; Monserrate, F.; Gómez, V.; Tristan, M.C.; Correa, A.; Huapalla, A. (2024) Synthetic report on codesign of agroecological innovations for Peru. 39 p. https://hdl.handle.net/10568/169060

6. Senegal

Belmin, R.; Dione, G.; Banna, M.; Fall, M.G.; Kebe, N.B.; Ka, A.; Mané, C.; Fall, D.; Senghor, A.; Diallo, I.; Lo, O.; Diouf, A.; Ndour, C.N.; Sene, M.B.; Piraux, M. (2024) Conception d'un idéotype de territoire agroécologique pour le département de Fatick, Sénégal. Rapport d'atelier d'idéotypage. Dakar, Sénégal 2-6 septembre 2024. 59 p. https://hdl.handle.net/10568/168907

Piraux, M.; Belmin, R.; Ndour, M.; Fall, M.G.. Mbaye, B.; Bayo, F.; Ba, M.; Dione, G.; Mané, C.; Diallo, I.; Kouakou, P.; Lairez, J.; Diouf, A.; Ndour, C.N.; Sene, M.B.; Barry, A.; Diakhaté, P.B. (2024) Co-design of the agroecological transition path for the Fatick department. 42 p. https://hdl.handle.net/10568/169511

Piraux, M.; Mbaye, B.; Belmin, R.; N'Dienor, M.; Kouakou, P.K.; Ba, M.; Berre, D.; Delay, E.; Muller, J.P.; Cesaro, J. (2024) Synthetic 2024 report on codesign of innovation for Senegal. 27 p. https://hdl.handle.net/10568/169466

Piraux, M.; Sourisseau, J-M.; Sene Mame, B. (2024) Integrating agroecology into local development plans in the Fatick department. 24 p. https://hdl.handle.net/10568/169471

7. Tunisia

Amal Mannai, Aymen Frija, Udo Rudiger, Veronique Alary, Mourad Rekik, Ons Tebourbi, Zied Idoudi, Hatem Cheikh M'hamed, Salah Ben Youssef, Khouloud Chetoui, Imen Hemissi, Amira Hachana, Hanen Arfaoui, Ines Rahma Zoghlami, Mohamed Annabi, Yassine Hidri, Larbi Ajmi, Mahdi Fendri, Hanen Zaier, Anis Zaiem, Khalil Rahali, Bouthayna Abdi, Amna Ouergui, Hanen Chaabani. (31/12/2024). Synthesis Report on the Co-design of Innovations for the Tunisian Agroecological Living Landscape. Beirut, Lebanon: International Center for Agricultural Research in the Dry Areas (ICARDA). https://hdl.handle.net/20.500.11766/69856

Udo Rudiger, Aymen Frija, Veronique Alary, Zied Idoudi. (18/9/2024). Farmer-to-farmer exchange visits in the El Kef-Siliana transect: An effective way to connect and expand innovative practices. URL: https://www.cgiar.org/news-events/news/farmer-to-farmer-exchange-visits-in-the-el-kef-siliana-transect/ https://hdl.handle.net/10568/159620

Rudiger U et al. 2023: "Co-designing agro-ecological innovations and developing participatory indicators". Workshop report https://hdl.handle.net/20.500.11766.1/d172fb

8. Zimbabwe

Dorcas Matangi, Craig Murazhi, Telma Sibanda, Vimbayi G. P. Chimonyo (July 2024). Co-designing innovations in Zimbabwe: A comprehensive strategy toward agroecology transition. *AEI Codesigning Poster.pptx*, poster presentation.

Sibanda, T., Chimonyo, V. G. P. & Baudron, F. (2024). Agronomic assessment of co-designed agroecological technologies and trials in Zimbabwe. CGIAR. https://hdl.handle.net/10883/35326

Sibanda, T., Matangi, D., & Chimonyo, V. G. P. (2023). Co-designing of innovation in Zimbabwe. https://hdl.handle.net/10568/135755, scientific report.

Vimbayi G. P. Chimonyo, Telma Sibanda, Dennis J. Choruma, Gatien Falconnier and Frédéric Baudron (December 2023) Agroecological Living Landscapes: A Context Assessment in Mbire, Zimbabwe. https://hdl.handle.net/10568/135532, scientific report.

Vimbayi G. P. Chimonyo, Telma Sibanda, Dennis J. Choruma, Gatien Falconnier and Frédéric Baudron (December 2023) Agroecological Living Landscapes: A Context Assessment in Murehwa, Zimbabwe. https://hdl.handle.net/10568/135754, scientific report.

Vimbayi G.P Chimonyo & Craig Murazhi (August 2024). Innovating agroecology living landscapes in Zimbabwe. *https://www.cimmyt.org/blogs/innovating-agroecology-living-landscapes-in-zimbabwe/, blog.*

Telma Sibanda, Vimbayi G.P Chimonyo & Dorcas Matangi (December 2024). Evaluating the effectiveness and farmer preferences for adapted agroecological practices in established agricultural landscapes. *AEI_WP1_ZIM_Output_4.1.1_Effectiveness and Farmer Preferences.docx* , scientific report.

Annex 1: Analysis questions submitted to ClaudeAI

ClaudeAI Sonnet 3.5 model, formal form, was used to help synthesize information across the country reports. ClaudeAI was provided with thematic compilations from reports from 7 out of 8 countries (considering the late date of arrival of the Laos report, only superficial integration of its content was done to capture complementary issues not raised by other countries).

All questions were (re)formulated or derived from the original questions included in the generic country report outline that countries were asked to use– but not all countries responded to these original questions or understood it the same way!

Related to analysis of the codesign process

- General questions
    - *What have been the main steps followed and activities organized by the various countries for implementing the codesign process?*
    - *What are the main similarities and differences among countries in the way they implemented codesign?*
    - *Which stakeholders were involved in the codesign process, with what roles and with what specific contributions? How similar or different has the participation of various stakeholder been among countries?*
    - *How did the codesign process evolve over time (for country teams that implemented 2 or more cycles of codesign)?*
    - *What have been the main challenges with the codesign process? What have been the main lessons?*
- Questions related to the technologies
    - *What technologies were selected, how and why? How similar or different has the selection process been among countries?*
    - *What experiments were implemented where and with whom? (common tables)*
    - *What data or information was collected in each experiment? (common tables)*

Related to analysis of the technology adaptation and adoption issues

- Of the many technologies tested in the different countries, which specific ones have reached a sufficient level of maturity to allow farmers to use them?
- Of the many technologies tested in the different countries, which ones are considered not ready for use, and why not?
- What are the actual or potential benefits, challenges and drawbacks of the various technologies by farmers?
- Which types of farmers have been adopting the various technologies or seem more likely to adopt them?
- Is there any evidence of use and scaling of some of the tested technologies by farmers who were not directly involved in the experiments? Pls provide any detailed information available on this topic for each technology
- What specific activities and strategies have the various countries implemented so far (up to end of 2024) to share, diffuse and scale the various innovations?
- What do the various countries done intend to do in the near future to share, diffuse and scale the various innovations?? Is it different from what they have been doing until now?
- Can you develop a table on the model of Table 29 in the Tunisia section "Evaluation of agricultural technologies: Maturity, benefits, challenges, and scaling strategies" by country and then specific technology?

Related to analysis of Reflections, lessons and recommendations

- How useful has the codesign process been from the viewpoint of (1) international researchers, (2) national or ALL-level research & development partners, (3) farmers? Provide examples with your synthesis
- What worked especially well, why, and for whom?
- What worked less well, why, and for whom? Provide a synthesis and illustrate with a few examples
- How did the codesign of innovations (process, results) contribute to the agroecological transition and the vision of the ALL stakeholders about their future?
- Are there any specific suggestions and recommendations for how to go about codesign in the future and especially during the upcoming Multi-functional landscapes program?
- Are there certain types of measurements / variables that have been considered particularly useful as part of the monitoring-evaluation of the trials and codesign process? Which ones and why? Provide synthesis and concrete examples
- How best can the monitoring and assessment of the results conducted by researchers on one hand and on the other hand by farmers can be combined /articulated? Provide synthesis and examples
- Are there specific reflections and recommendations about how to conduct the monitoring, assessment and analysis process?
- What are the main generic recommendations that have been formulated for the next cycle of experimentation?

Annex 2: Highlights on specific useful methods and tools developed and used by some countries

The following Annex consists of four different highlights on specific approaches implemented in Kenya, Senegal, Burkina Faso, and Zimbabwe, respectively. The various highlights were provided upon request from WP1 leadership and authored by the corresponding teams. They are mere snapshots of approaches and tools being documented and sometimes published autonomously from this report by those same teams.

The four highlights included in this report are as follows:

1. A method for assessing existing innovative practices, by the Kenya team. It is up to now the most meticulous and systematic approach used in the AEI to look at existing practices before engaging in codesign, something frequently overlooked as scientists tend to focus more on external technologies or on diagnosing problems and constraints.
2. A method for codesigning ideotypes of agroecological cropping systems, by the Senegal team. Key in this approach is a focus on cropping systems rather than individual practices. Also, participants in the codesign are asked to explore creatively new horizons and new solutions without limiting themselves to what they already know, something scarcely done in typical approaches that favor the known rather than creativity.
3. A method for cascading experiments, by the Burkina Faso team. This relies on the fact that, at the farming system level, one innovation may be possible only if other ones are already in place. This is true in dairy systems in which interactions and synergies between crops and livestock are critical to the functioning of the farm.
4. Use of digital participatory tools for monitoring experiments, by the Zimbabwe team. This is useful to facilitate what can be a tedious and error-prone task. It also accelerates the interval between data collection and data use/return to farmers and scientists, which in more manual monitoring systems can be quite delayed.

1. Assessing existing innovative practices in Kenya

Lisa E. Fuchs,[12] Anne Kuria,[1] Peter Bolo,[2] Winnie Ntinyari,[3] Levi Orero,[1] Beatrice Adoyo,[1] Hezekiah Korir[3]

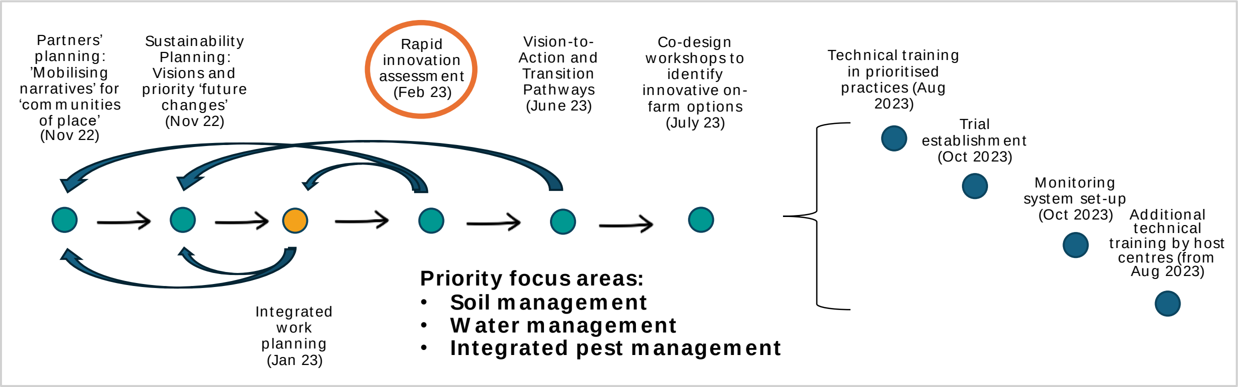
[1]World Agroforestry Centre (CIFOR-ICRAF). [2]Alliance of Bioversity International and International Center for Tropical Agriculture (CIAT). [3]International Institute of Tropical Agriculture (IITA).

Background

Agroecology is about co-creation and codesign. Both typically emphasize iteration cycles, which allow different individuals and groups of people to come together, present their views and perspectives, interact with each other's understandings and insights, and create new knowledge through these interactions. In the context of the CGIAR Agroecology Initiative (AEI), and its objective to contribute to improving the sustainability and resilience of agroecological on-farm practices in the Agricultural Living Landscapes (ALLs), the Kenya project team developed an innovative method to gain sufficient context-specific insights into the practices that already existed in each of the ALLs before engaging in further co-learning cycles.

The team was also interested in understanding more about farmers' experience with, and their evaluation of, these practices, and ultimately which practices they liked and were likely to be interested in adopting. The team considered this information vital to developing an evidence-based opinion that would allow making informed recommendations for practices that could potentially be interesting for farmer trials.

Drawing on the options by context (OxC) approach formulated by Sinclair and Coe (2019) and widely used at CIFOR-ICRAF and beyond, the Kenya team developed and applied an original method to assess existing innovative practices in its two ALLs in preparation of the planned codesign workshops. The rapid innovation assessment approach was also informed by previous engagement steps, including the partners' planning workshop through which the partners identified a mobilizing narrative around which the communities of place in their respective ALLs could be mobilized (see step 1 of the sustainability planning method of Fuchs et al., 2021). It further built on the initial engagement workshops (see steps 2 to 5 of the sustainability planning method) as well as the integrated 2023 work plans that the AEI Kenya team and partners developed and that operationalized the AEI logical framework while being responsive to priorities identified through previous engagements (**Error! Reference source not found.**).



Source: Authors

Figure 1: Innovation assessment context, iterations, and timelines in the Kenya ALLs.

Note: The orange circle on the timeline signifies that this was primarily an inclusive and reflexive team-led planning activity, while the other five were interactive and participatory workshops.

The method

Planning to interview and survey the farms of a sample of farmers in the ALLs (both those who had previously been trained and interacted with the ALL host centers and those who had not), the survey, or rather conversation guide entailing several closed- and many more open-ended questions, included three sections:

- Section 1: Socioeconomic farm and household characterization
- Section 2: Assessment of individual practices
- Section 3: Future aspirations and preferences

The first section focused on the central socioeconomic characteristics of the respondents, alongside the dominant farming system, perceptions of soil quality and their indicators, as well as perceptions of the effects of climate change.

To identify relevant existing innovative on-farm practices, the second section focused on precise farm and practice characterizations, alongside subjective performance evaluations. After naming and classifying existing options in terms of the existing soil, water, and IPM practices on-farm, as well as the crops on which the practices are implemented, their evaluation and performance in that specific context was addressed in six sections:

- General characterization: implemented since when, practice known/learned from where?
- Materials and mechanisms: use of locally available materials, reduction in or substitution of synthetic inputs, interaction with other organic or inorganic treatments, awareness of the scientific mechanisms behind the practice.
- Cost and viability: financial cost, labor intensity, gender roles in labor.
- Data collection and methods: previous data collection about the practice.
- Evaluation and context: effectiveness of the practice, contextual factors determining effectiveness, sensitivity to climate change.
- Additional observations: strengths, challenges, recommendations of wide application.

The last section then asked respondents more specifically about their aspirations in terms of future preferences; their main interests in terms of soil, water, and IPM; as well as their potential interest in participating in the trials and expected benefits from doing so.

Implementation

With the help of the ALL host centers, a total of 80 farms and their households were sampled for the rapid assessment across the two ALLs in Kenya (40 farms per ALL).

Because of the diversity and heterogeneous nature of the study areas, stratified random sampling was applied in each ALL. The sampling approach involved multiple stages to derive a sample that was representative of the biophysical and socioeconomic context and characteristics of the respective ALL populations. Five key factors were considered: (1) whether they had previously been trained by the host centers), (2) in which village they lived, (3) their gender, (4) their age, and (5) their land size.

The assessment was then conducted and data collected in February 2023 using semi-structured questionnaires that entailed both open- and closed-ended questions. Section 1 mostly entailed close-ended questions, while Section 2 combined closed- and open-ended questions and Section 3 almost exclusively open-ended questions. Prior to data collection, training and pre-testing were conducted at the host centers. The data were collected by the members of the WP1 team comprising researchers from CIFOR-ICRAF, the Alliance of Bioversity and CIAT, and IITA, as well as staff of the host centers.

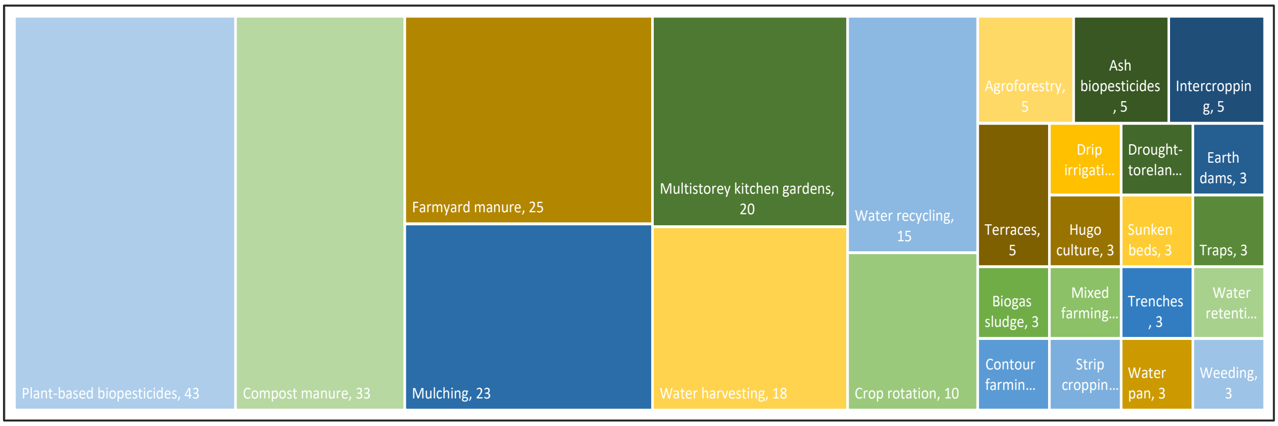
Results

The data analysis report (Kuria et al., 2023) focuses on the core themes targeted by the rapid assessment:

- Existing practices (options)
- Performance and evaluation (context)
- Future aspirations (preferences)

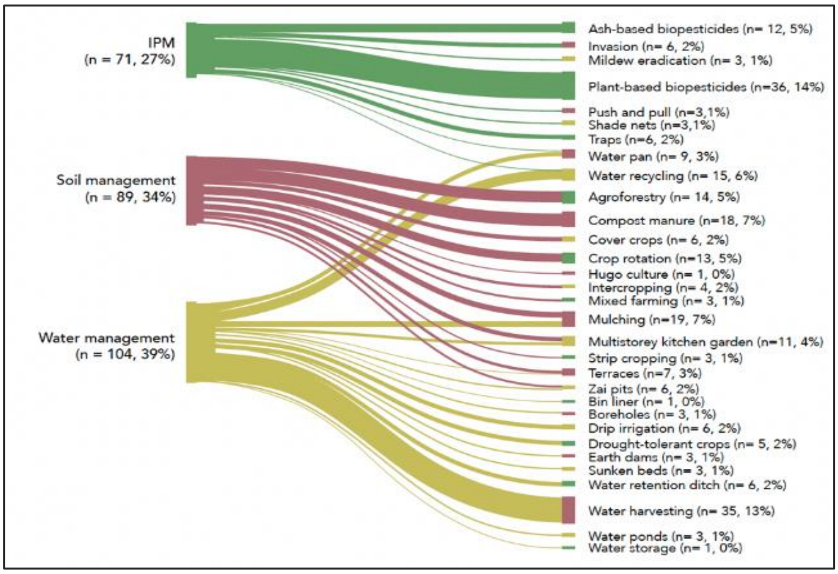
Some core highlights of the assessment were the identification of 27 unique options (see Figure), including 26 different practices identified in the Kiambu ALL and 13 in the Makueni ALL. In Kiambu, the five most commonly found options were plant-based biopesticides (43% of Kiambu ALL respondents), compost manure (33%), farmyard (animal) manure (25%), mulching (23%), and multistorey kitchen gardens (20%). In Makueni, the most common ones were farmyard (animal) manure (50% of Makueni ALL respondents), terraces (35%), compost manure (28%), plant-based biopesticides (25%), water harvesting (20%), and also agroforestry (18%).

- Looking at the preferences expressed in the Kiambu ALL, several interesting results emerged (see **Error! Reference source not found.**). Of the practices that were mentioned as preferred independently from whether or not they were currently implemented, the top ones were plant-based biopesticides (14% of all responses given by Kiambu ALL respondents), followed by water harvesting (13%), multistorey gardens (12%), compost manure (7%), mulching (7%), water recycling (6%), agroforestry (5%), crop rotation (5%), and ash-based biopesticides (4%). Although three-quarters of these practices were listed under a single priority area, about one-quarter were listed under two focus areas. The following practices were mentioned as addressing multiple functions: Soil and IPM: plant-based biopesticides
- Soil and water: terraces, mulching, multistorey gardens, zai pits
- Water and IPM: water recycling, water pans



Source: Fuchs et al. (2023)

Figure: Existing innovative practices (options) identified in the two Kenya ALLs.



Source: Kuria et al. (2023)

Figure : Preferred practices and their multiple functions identified in the Kiambu ALL, Kenya.

Note: Results from Makueni are not presented here but can be found in Kuria et al. (2023).

As indicated, while the context section entailed initial nominal (yes/no) questions, each of these questions entailed a qualitative follow-up question. The data analysis hence focused predominantly on identifying themes and patterns in the qualitative data, which are reported in detail in the data analysis report (Kuria et al., 2023) as well as in the summary codesign report (Fuchs et al., 2023).

Why assessing existing innovation practices matters

Agroecology is commonly defined by a set of elements or principles – in the AEI specifically by the 13 CFS HLPE (2019) principles – rather than a fixed list of on-farm (and off-farm) practices. Although arguably not restricted to only the agroecosystem, more than half of these principles are explicitly applicable to the agroecosystem, and hence to various on-farm system components. These include principles 1 to 7: recycling, input reduction, soil health, animal health, biodiversity, synergy, and economic diversification (see, for instance, Wezel et al., 2020).

Since there is no comprehensive list of what constitutes an agroecological practice in general, and existing lists focusing on Kenya focus on a small number of practices (see, for instance, PELUM's 2021 publication called *12 Best Agroecological Practices* (Kibui, 2021), it was important to first foster conversation among the team about what might indeed qualify. The learning led to the identification of a complementary classification of numerous soil, water, and integrated pest management practices that are relevant for the Kenyan context, including both those that can be defined as agroecological and those that cannot (see Table 1 in Kuria et al., 2023).

These conversations about existing on-farm practices, their degree of agroecological integration, as well as their classification also involved the staff of the ALL host center, as the farmers interviewed with whom existing practices were jointly identified during farm visits contributed to further co-learning.

Beyond looking at the existence of and the extent of engagement in specific practices, and their justified classification, the co-identification of practices alongside farmers and learning about farmers' experiences and views led to tremendous additional learning. This learning extended to important aspects such as the following:

- The multiple functionalities of practices: initially by seeing how people classified them across the three focus areas (water, soil, IPM).
- Their application context: specifically through questions that were phrased in a way that addressed common agroecological principles, as well as the agroecological benefits targeted alongside, which allowed the team to measure what matters beyond yield and other common indicators that often provide a limited perspective on their performance (Geck et al., 2023), with an assessment framework that is echoed in the One Million Voices of Agroecology citizen science platform as well (Henry, 2023).
- Preferences not always equating existing practice: what people do is one thing, but what they aspire to do might be different.

These and other learnings provided important insights and entry points to developing recommendations or suggestions for what practices might be suitable that considered multiple aspects at the intersection of ecological, historical, cultural, and perspectival relevance in view of different people's identities, interests, and preferences. Practically, the team composed simple single practice-focused posters for the most common and most preferred practices that were used during the codesign workshops (see Kuria et al., 2023). These posters fed the discussion during the highly structured codesign workshops and helped to select the final practices that underwent farmer trials (see more details in Fuchs et al., 2023).

Although the team's initial recommendations erred on the side of caution (see details in Fuchs et al., 2023), and hence emphasized practices that farmers tended to be more familiar with and that aligned more clearly with local and sometimes traditional knowledge, the gap between current options and preferences also allowed glimpses into potential opportunity spaces in view of the farmers' contextual suitability and performance evaluations. The rapid innovation assessment will hence help the team in the continuation of the farmer trial cycles and will allow making recommendations about how trials might become even more innovative while remaining rooted in local practices and preferences.

References

CFS HLPE. 2019. Agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition. A Report by the High-Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security. https://www.fao.org/3/ca5602en/ca5602en.pdf

Fuchs LE; Bourne M; Achieng W; Neely C. 2021. Sustainability planning with community and local stakeholders: Guidance Note, Regreening Africa. World Agroforestry (ICRAF), Nairobi, Kenya. https://regreeningafrica.org/wp-content/uploads/2022/01/Sustainability_Guidance_Note_Final

Fuchs LE; Korir H; Adoyo B; Bolo P; Kuria A; Sakha M; Gumo P; Mbelwa M; Syano N; Kiruthi E; Orero L; Ntinyari W. 2023. Co-designing on-farm innovations in the Agroecological Living Landscapes (ALLs) in Kenya. https://hdl.handle.net/10568/138714

Geck MS; Crossland M; Lamanna C. 2023. Measuring agroecology and its performance: An overview and critical discussion of existing tools and approaches. Outlook on Agriculture 52(3):349-359. https://doi.org/10.1177/00307270231196309

Henry D. 2023. New citizen science platform allows everyone to shape agroecological transitions, Forests News 2 August 2023, available at https://forestsnews.cifor.org/83738/new-citizen-science-platform-allows-everyone-to-shape-agroecological-transitions?fnl=en (accessed 30 November 2023).

Kibui R. 2021. 12 Best Agroecological Practices. PELUM Kenya, 50 pp. https://www.pelumkenya.net/wp-content/uploads/2021/11/12-Best-Agroecological-Practices.pdf

Kuria A; Bolo P; Ntinyari W; Orero L; Adoyo B; Korir H; Syano N; Kiruthi E; Fuchs LE. 2023. Assessment of existing and preferred agroecological soil, water, and integrated pest management practices in the Makueni and Kiambu agroecological living landscapes. https://www.cifor-icraf.org/knowledge/publication/35523/

Sinclair F; Coe R. 2019. The options by context approach: a paradigm shift in agronomy. Experimental Agriculture 55(S1):1–13. https://doi.org/10.1017/S0014479719000139

Wezel A; Herren BG; Kerr RB; Barrios E; Gonçalves ALR; Sinclair F. 2020. Agroecological principles and elements and their implications for transitioning to sustainable food systems: A review. Agronomy for Sustainable Development 40(40). https://doi.org/10.1007/s13593-020-00646-z

2. Designing ideotypes of agroecological cropping systems in Senegal

Raphael Belmin (CIRAD), Banna Mbaye (ISRA), and Bernard Triomphe (CIRAD)

In 2022, Senegal applied an approach to codesign ideotypes of agroecological cropping systems (see useful definitions in Box 1), mobilizing several local stakeholders and representatives from Fatick's ALL (the DyTAEL) for a five-day mission. The overall process workshop was organized in three stages: a preparatory meeting, a three-day workshop, and a field day. Here are a few highlights of the corresponding approach, based on the workshop report (Belmin et al., 2022).

Box 1: A few useful definitions used in the codesign of ideotypes of agroecological cropping systems (Belmin et al., 2022)

Ideotype = Theoretical (i.e., ideal) cropping system that seems coherent from an agronomic and socio-technical point of view. An ideotype responds to a set of identified constraints and is based on knowledge of the diversity of cropping systems and farms in a given area. The ideotype is therefore a result in itself and has intrinsic value (i.e., it can be published) even if it has not yet been tested in the field.

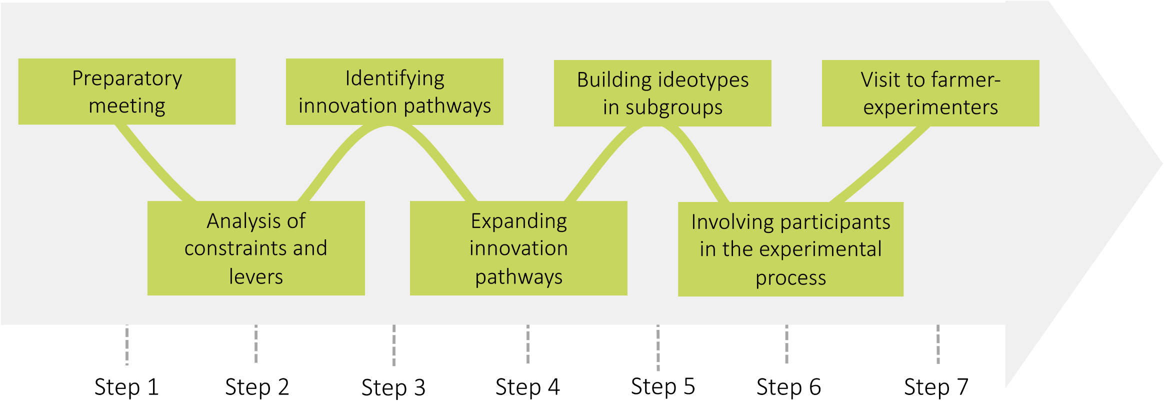
Ideotyping = Co-construction of one or more cropping system ideotypes in a multi-stakeholder workshop.

Prototype = Real (and therefore sometimes incomplete) cropping system implemented by researchers (experimentation in semi-controlled conditions) or growers with the aim of testing an ideotype. There can be a variety of prototypes around an ideotype.

Prototyping = *In situ* or *ex situ* testing of a range of cropping systems that are as close as possible to one or more ideotypes. To do this, we prefer to select growers' plots that already match certain characteristics of the target ideotypes. The prototypes cannot always match the ideotypes because growers cannot change their practices quickly and radically in just one year. On the other hand, ideotypes can be used as compasses to guide farmers through step-by-step changes to their production systems. Prototyping produces knowledge that can lead researchers to develop their ideotypes in an iterative approach.

Overall approach

Figure1 summarizes the seven-step approach used in this workshop. Each step is described briefly below.



Source: Authors based on Belmin et al. (2022)

Figure 1. General approach to constructing ideotypes and embedding farmer-experimenters as used in Senegal.

- *Step 1: Holding a preparatory meeting of the project team*

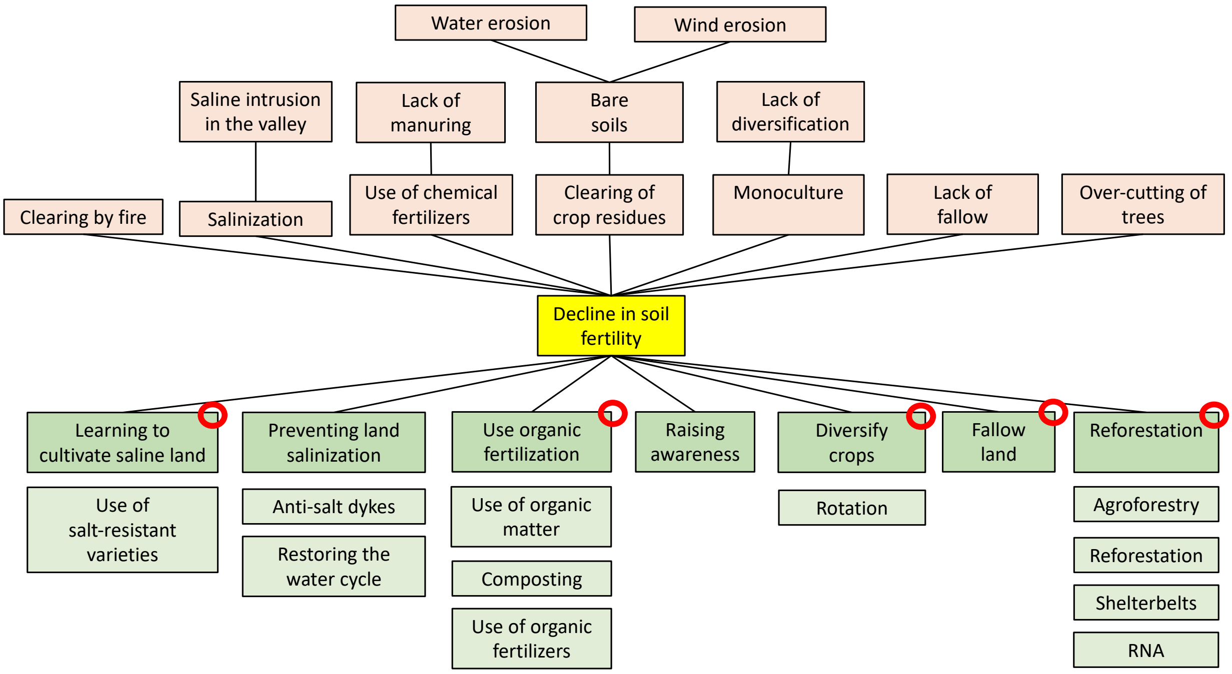
The day before the start of the workshop, the project team met for a briefing session. The goal was to discuss how the workshop would be run, identify the role of each team member, and agree on the agenda.

- *Step 2: Analyzing constraints and levers for ecological intensification*

The workshop began with group work with two objectives: (1) to identify the underlying causes of the agronomic constraints in the area (pre-identified via a rapid diagnosis in 2021) and (2) to propose technical or organizational levers that could potentially remove these constraints and subconstraints. The participants were divided into four working groups. All the groups worked on all the pre-identified constraints.

- *Step 3: Assembling levers into innovation pathways*

The project team constructed summary figures (see Figure for an example) bringing together, for each constraint, the underlying causes (orange) and the levers (light green) identified by the four groups. Innovation pathways (dark green column headings) have been constructed by grouping together several levers based on the same logic for transforming cropping systems. The innovation paths that directly concern farmers were selected (red circles) for the rest of the workshop. In all, 10 and 12 avenues of innovation were identified for market gardening systems and bush fields, respectively.



Source: Authors based on Belmin et al 2022

Figure 2. Example of a diagram summarizing the results of the group work for the "Decline in soil fertility" constraint codesign workshop, Ndiop, Senegal, August 2022. *[Inside figure, change "salt-resistant" to "salt-tolerant"]*

- *Step 4: Expanding innovation pathways*

On the second day of the workshop, group work enabled a broader exploration of the avenues for innovation identified the previous day. The participants were divided into four working groups (three bush fields + one market garden). For each avenue of innovation, they had to (i) put forward at least four concrete options, (ii) describe the options selected in detail, and (iii) not limit themselves to what is currently being done in the area. The integration of four options for all innovation pathways (8 to 12 pathways depending on the group) resulted in the construction of "innovation boxes," which served as resources the following day for the ideotype construction stage (see below).

- *Step 5: Constructing cropping system ideotypes*

On the third day, group work enabled participants to construct ideotypes. Building ideotypes involves selecting, assembling, and matching technical and organizational levers from innovation boxes. The participants were asked to explain the relationships between each of the levers making up the ideotype.

- *Steps 6 and 7: Selecting and visiting farmer-experimenters*

At the end of the workshop, the project team asked the participants to indicate their interest in trying out one of the four ideotypes that had been constructed. The following day, the project team visited several potential farmer-experimenters to assess the conditions for and feasibility of such experiments.

Conclusions and perspectives

The ideotypes thus created have intrinsic value because they are the result of a collective thought process. Thanks to an appropriate methodological framework, the participants were able to construct (at least in their minds) radically new forms of agriculture for their commune, based solely on their own knowledge. But if these ideotypes are to become resources for effective transformation, they need to be appropriated and put to good use by the development players. They can serve as a compass to guide technical support for agricultural projects or policies. The activity was also intended to provide input for the Fatick DyTAEL by defining the territorial changes needed to facilitate the adoption of the cropping system ideotypes. However, the ideotyping process took longer than expected and it will be the task of a future workshop to tackle the regional scale.

The ideotyping approach presented above was carried out in 2022 in Fatick Department as part of a project to codesign cropping systems. In 2023, work on other projects enabled the ideotyping approach to be tested at production system (Belmin, 2023) and food system (Belmin, 2024) scales. In 2024, new ideotyping work will be undertaken with the Fatick DyTAEL to imagine how the area could effectively combat land salinization. The ideotyping will be followed by backcasting work (Robinson et al., 2011) to consider the concrete conditions for change. The problem of salinization of agricultural land has been identified by members of the DyTAEL technical committee as a priority.

References

Belmin R; Ka DY; Mbaye B; Triomphe B; Sow M; Ndiaye A; Diop A; Diouf I; Séne JM; Cissé F; Ndiénor M; Gueye A. 2022. Co-conception d'idéotypes de systèmes de culture innovants dans la commune de Ndiob, Sénégal. Compte rendu de mission. Ndiob (Sénégal), 1-5 August 2022.

Belmin R, et al. 2023. Co-conception d'idéotypes de systèmes de production innovants dans le Living Lab de Mbane. Compte rendu d'atelier et de mission. Dakar, October 2023. https://agritrop.cirad.fr/606630/1/CR%20Atelier%20Ide%CC%81otypage%20Light.pdf

Belmin R, et al. 2024. Conception de systèmes agri-alimentaires résilients au changement climatique. Rapport d'atelier d'idéotypage, Yamoussoukro, Côte d'Ivoire, 6-11 November 2023.

Robinson J; Burch S; Talwar S; O'Shea M; Walsh M. 2011. Envisioning sustainability: Recent progress in the use of participatory backcasting approaches for sustainability research. Technological Forecasting and Social Change 78(5):756-768.

3. Loops and cascade approach used for codesigning and experimenting for more agroecological dairy farming systems in Burkina Faso

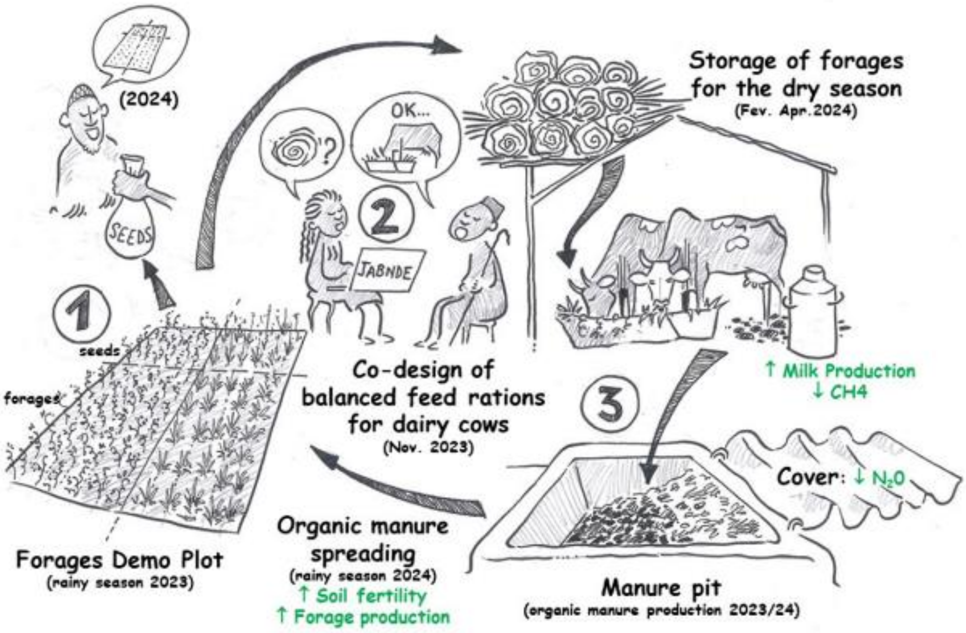
S.D. Ouattara,[1] O. Sib.,[1] S. Sanogo.,[2] E. Sodré.,[3] and E. Vall[1]

[1]Cirad, [2]Cirdes, [3]INERA

In the agrosilvopastoral systems of Burkina Faso, and particularly in farming systems oriented to milk production, biodiversification of the fodder system, crop-livestock interactions, and co-product recycling are key factors of agroecology (Sib et al., 2017; Vall et al., 2021; Sodré et al., 2022; Vall et al., 2023).

These principles refer to agricultural practices that concern the different components of the farm (cropping system, livestock system, co-product management system) and that follow one another over time (production of crop biomass => management strategy for this biomass => feeding animals with this biomass and farmers using it => recycling of livestock and crop co-products into manure => applying manure to fields, etc.). It is therefore a succession of cascading actions that loop over a year.

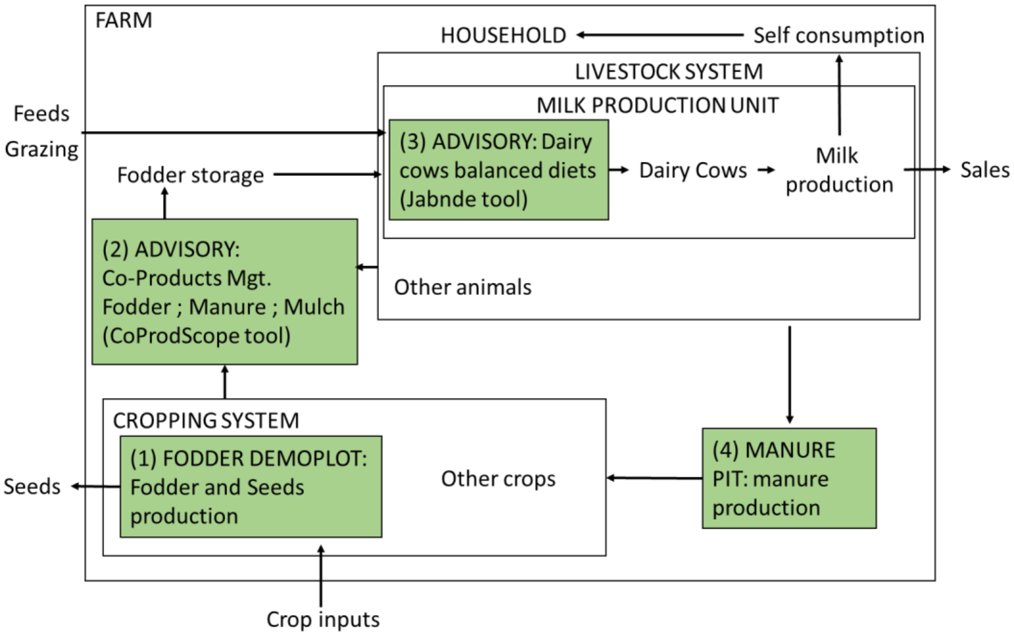
However, these practices can be improved to increase biodiversification, interactions, and recycling and particularly to better give value to farm co-products (Zoungrana et al., 2023). This is why we have proposed testing some of these practices in an experimental system on farms involving loops and cascades of actions aimed at intensifying production by agroecological means, imitating what happens on a farm. The results of one action feed into the next action as shown in Figure , following the principle of step-by-step codesign and experimenting changes (in which the novelty is built in at the same time as we learn to control it; Meynard et al., 2023).



Source: Authors

Figure 1. Simplified representation of the loops and cascade approach used with dairy farmers in Burkina Faso. *[Inside figure, remove hyphen from Codesign; change to Feb.-Apr. 2024; use CH_4; change to demo plot]*

At the beginning, during a codesign workshop, an agroecological package was proposed to the stakeholders of the Agroecological Living Landscape (ALL), who amended it and suggested adjustments to meet their needs and constraints. This package (validated by the actors) is based on three components: (1) a fodder demo plot (~0.5 ha of mucuna, cowpea, maize, and sorghum); (2) a covered cement manure pit (~9 m^3); (3) the use of two tools: CoProdScope (Zoungrana et al., 2023) for codesigning with the farmer smart strategies of co-product management and *Jabnde* to codesign balanced diets for dairy cows based on fodder and other feed resources available (rangeland, local feeds). These three components are engaged in a cascading and looping process represented in Figure 2. Then, the participants gave feedback on the process to the volunteer dairy farmers for experimenting with the AE package. Local workshops were organized with the volunteers committed to participating in a training session on the looping and cascading approach and management of innovations (demo plot, manure pit).



Source: Authors

Figure 2. Theoretical representation of the experimentation with the agroecological package on a farm following the loops and cascade approach as used in Burkina Faso. *[Inside figure, hyphenate Self-consumption; lowercase (in (3)) cows after Dairy; lowercase (after (2)) Co-product mgt., fodder, manure, and mulch; leave space in DEMO PLOT; change to Fodder and seed production]*

In this looping and cascading participatory experimentation, we work at the farm scale and we consider the household and its resources, the cropping system, the livestock system, and the co-product recycling system. However, we focus on specific elements: (1) the fodder demo plot, (2) the advisory on co-product management, (3) the advisory on dairy cow feed management, and (4) the production of organic manure. Data are collected on the entire farm by a survey to fully understand its general functioning. However, detailed data collection is carried out (1) first on fodder demo plots and manure pits during monthly monitoring and (2) second during the advisory activity on the management of crop and livestock co-products in fodder and manure (with CoProdScope tool) and during the advisory activity on the management of cow diets (with Jabnde tool). Farm surveys, on-farm experimentation monitoring, and elaborating advisories take a lot of time (i.e., ~15 days/farm/year with 1 day per survey, 12 days for monitoring, and 2 days for advisory). That's why we cannot measure everything in this type of looping experiment.

In 2023, this AE package was implemented with 55 volunteers by a junior researcher assisted by a technician. Demo plots were set up by almost all the volunteers (a few got together to set up a collective demo plot). A part of the fodder seeds produced on the demo plot will be shared with two new volunteers in 2024 (theoretically, one mother DP in year 1 will give three baby DPs in year 2, and then 3^N babies in year N. We know that such speed of progress will never be achieved. But this seed-sharing action will make it possible to concretely put into action principle number 8 of agroecology (co-creation of knowledge). It will allow us to assess whether disseminating changes can be partly achieved without relying on the market. A manure pit was set up and started with approximately 30 volunteers. Co-product management advice was carried out with 10 volunteer farmers (there wasn't enough time to do more). Cow feeding management advice will be undertaken with 34 volunteers. These figures show that it is difficult to implement all the package for everyone as this type of on-farm experimentation is time-consuming. In this cascading and looping on-farm experimental approach, there is also a risk of losing volunteers Farmers who fail at step N have difficulty continuing work at step N + 1. Such losses break the expected looping effect of novelties, which could convince the farmers to change their current practices. This is, in the end, a risk for the research, which might end up with a small sample of farmers having successfully carried out the experiment from start to finish.

However, despite these risks and constraints, this loops and cascade approach of on-farm experimentation allows us to learn from the successes (outcomes) but also from the failures (causes of failures). This approach allows us to understand why the principles of agroecology are not always so easily implemented by farmers. It allows volunteers to adjust the protocol to their situation. This flexibility should make it possible to obtain results more adapted to the needs of farmers, which can then be more easily adopted by the farmer community. It therefore allows us to better understand the levers and barriers that act on the transformation of agricultural systems.

References

Meynard JM; Cerf M; Coquil X; Durant D; Le Bail M; Lef`evre A; Navarrete M; Pernel J; Périnelle A; Perrin B; Prost L; Reau R; Salembier C; Scopel E; Toffolini Q; Jeuffroy MH. 2023. Unravelling the step-by-step process for farming system design to support agroecological transition. European Journal of Agronomy 150:126948. doi.org/10.1016/j.eja.2023.126948

Sib O; Bougouma-Yameogo VMC; Blanchard M; Gonzalez-Garcia E; Vall E. 2017. Dairy production in Western Burkina Faso in a context of emergence of dairies: Diversity of breeding practices and proposals for improvement. Revue d'elevage et de medicine veterinaire des pays tropicaux 70(3):81-91. doi: 10.19182/remvt.31521

Sodré E; Moulin C-H; Ouédraogo S; Gnanda IB; Vall E. 2022. Améliorer les pratiques d'alimentation des vaches traites en saison sèche, un levier pour augmenter le revenu des éleveurs laitiers extensifs au Burkina Faso. Cahiers Agricultures 31:12. doi.org/10.1051/cagri/2022006

Vall E; Sib O; Vidal A; Delma JB. 2021. Dairy farming systems driven by the market and low-cost intensification in West Africa: the case of Burkina Faso. Tropical Animal Health and Production 53:288. doi.org/10.1007/s11250-021-02725-z

Vall E; Orounladji BM; Berre D; Assouma MH; Dabiré D; Sanogo S; Sib O. 2023. Crop-livestock synergies and by-products recycling: major factors for agroecology in West African agro-sylvo-pastoral systems. Agronomy for Sustainable Development. 43:70. doi.org/10.1007/s13593-023-00908-6

Zoungrana SR; Ouedraogo S; Sib O; Bougouma-Yameogo VMC; Fayama T; Coulibaly K; Berre D; Assouma MA; Vall E. 2023. Recycling crop and livestock co-products on agro-pastoral farms for the agroecological transition: more than 60% potentially recoverable in western Burkina Faso. Biotechnology, Agronomy, Society and Environment 27(4),270-283. DOI: 10.25518/1780-4507.20537

Zoungrana SR; Saadatou D; Sib O; Loabé Pahimi A; Ouédraogo S; Bougouma Yaméogo VMC; Vall E. 2023. The CoProdScope: an assessment and advisory tool for crop and livestock co-product management to intensify agroecology in agro-pastoral farms. Revue d'elevage et de medicine veterinaire des pays tropicaux 76:37167. doi: 10.19182/remvt.37167

4. Integrating digital tools for agroecology in Zimbabwe

Vimbayi Chimonyo, Dorcas Matangi, and Telma Sibanda
CIMMYT-Zimbabwe

The Agroecology Initiative in Zimbabwe integrates digital tools for monitoring, analyzing, and visualizing both qualitative and quantitative data derived from trials and engagements. Using R statistical software and a variety of packages, the team processes datasets gathered through surveys and monitoring activities conducted with KoboToolbox. KoboToolbox serves as a practical digital tool for data collection, installed on mobile devices to facilitate offline data collection in areas with connectivity challenges. The team has designed forms in KoboCollect for diverse purposes, such as recording management aspects within demonstration plots (i.e., planting date, frequency of weeding and fertilizer application); collecting data on pest and disease incidences and severity; tracking harvesting activities; and obtaining stakeholder perceptions on technologies through rating and ranking exercises.

R contributes to precision and accuracy in data collection through the development of QR codes, thus ensuring precise capture, especially in cases of repeated measurements. Each demo plot holder and farmer with assessed technology receives a unique QR code, thus simplifying host identification during data collection. QR codes are also assigned to signages for different treatments within trials to enhance data reliability (*Illustration*1).

Illustration 1*. Signage with QR code also showing farmer name and technology being tested in Zimbabwe.*

Simultaneously, R aids in creating visuals such as graphs and charts to facilitate a clear presentation of research outcomes. R's versatility extends to developing applications such as the Shiny app, which promotes citizen science engagement. Playing a pivotal role in the initiative, R offers a multifaceted approach to data analysis, visualization, and dashboard creation, thus ensuring comprehensive insights into agroecology within Zimbabwe (*Figure 1*). Its statistical rigor in data analysis, coupled with customizable visualizations, enhances clarity for diverse audiences, while interactive dashboards foster real-time engagement with stakeholders, making complex data accessible and promoting inclusive communication with policymakers, funders, and the general public.

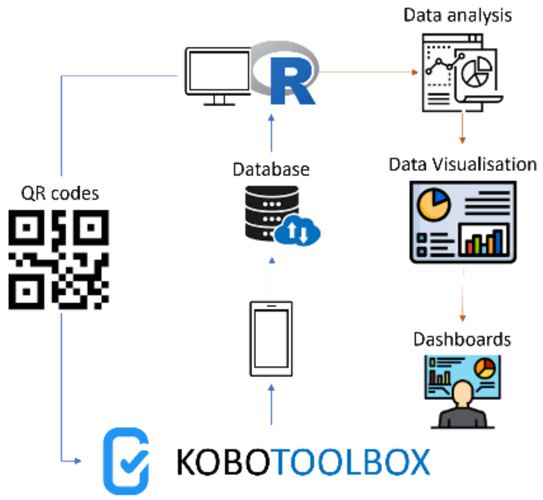


Figure 1. Data management workflow used by the Zimbabwe country team of the AEI. [Inside figure, change to visualization after Data]

Bibliography

Wickham H; Grolemund G. 2016. R for Data Science. O'Reilly Media.

Crawley MJ. 2013. The R Book. Wiley.

KoboToolbox Documentation. https://support.kobotoolbox.org/

Matangi D; Sibanda T; Chimonyo VGP; Baudron F. 2023. AEI_2023Reporting_WP1_Output1.3. Report on tested technologies, Zimbabwe.Sibanda T; Matangi D; Zingwena T; Chimonyo VGP; Baudron F. 2023. AEI_2023 Reporting_WP1_Output1.3. Farmer_Evaluation of_Technology, Zimbabwe.

Annex 3: Cross country Technology Evaluation Matrix

Integrated Farming Systems

Zimbabwe: Push-pull Technology & Conservation Agriculture

Dimension	*Details*
Technology Maturity	Mature for implementation in Murehwa district with strong engagement in biodiversity and soil health practices. Less mature in Mbire due to resource constraints.
Benefits and Challenges	Benefits: - Addresses critical challenges like pest pressures and soil degradation - Integrates with existing farming systems - Promotes biodiversity and soil health Challenges: - High labor requirements - Resource constraints in some regions - Limited access to inputs
Target Farmers	Farmers in areas with established soil health practices; those with access to sufficient labor and resources
Evidence of Use	83 farmers (64 in Murehwa, 19 in Mbire) selected treatments for adaptation in their fields after 2023 mother trials
Actions for Scaling	- Farmer field days and fairs - Participatory evaluations - Integration with community-based organizations
Future Plans	Development of innovation bundles combining push-pull with drought-resilient varieties

India: Agroecological Homestead Models

Dimension	*Details*
Technology Maturity	Ready for implementation with proper support systems
Benefits	- Improved food security - Income diversification - Sustainable farming practices - Enhanced nutrition
Challenges	- High initial infrastructure investment - Labor intensity - Technical knowledge requirements
Target Farmers	- Women farmers - Marginal landholders - Farmers with homestead areas
Evidence of Use	Partial adoption of components like multi-layer farming and bio-input preparation
Current Scaling Actions	- Training programs - Exposure visits for women SHGs - Local government partnerships
Future Plans	- Development of customized training modules - Creation of financial support mechanisms

Kenya: Set of basic agroecological practices

Dimension	*Details*
Technology Maturity	Mature - deliberately selected basic, familiar practices for initial implementation
Benefits and Challenges	Benefits: - Affordability - Ease of implementation - Familiarity to farmers Challenges: - Initial response time for results - Need for consistent application
Target Farmers	Mixed gender participation through structured selection process; focus on farmers with potential to become trainers
Evidence of Use	Extended adoption through 27 farmer groups, each with 30-100 members
Actions for Scaling	- Structured partnerships with farmer training centers - Regular exchange visits - Integration with national networks
Future Plans	- Enhanced engagement with local government - Improved farmer-to-farmer outreach - Expanded use of communication channels

Forage and Feed Management Technologies

Tunisia and Burkina: Forage Intercropping/Demo-Plots

Dimension	*Details*
Technology Maturity	Tunisia: Mature and ready for scaling with available market seeds Burkina Faso: High maturity with 90.28% acceptance rate among volunteer farmers
Benefits	- Higher nutritional value than conventional options - Improved soil fertility through nitrogen fixation - Ecosystem services (disease barriers, pollinator support) - Reduced crop failure risk through diversification - Lower input requirements (water, nitrogen, herbicides)
Challenges	- Availability of quality seeds during planting seasons - Farmers' limited knowledge of mixture management - Protection of plots from animals - Drought pockets and crop pest attacks - Seed conservation and storage difficulties
Target Farmers	- Farmers with animal flocks - Mixed farming operations regardless of size - Farmers with access to agricultural waste
Evidence of Use	- Local seed providers selling to various projects and NGOs - Large state farms adopting as alternative to traditional hay - 97% of Mother farmers and 76% of Baby farmers implementing independently
Current Scaling Actions	- Field demonstrations - Training sessions - Partnership development - Technical support for establishment
Future Plans	- Continued support for cooperative seed sharing systems - Enhanced monitoring of adoption patterns - Integration with existing agricultural programs

Burkina Faso; Digital Livestock Management Tools

Dimension	*Details*
Technology Maturity	CoProdScope: Functional but requires ergonomic improvements Jabnde: Effective but needs technician support
Benefits	- Improved awareness of farm resource management - Better manure management - Enhanced milk production - Clear planning for dry season fodder availability
Challenges	- Limited farm record keeping - Need for technical support - User interface limitations - Dependency on technician presence
Target Farmers	Dairy farmers with basic record-keeping capabilities
Evidence of Use	100% of volunteer farmers reporting improved milk production with Jabnde tool
Current Scaling Actions	Implementation with 30 farmers for CoProdScope and 20 for Jabnde
Future Plans	- Mobile application development for CoProdScope - Development of group-based diet recommendations for Jabnde

Soil Management Technologies

Tunisia and Zimbabwe: Biochar Application

Dimension	*Details*
Technology Maturity	Varies by agricultural system; mature in specific contexts like olive farming regions
Benefits	- Improved soil productivity - Enhanced environmental sustainability - Effective use of agricultural waste - Potential foundation for sustainable farming
Challenges	- Requires improvement in traditional production methods - Economic and technical barriers - Need for extensive farmer training - Production and application knowledge gaps
Target Farmers	Farmers with access to agricultural waste, especially olive pruning residues
Evidence of Use	Localized adoption in olive-growing regions
Current Scaling Actions	- Local workshops in olive-farming communities - Demonstration of production methods
Future Plans	More demonstration fields needed for sustainable soil improvement

Zimbabwe: Conservation Agriculture

Dimension	*Details*
Technology Maturity	Fairly high, with more “adoption” in Murehwa than in Mbire
Benefits	- Improved soil health - Enhanced biodiversity - Reduced erosion - Better water retention
Challenges	- High labor requirements - Resource constraints - Limited access to inputs
Target Farmers	Farmers with adequate labor and resource access
Evidence of Use	Strong adoption rates in Murehwa: crop rotation (81%), compost use (79%)
Current Scaling Actions	- Farmer field days - Community-based organizations - Peer learning
Future Plans	Integration with other technologies in innovation bundles

Pest management

Peru: Bio-inputs for Cocoa Disease Management

Dimension	*Details*
Technology Maturity	Requires additional validation cycles;
Benefits	- Self-generation of inputs - Reduced disease incidence - Preventive effectiveness - Lower input costs
Challenges	- Determining Optimal application frequency determination - Weather-dependent validation - Knowledge requirements for preparation - Long harvest periods creating disease conditions
Target Farmers	- Farmers with secure land tenure - Adequate family labor availability - Access to organic matter
Evidence of Use	Promotion to 400+ cooperative members; statistical validation pending
Current Scaling Actions	- Use experimental plots as Learning center - Technical team training - Farmer exchanges
Future Plans	- Implement a rotational exchange system - Develop specific training - Develop a comprehensive scaling strategy after second cycle

Irrigation and Water Management

India: Solar Irrigation Systems (SIP)

Dimension	*Details*
Technology Maturity	Technologically mature but adoption limited by infrastructure costs
Benefits	- Sustainable water access - Increased crop diversity - Women's empowerment - Reduced fossil fuel dependency
Challenges	- High upfront costs (USD 10,000) - Maintenance requirements - Technical knowledge needs
Target Farmers	- Farmers with perennial water sources - Access to government subsidies - SHG members
Evidence of Use	Interest from non-participant farmers but limited by resource constraints
Current Scaling Actions	- Formation of women-led water user groups - Capacity building workshops - Pilot demonstrations
Future Plans	- develop a Business model - Integrate with agroecological framework - leverage Government support

Waste Management Technologies

Tunisia: Olive Mill Wastewater Valorization

Dimension	*Details*
Technology Maturity	Evolving from neglect to recognized agricultural resource; requires further development
Benefits	- Enhanced soil fertility - Environmental sustainability - Increased profitability - Cost-effective compared to chemical fertilizers
Challenges	- Technical issues with transport and storage - Application methodology needs - Social resistance - Training requirements
Target Farmers	- Farmers with perennial crops near oil mills - Small farmers in marginal areas
Evidence of Use	Localized adoption in olive-growing regions
Current Scaling Actions	- Awareness days - Training sessions - Environmental precaution education
Future Plans	- National recognition development - Policy support enhancement - Financial backing for farmers

Burkina Faso: Efficient Covered Manure Pits

Dimension	*Details*
Technology Maturity	Moderate - 59% of volunteer farmers successfully implemented complete process
Benefits and Challenges	Benefits: - Improved soil fertility - Enhanced fodder yields - Long-term soil improvement :
Challenges	- Heavy workload for construction - Labor intensive maintenance - Gender-specific adoption barriers
Target Farmers	Primarily male farmers due to labor requirements; 42 new volunteers identified for 2024/2025
Evidence of Use	6 mother farmers have applied the technology independently
Actions for Scaling	Technical support for pit construction and management
Future Plans	Continued monitoring of adoption patterns and effectiveness

Bernard Triomphe, CIRAD: bernard.triomphe@cirad.fr

Songdah Désiré OUATTARA, CIRAD: songdah2015@gmail.com

Gopal Kumar, IWMI: G.Kumar@cgiar.org

Lisa Elena Fuchs, Alliance Bioversity-CIAT: L.Fuchs@cgiar.org

José Sánchez-Choy, Alliance Bioversity-CIAT: J.G.Sanchez@cgiar.org

Marc Piraux, CIRAD: marc.piraux@cirad.fr

Amal Mannai, ICARDA: A.Mannai@cgiar.org

Telma Sibanda, CIMMYT: T.sibanda@cgiar.org

CGIAR is a global research partnership for a food-secure future. CGIAR science is dedicated to transforming food, land, and water systems in a climate crisis. Its research is carried out by 13 CGIAR Centers/Alliances in close collaboration with hundreds of partners, including national and regional research institutes, civil society organizations, academia, development organizations and the private sector. www.cgiar.org

We would like to thank all funders who support this research through their contributions to the CGIAR Trust Fund: www.cgiar.org/funders.

To learn more about this Initiative, please visit this webpage.

To learn more about this and other Initiatives in the CGIAR Research Portfolio, please visit www.cgiar.org/cgiar-portfolio

CGIAR

INITIATIVE ON
Agroecology