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Intervening in complex food systems: how outcome mapping of multi-actor platforms traces change in central Mozambique

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ABSTRACT

Purpose: Agricultural Innovation Platforms (AIPs) are increasingly applied by advisory services as approaches to facilitate learning and co-create food system solutions. However, the outcomes of such processes are rarely documented. In this study, we present an approach for capturing process outcomes and share findings from applying the approach to an AIP in central Mozambique.

Design/methodology/approach: We complemented propensity score matching with regression adjustments and incorporated outcome harvesting as a participatory, retrospective evaluation method.

Findings: We find that the AIP led to the formation and registration of a farmer association. This improved self-organisation and fostered ownership among participants in driving systemic change and generated spillover effects to farmers who were not directly involved in the process. Moreover, AIP members reported adopting improved agricultural practices compared with the control group.

Practical implications: Our study highlights the challenges of providing evidence for outcomes and offers ways to address some of them. The proposed approach can support future AIP initiatives in embedding the documentation of process outcomes into the implementation process.

Theoretical implications: Our research reaffirms that improving food systems requires integrated approaches that address multiple components of the system while accounting for trade-offs and synergies. To capture changes across these components,

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research designs need to be flexible and employ multiple methods. **Originality/value:** Strengthening this evidence base on the impacts and outcomes of AIP processes is essential for refining the approach and increasing the confidence of extension agents in applying AIPs at a larger scale.

1. Introduction

Achieving improvements in food system requires integrated approaches (Blundo-Canto et al. 2023; Leeuwis, Klerkx, and Schut 2018) that simultaneously target multiple system components and consider trade-offs and synergies between different outcomes beyond agricultural productivity (Knickel et al. 2009). Socio-technical innovations are the basis for such approaches (Folke et al. 2010; Nelson, Adger, and Brown 2007). These innovations go beyond the farm and involve changing the rules, procedures, and structures that systems are built on (Hall and Dijkman 2019; Weber and Rohracher 2012). System changes depend on diverse actors who create opportunities and manage barriers and risks (Garrity, Dixon, and Boffa 2012; Giller et al. 2011). In Mozambique, this includes farmers, local government, public advisory services, and private agribusiness companies. The co-design of food system innovations brings together diverse bodies of knowledge relevant for solutions that fit the context and, over time, influence the food system (Loorbach, Frantzeskaki, and Avelino 2017). Doing so requires motivation, capabilities, and agency across actors to embrace innovation (Meinzen-Dick and Bruns 2024; Michie, Van Stralen, and West 2011; Pigford, Hickey, and Klerkx 2018; Schut, Leeuwis, and Van Paassen 2013; Swaans et al. 2013; Wigboldus et al. 2016). It is critical that innovations are place-based, build on social relations and institutional arrangements, and can therefore mobilise collective action (Kilelu, Klerkx, and Leeuwis 2013; Schut et al. 2019), which can weaken path dependencies (Hall and Dijkman 2019). Furthermore, co-design strengthens the adaptive capacity of actors to respond to stresses, shocks and opportunities (Hall and Clark 2010; Van Rooyen et al. 2017). Extension service providers can play an important role in building actors' knowledge and agency and ensuring that the benefits of innovation are clear and accessible to everyone involved (Njuki et al. 2023). In cooperation with 'innovation brokers' that facilitate partnership-building and knowledge exchange, they can help connecting different groups and ideas (Leach et al. 2012).

To enable integrated co-design, research has experimented with multi-actor approaches in recent decades (Duru, Therond, and Fares 2015; Geels and Schot 2007). Agricultural Innovation Platforms (AIPs) represent such an approach. We define AIPs as multi-stakeholder arrangements that bring together actors needed for identifying particular food system challenges, co-creating solutions, and facilitating systemic change (Klerkx et al. 2012). AIPs mobilise knowledge and resources held by actors in food systems (Klerkx, Van Mierlo, and Leeuwis 2012). AIPs also facilitate experimentation, learning, and self-organisation, with a focus on problem solving (Abson et al. 2017). Participants integrate technical and social innovations adapted to the specific ecological, political, institutional and economic circumstances (Sartas et al. 2020). Despite their wide application, the pathways through which AIPs generate outcomes remain insufficiently understood (Cadilhon 2013; Davis et al. 2015; Schut et al. 2018; Swaans et al. 2013).

Attributing outcomes to AIP processes is challenging (Wigboldus et al. 2016). AIP outcomes are multidimensional and often indirect, coupled with other internal and external dynamics. They emerge through participation and are not defined in advance by a theory of change. We understand outcomes as changes in behaviour and intermediary outcomes as changes in behaviour drivers (Davis et al. 2015; Wilson-Grau and Britt 2012). AIPs can create benefits from the association to the regional level as different actors change behaviour (Schut et al. 2018). Certain behaviours, such as the adoption of innovative agricultural practices, are changed by a larger group, in this case farmers. A key challenge in attributing such behavioural changes to the AIP process is identifying a meaningful counterfactual. Other behavioural changes, such as changes in business actions, securing rights, or changing the modalities of implementing policies, are made by few actors. Because such outcomes cannot be meaningfully counted and are influenced by multiple factors, it is challenging to make rigorous claims of attribution (Beardmore, Jones, and Seal 2023). Qualitative methods such as 'Outcome harvesting' have therefore been proposed to collect evidence on contributions of complex interventions to diverse behavioural changes in a retrospective way (Wilson-Grau and Britt 2012).

Given these challenges in attributing outcomes and the potential of qualitative approaches to capture contributions in complex settings, our paper pursues two overarching objectives. First, we contribute to the body of literature documenting the performance of AIPs regarding defining and achieving outcomes at different scales (Schut et al. 2016). We evaluate behavioural and institutional changes associated with a participatory AIP process in collaboration with the public extension system and implemented in a mixed crop-livestock system in central Mozambique. Second, we share our approach to address common challenges in the evaluation of AIPs by using a mix of qualitative and quantitative methods. More specifically we demonstrate the potential of integrating outcome harvesting into the assessment process, an approach which, to the best of our knowledge, has not yet been widely applied and documented in the context of AIPs. Lessons from this experience can inform the design of future multidimensional outcome assessments in AIP initiatives.

2. Conceptual background

We adapt the Agency and Behaviour Change for Transforming Agri-Food Systems (ACT) framework (Freed et al. 2025) to structure our assessment of behavioural and institutional change associated with the AIP. ACT links individual and collective behaviours, actor interactions, and system transformation. Changes in food systems occur through shifts in stocks and flows (e.g. livestock feed availability), driven by actions and behaviour of actors such as farmers, extension officers, and entrepreneurs (Duru, Therond, and Fares 2015; Pahl-Wostl et al. 2010). These behavioural changes respond to institutional and relational shifts that create incentives for socio-technical innovations at multiple levels (Abson et al. 2017; Loorbach, Frantzeskaki, and Avelino 2017).

Based on Ostrom's Institutional Analysis and Development (IAD) framework, ACT centres on *action situations* in which actors learn, make decisions, and interact (Ostrom 2011). In our analysis, we conceptualise the AIP as a subspace for innovation co-creation within these action situations. Such situations are shaped by economic, governance, resource, and social-relational contexts, as well as each actor's individual knowledge, motivation, and agency.

Economic factors include markets and exchange institutions; governance covers multi-level coordination and accountability (Leach et al. 2012). The resource subsystem includes natural and human-made infrastructure supporting agriculture. Social-relational factors involve norms, networks, and roles that influence behaviour, and feedback loops can accelerate or inhibit change.

At the individual level, we draw on the Knowledge, Motivation, and Agency (KMA) framework (Meinzen-Dick and Bruns 2024). Knowledge is understood as strategic information use (Logan 2012); motivation drives goal-directed action (Max-Neef, Elizalde, and Hopenhayn 1991; Michie, Van Stralen, and West 2011); and agency is the capacity to act within structural constraints (Kabeer 1999).

Individual behaviour and collective action as outcomes of interactions in the action situation may influence the governance, economic and social and relational context (McGinnis and Ostrom 2014) as well as the knowledge, motivation and agency of actors. Through these feedback, structural aspects of the food system can be influenced (Figure 1).

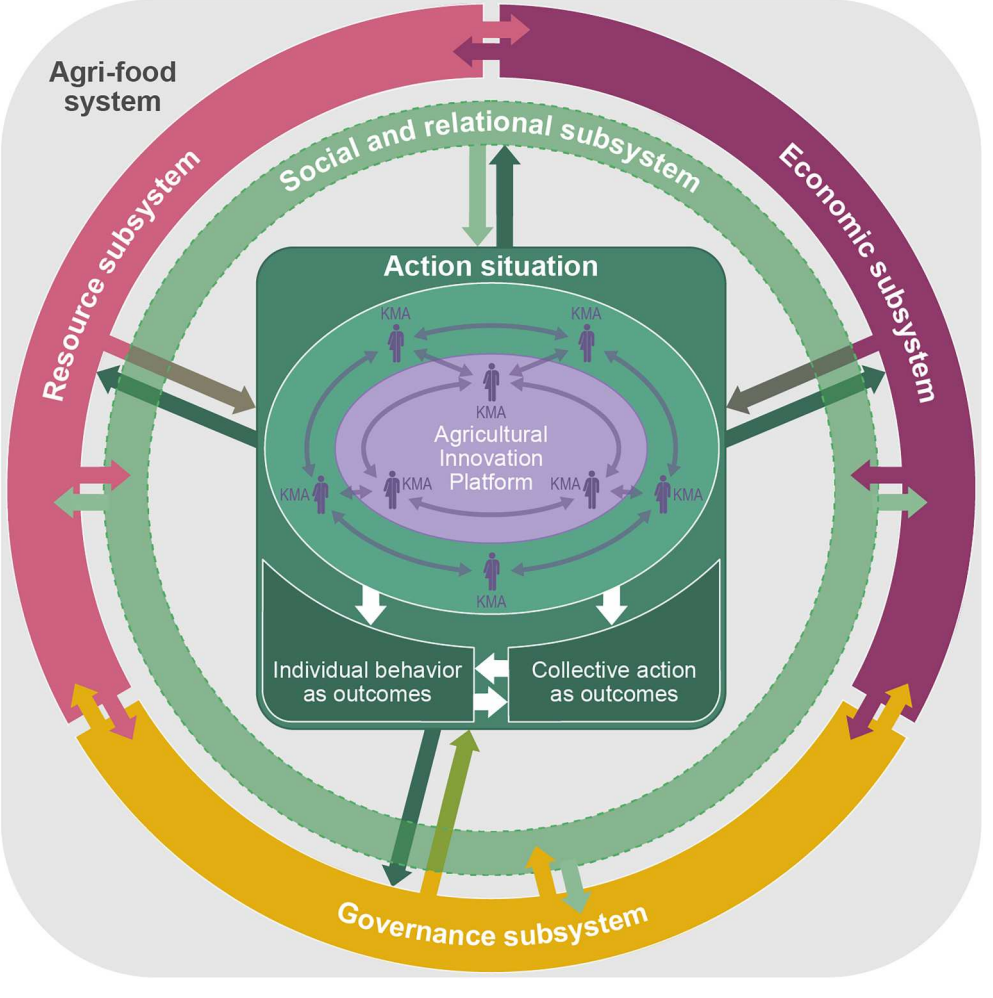

Figure 1. Conceptual framework structuring outcome assessment of AIP process (based on Freed et al. 2025). KMA refers to Knowledge, Motivation, and Agency.

3. Methodology

3.1 Study area

This study was conducted in the Marara District in Tete Province, central Mozambique. The remote area represents a typical semi-arid agroecological zone with less than 650 mm of rainfall annually. Smallholder farmers in Marara practice a mixed system with growing small grains under rainfed conditions and keeping goats and cattle. Productivity is low and farmers experience regular dry season feed shortages. They have limited access to infrastructure and markets, and public extension largely focuses on most accessible and wealthier farmers for their services (Homann-Kee Tui et al. 2013, 2014). In response, the project on Nudging Sustainability Transitions Using Innovation Platforms and Market-Oriented Development in Mozambique (MOREP) project (2012–2018) implemented an AIP over two phases to enhance community resilience by involving diverse state and private sector actors in co-designing market access strategies.

3.2 Selecting AIP participants

MOREP staff invited farmers to join the AIP. In total, 58 farmers representing different wealth strata accepted the invitation. Agricultural extension officers supported the mobilisation of participants and co-facilitated AIP activities. Relevant private sector partners were invited to AIP events as required.

The AIP members joined the process based on interest, implying self-selection. Due to ethical and financial constraints, replicating this process for control groups was not feasible. As controls, we randomly selected 55 Marara community members who did not participate in the AIP and 61 randomly chosen members from the neighbouring Changara District, which shares similar agroecological conditions. Differing sampling procedures contribute to structural differences between the AIP and the control samples. Balance tests confirm, for example, that Changara respondents owned more livestock than both Marara subsamples, and the share of women-headed households was also significantly different (Appendix 1a). To mitigate bias arising from baseline differences and to strengthen causal interpretation, we estimated propensity scores for AIP participation using a logistic regression with socio-economic covariates (age, gender, education level, livestock ownership), then applied nearest neighbour matching with one control per treated participant using a calliper of 0.01. After excluding 23 poor matching observations, post-matching balance tests showed no significant differences between the matched AIP and control groups (Appendix 1b).

3.3 Assessment of change

We adopted a mixed-methods approach to capture the multidimensional nature of outcomes associated with the AIP. Mixed-methods were chosen because they allow the integration of quantitative and qualitative evidence to capture more system complexity than single-method designs can capture (Poteete, Janssen, and Ostrom 2010). Quantitative household survey data were used to assess behavioural changes, while qualitative outcome harvesting provided insights into changes of contextual mechanisms. Such an approach is particularly suitable for participatory and open-ended processes such as

AIPs that evolve without a predefined theory of change and involve diverse actors, institutions, and feedback. This combination strengthens causal plausibility and integrates behavioural, social, and structural perspectives to understand change across scales (Freed et al. 2025; Schut et al. 2016; Wigboldus et al. 2016; Wilson-Grau and Britt 2012).

Structured in-person interviews were conducted with farm household heads at the end of the MOREP project's support in May to June 2018. The questionnaire documented changes in behavioural drivers and behaviour, as co-identified in the AIP process. Indices were created by calculating the total of the value of dummy indicators related to a specific behavioural concept. The question items and detailed descriptions of indices are presented in Appendix 2.

To improve the precision and statistical power of treatment effect estimates, we combined propensity score matching with regression adjustment following Austin (2011). Specifically, after matching, ordinary least squares (OLS) regression models were estimated with the matched balanced samples to examine the relationship between the outcome and AIP participation, controlling for the same socio-economic covariates used in the matching process. This approach helps reduce potential bias and adjust for any residual confounding within the matched sample.

We integrate outcome harvesting into the AIP process as an evaluation method suitable if outcomes emerge during implementation, which is an inherent feature of AIPs. Outcome harvesting works backwards to understand how interventions contributed to changes (Beardmore, Jones, and Seal 2023). AIPs interact and intend to influence a diverse purposely selected system actors. Providing rigorous evidence for the attribution of interventions to behavioural changes of some of these actors is difficult, for instance, because they are represented by a few influential people with no meaningful counterfactual. Outcome harvesting documents plausible contributions by triangulating diverse sources of information (Wilson-Grau and Britt 2012). We considered alternative qualitative approaches such as Contribution Analysis or Process Tracing and found them less suited as the former presupposes a predefined theory of change and the latter focuses on single causal chains and less on capturing the diversity of outcomes emerging from multi-actor interactions.

Outcome harvesting is an iterative process comprising four steps: defining purpose and hypotheses, substantiating claims with evidence, formulating outcome statements, and supporting their use.

We will next present how we integrated these steps into the AIP process. The process was documented through field notes, workshop reports, protocols, and other documentations (Homann-Kee Tui 2015).

3.4 Define the purpose of the outcome assessment

The starting point for defining outcomes in an open and demand-driven AIP process is the joint formulation of a vision provided by actors with direction and cohesiveness. This creates agency, which supports actors' willingness to contribute to achieving the vision by taking actions and changing their behaviour (Schut, Leeuwis, and Van Paassen 2013). In the inception, review, and planning workshops held in January 2013 and May 2015, the actors reflected on major challenges in the food system. Based on these reflections, the AIP members created a shared vision at the beginning of phase 1 and revised it at the beginning of phase 2 of the project. They discussed, agreed on, and visualised the

changes they would want to see within a period of about 10 years (Homann-Kee Tui 2015). The process was important for sharing perspectives among AIP members and reflecting on key relations within the food system.

3.5 Identifying behavioural changes as outcomes

In the next step, AIP members reflected on stocks and flows and relations between key actors to identify, following a back-casting logic, what changes in the system would be required to move toward the vision. Connecting the identified system changes to actors led to the formulation of priority behavioural changes. These behavioural changes became the primary outcomes of the quantitative and qualitative outcomes assessment. In addition, a participatory SWOT (strengths, weaknesses, opportunities, and threats) analysis was applied to identify priority behavioural drivers, as secondary outcomes.

Subsequently, AIP members defined interventions supporting changes in the earlier identified behaviours and behavioural drivers. The co-design of interventions was an iterative process, including regular reflections on the effectiveness of interventions and the setting of new priorities. This was supported by AIP members who formulated their own action plans. The action plans are the basis for the outcome assessment hypothesis about how AIP activities contributed to behavioural changes.

3.6 Substantiate outcome claims

Behavioural changes of farmers were captured in structured in-person interviews. Information about behavioural changes of other actors was collected in open interviews with key system actors and district and national-level experts, asking for their impression of the contribution of the AIP to certain behavioural changes. Depending on the type of behavioural change, legal documents or physical evidence, e.g. of newly built infrastructure, were used to substantiate outcome claims.

4. Results

The results section presents the impact pathway that emerged through the AIP process. This pathway is the foundation for our outcome assessment. We explain the main outcomes, co-created interventions and provide evidence for changes on elements of this pathway (Figure 2), with subheadings linked to the ACT framework elements.

4.1 The shared vision as a starting point for the outcome assessment

AIP members' vision included three main targets: poverty reduction (typically articulated as increased household income), food security, and diversified livelihoods through improved livestock production and inclusive market development.

4.2 Identification of behavioural changes and evidence of change

To achieve these visions, AIP members identified farmers, community leaders, district extension services, and local governments as key actors. Research and provincial

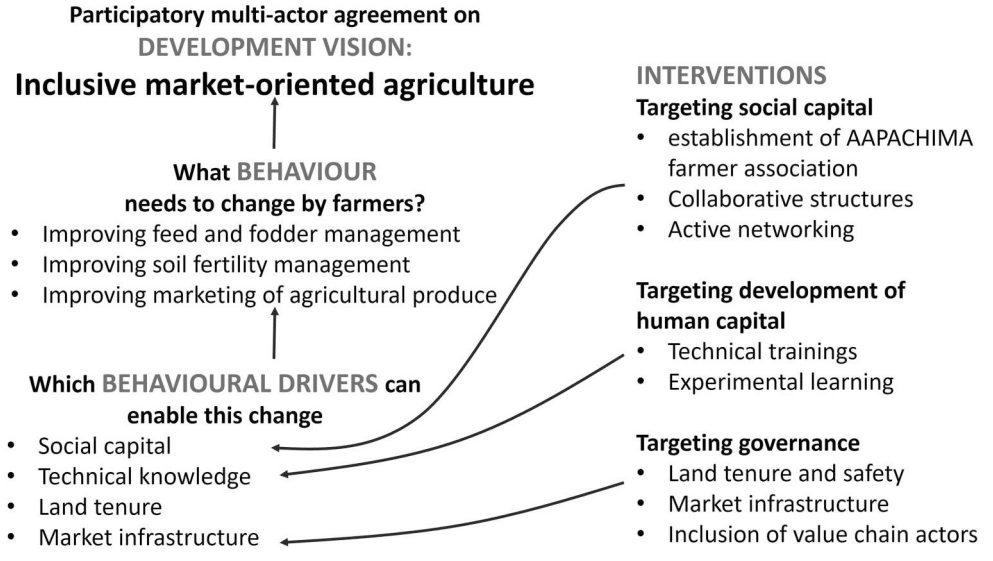

Figure 2. The emerging impact pathway of the MOREP AIP.

extension services were seen at the periphery, although supporting the process for instance by building networks. The private sector featured less prominently in the participants' perceptions.

Participatory system mapping highlighted critical food system elements and outcomes, which all required farmers to change behaviour: improved fodder management, improved soil management, and better participation in markets (see the dark grey boxes in Figure 3).

Holistic farm management was measured through the number of farming system components that farmers mentioned in the individual endline interviews to have changed over the last five years. This index was significantly higher among the AIP members compared to both control groups (Figure 4, Appendix 2.4).

4.2.1 Improved feed and fodder management addressing a bottleneck in the resource system

AIP members emphasised feed quality and availability as essential for better livestock management, productivity and marketing. This involves increasing dual-purpose crop use and expanding land for food and forage legumes. Better feed management improves livestock health, fertility, and manure production, benefiting soil fertility. Additionally, they linked market demand for feed and forage legumes to increased livestock production, and therewith increased farm productivity and income, which supports farmers' investment in improved crop and forage seeds and livestock breeds.

Quantitative results on improved feed management as a behavioural change outcome were assessed at the farmer level. We asked a series of questions related to growing legumes, use of supplementary feed, and fodder management. The results for this index indicate that AIP members practice better feed and fodder management than respondents of both control groups. There is no difference between Marara community

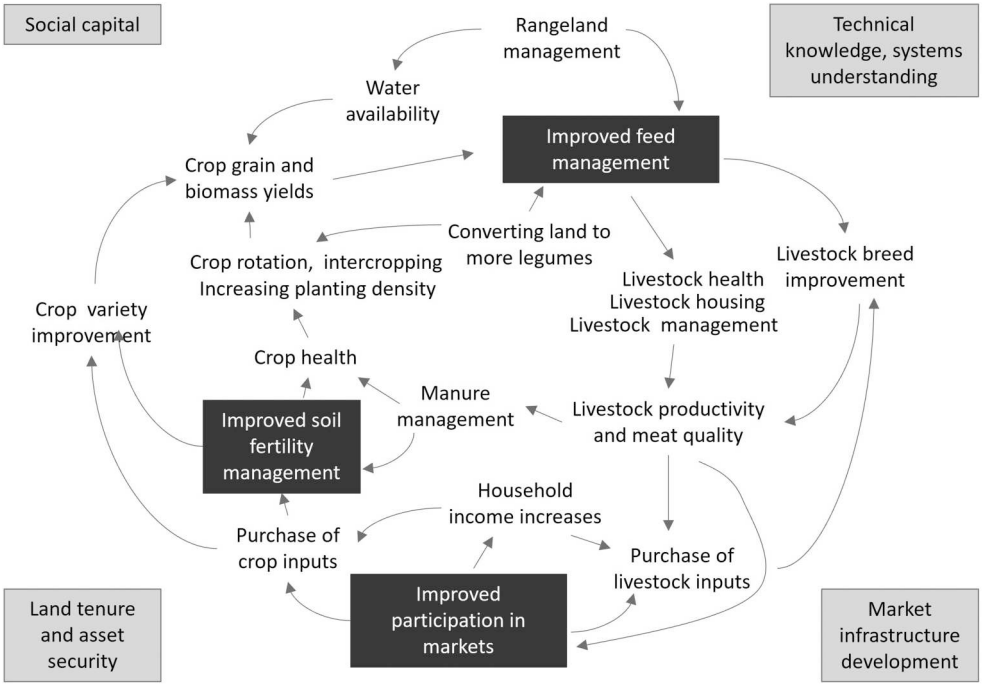

Figure 3. Systems diagram produced through participatory system mapping. Light grey boxes represent behavioural drivers and dark grey boxes targeted behavioural changes.

members not directly participating in the AIP and Changara respondents (Figure 4, Appendix 2.3).

4.2.2 Improved soil health management creating feedback to the resource system

AIP members expressed strong interest in improving the quality of soils as the foundation for all other farm components. Well-nourished livestock can contribute manure that enhances soil fertility and supports crop production. Growing legumes can improve soil fertility, provide quality biomass for livestock feed, and supply nutritious food for household consumption and sale.

The outcome index capturing behavioural changes related to soil management included the use of manure and legumes for improving soil health. AIP members report stronger efforts to improve soil health than both control groups (Figure 4, Appendix 2.3).

4.2.3 Improved participation in livestock markets as interaction with the economic system

AIP members saw potential for smallholder farmers to increase their incomes by engaging more actively in livestock markets, which is expressed in increasing sales, better timing of sales, selecting optimal animals for sale, enhancing transparency (e.g. by weighing livestock), negotiating with buyers, and collaborating in marketing. At baseline, most farmers sold livestock only out of necessity. Particularly, AIP members with larger herds

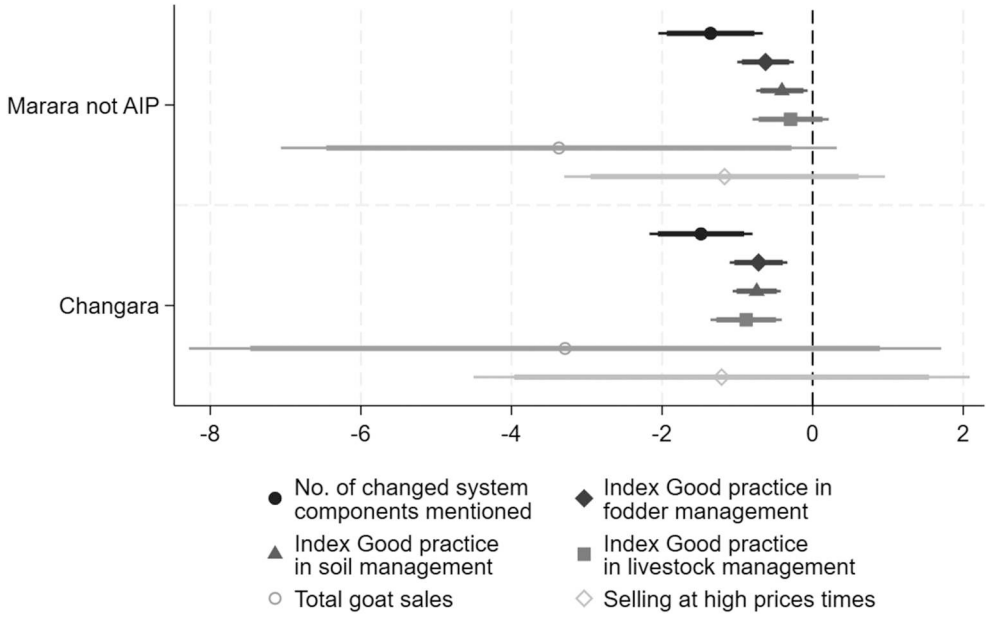

Figure 4. Coefficient plots of ordinary least square models explaining the outcome indices of behavioural changes. The markers represent the coefficients of the dummies for the control subsamples, the thick lines the 90% and the thin lines the 95% confidence intervals. Marara AIP subsample is the reference group. Lines not touching the zero dotted line indicate that the outcome for the respective control group was significantly different from the Marara AIP subsample.

acknowledged the benefits of market involvement and noted the important transition from subsistence farming to market-oriented agriculture.

Three indicators were used to assess changes in livestock management and marketing, including good breeding and marketing practices, the total number of goats sold in the year prior to the interview, and whether a respondent reported having sold livestock during the time of the year when prices are typically highest.

The results indicate that AIP members sold more goats than both control groups (significant at the 10% level). They practice better livestock management than Changara respondents though there is no significant difference to Marara respondents not participating in the AIP. We did not find evidence for changes in the timing of sales and the average prices received (Figure 5, Appendices 2.4 and 2.5).

4.3 Identified behavioural drivers, co-created interventions and evidence of change

The AIP participants identified entry points for interventions (see light grey boxes in Figure 3) that can support the aforementioned behavioural changes and co-created interventions in the AIP process to influence them.

4.3.1 Social capital as an aspect of agency

AIP members emphasised improving connectedness among farmers, inclusion of resource-poor farmers and women, and improved coordination with the Marara District government and external partners to enhancing information flows within communities.

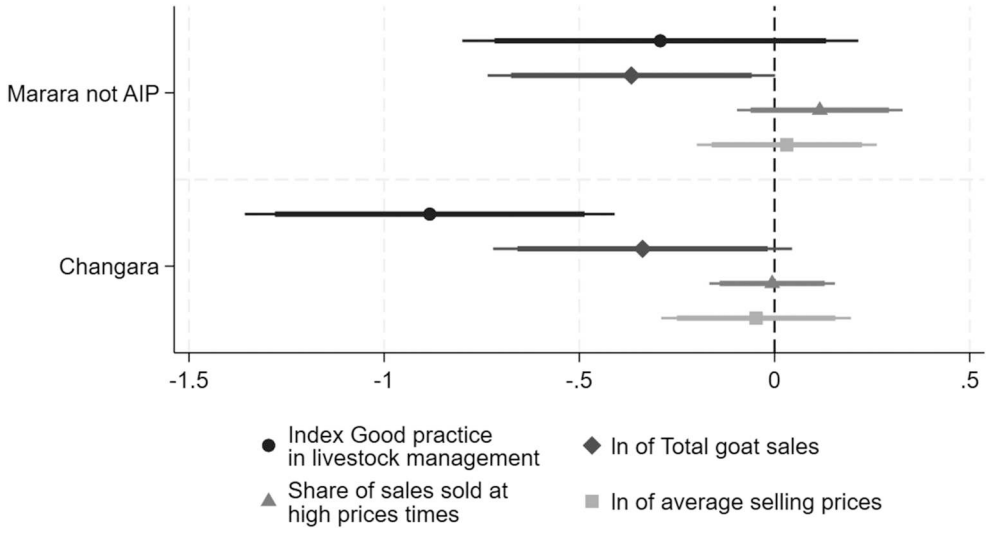

Figure 5. Coefficient plots of ordinary least square models explaining the outcome indices of livestock management and marketing. The markers represent the coefficients of the dummies for the control subsamples, the thick lines the 90% and the thin lines the 95% confidence intervals. Marara AIP subsample is the reference group. Lines not touching the zero dotted line indicate that the outcome for the respective control group was significantly different from the Marara AIP subsample.

Participation of women would influence their role in decision-making regarding selling farm commodities and how to use income. Engaging with networks and improving interconnections within the wider food system was perceived to be crucial. Self-organisation attracts cooperation with the government, technical service providers, and the private sector. However, power imbalances discouraged farmers from participating in markets. Better communication between farmers and value chain actors would allow them to express preferences for stronger engagement in market exchange.

To build social capital, project partners linked farmers and a local advocacy NGO that mentored AIP members in establishing the Associação de Produtores Agricolas Chiticuco de Marara (AAPACHIMA) farmer association. Subsequent initiatives were implemented through the association.

Selecting village-level farmer coordinators and developing their capacities allowed for sharing information with remote households and improving farmers' cooperation. Farmers were equipped with and trained in the use of cell-phones and linked to technical experts and larger market development initiatives. The farmer coordinators provided the association members with information, for example, on market prices and pest and disease outbreaks. They also coordinated livestock sales to strengthen farmers' market power, with the explicit intention of improving market access of poor households.

As a first critical outcome documented by outcome harvesting, local farmer representatives established AAPACHIMA, through the AIP process and involving 60 farmer members, as the first farmers' association in Marara District. The registration strengthened commitment and local leadership and formalised farmers' partnership with agricultural advisory services, the government, civil society partners and private sector actors, development organisations, and investors. Farmers' ability to represent their interests

and claim support through formal structures was considered by farmers and other stakeholders as a precondition for most of the changes documented here. For instance, the AIP facilitated new and improved collaborations between communities and the local government and police which can be plausibly linked to the establishment of roadblock controls that curbed livestock theft and illegal slaughtering of livestock, thus improving the security situation beyond the intervention area.

To quantitatively assess the individual level changes in social capital, participants named key actors in goat marketing. Figure 5 indicates that AIP members mentioned more actors than both control groups. In addition, we presented respondents cards with four actors playing a role in influencing farmers' access to agricultural technologies, access to agricultural markets, and protection against livestock theft. Respondents were asked to draw relations between those actors that influence these system components. We find that AIP members are more likely to identify priority connections than respondents of both control groups (Figure 5, Appendix 2.1). As another indicator, we created a gender index expressing different dimensions of women's agency in agriculture. We do not find any difference between Marara respondents who have participated and those who have not participated in the AIP. The gender index is, however, significantly lower for the Changara control group compared to AIP participants (Figure 6, Appendix 2.2).

4.3.2 Technical knowledge and system understanding as individual behavioural drivers

AIP members expressed need for better technical knowledge (Figure 3). Stimulating information flows through farmer-to-farmer exchange and learning was identified as a

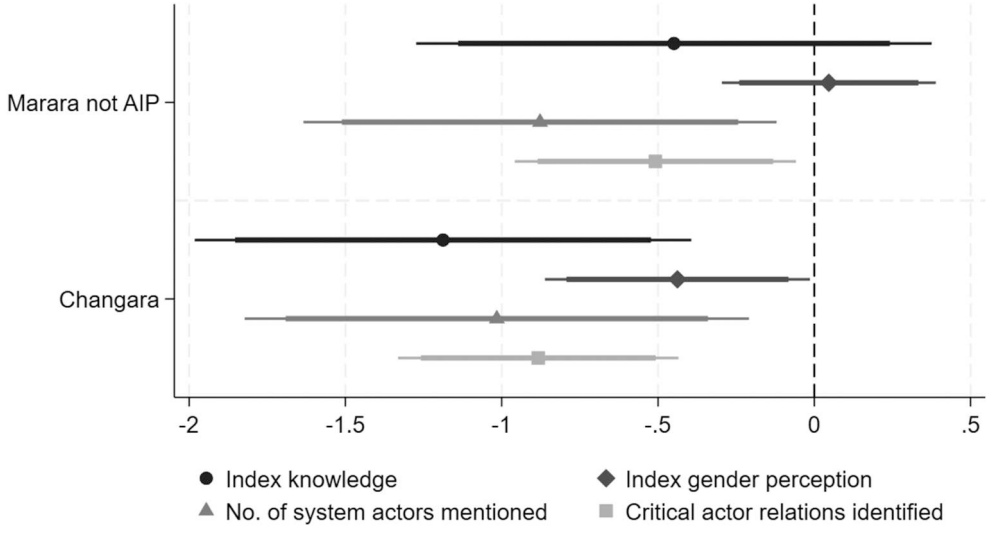

Figure 6. Coefficient plots of ordinary least square models explaining the outcome indices for behavioural drivers. The markers represent the coefficients of the dummies for the control subsamples, the thick lines the 90% and the thin lines the 95% confidence intervals. Marara AIP subsample is the reference group. Lines not touching the zero dotted line indicate that the outcome for the respective control group was significantly different from the Marara AIP subsample.

critical strategy to enhance system integration. Women were seen as particularly disadvantaged in accessing extension services and markets. Hence, AIP members expressed the need to strengthen women's technical knowledge and decision-making capacity and women farmer representation through the AIP.

As an initial step toward enhancing knowledge and understanding of the system, the MOREP project applied system mapping with the AIP participants. In addition, the project, in cooperation with extension agents, offered trainings, demonstrations and participatory experiments for testing a wide range of improved agricultural, livestock and feed and fodder management options on farms. The project strengthened the capacity of AIP members to adopt and integrate practices that enhance legume yields, improve livestock production, assess and manage soils more effectively, and expand as well as improve feed and fodder production. To facilitate farmers' access to legume seed, a training on community-based legume seed multiplication was organised, and a forage legume seed bank was established. Farmers received three crop residue chopper machines to gain experience in their use and in group management by AAPACHIMA members. Restocking of goats was specifically intended to link resource-poor farmers to sustainable livelihood and income opportunities. MOREP organised exposure visits to meat processors and markets to improve understanding of market mechanisms. Participatory farm health experiments were another approach to support learning.

As a first step of related outcome assessments, farmers self-evaluated their progress at interim monitoring visits and review workshops. Women and poor farmers especially appreciated the participatory learning format as they were usually side-lined by other knowledge-exchange schemes. AIP members further expressed that government extension officers who were involved in the AIP became more responsive to farmers' demands, improving partnerships to last beyond the project.

Women farmers expressed that they most strongly benefited from crop demonstrations, goat restocking, and pass-on and market activities as all these enhanced their assets and negotiation power.

We developed an index to quantitatively assess individual-level knowledge and understanding outcomes. Marara community members directly participating in the AIP showed significantly better knowledge than Changara respondents. There was no significant difference in knowledge and understanding between AIP members and the control groups in Marara (Figure 6, Appendix 2.1).

4.3.3 Land tenure and asset security

AIP members highlighted that insecure land tenure exposed them to the risk of mining companies taking land without compensation. They argued that the formal recognition of land ownership would support long-term commitment by AIP participants to invest in agriculture and rangelands, as well as in water and market infrastructure. In addition, livestock theft discouraged investments in livestock keeping. Insufficient law enforcement responses lead to an almost uncontrolled situation. For example, social conflicts had undermined traditional systems of mutual assistance, resulting in a reluctance to assume the risks associated with lending or borrowing livestock.

On demand by the AIP members and with support by the MOREP project, a local NGO supported the registration of the AAPACHIMA farmer association and advocated

the association's land title claim to the local market place and adjacent agricultural land. The registration of AAPACHIMA was accompanied by the demarcation and titling of 13,000 ha of land, including the Marara livestock market and associated grazing land. Key informants, including local government officials, extension officers, and community members expressed that the formal land title improved coordination with the local authorities on livestock movement control and reduced theft and illegal slaughter of livestock. It further created credibility and provided incentives for farmers and private actors to invest in market infrastructure and to organise more effectively around satellite sales of goats. Furthermore, improved security was perceived as encouraging communities to re-establish local goat re-stocking mechanisms.

4.3.4 Market infrastructure development

AIP members emphasised the importance of a well-functioning market system, thus underscoring the need for easily accessible market facilities and transparent operations. At baseline, farmers showed limited willingness to engage in improving the existing market system, reflecting a general lack of trust in the market system. They expressed difficulties in directly communicating with market actors to establish more effective market arrangements. Large abattoirs, in turn, were actively seeking to purchase more goats of higher quality from smallholder farmers. AIP members also acknowledged the importance of better and coordinated collaboration with more diverse market actors (see section on social capital above). They saw the potential to create incentives for market actors, including farmers, through collaborative arrangements and investments in more functional market infrastructure.

The AIP with project support facilitated an innovation process between farmers, large abattoirs, and other market actors to address limitations in the market system associated with high transaction costs, unreliable supply of livestock to abattoirs, and untransparent contract conditions. Structured discussions opened up a dialogue, and farmers learned about meat quality and market requirements. In addition, the project had a goat restocking and pass-on component, to provide extremely poor farmers, notably women-headed households, with access to goats. The approach was designed as a social support measure in response to abandoned traditional assistance mechanisms. Goat recipients were mentored by established goat owners.

Key informants stated that as the result of this process, extension officers started connecting farmers with the private sector, which contributes to the long-term impacts of the AIP. They observed that the new connections eased direct interactions between AIP members and market actors, for instance, during market events.

Outcome harvesting indicates that the concept of satellite sales was well accepted by farmers and private actors, and three satellite sales points were established by AAPACHIMA members in 2017, for aggregating livestock for sale to large abattoirs. Community members contributed labour and material for the construction. Part of the sales point concept was negotiation on quality-based prices. It was documented that abattoirs provided their weighing infrastructure and transport to increase market transparency and to create trust and incentives for selling higher quality livestock. Quantitative assessments, however, suggest that these developments did not significantly affect selling times and prices (Figure 5, Appendices 2.4 and 2.5).

5. Discussion

With reference to our first research objective, our assessments provide compelling evidence that the AIP process catalysed behavioural and institutional changes. The findings indicate that the AIP influenced the knowledge and agency of its members, and there are plausible links tying changes in the market and governance contexts to AIP activities. This combination of behavioural and institutional shifts likely altered the dynamics of the AIP action situation and has improved livestock, fodder, and soil management as well as market participation. The participatory co-creation of outcomes and interventions, combined with a flexible, emergent evaluation process, allowed participants – including marginalised groups – to enhance their knowledge, thereby supporting goal-directed behavioural change in line with conceptual frameworks emphasising adaptive capacity and individual agency (Meinzen-Dick and Bruns 2024; Michie, Van Stralen, and West 2011). The establishment and formal registration of the AAPACHIMA farmer association exemplify strengthened collective agency and self-organisation as foundational institutional changes, which extended beyond immediate participants (Bisseleua et al. 2018). These institutional achievements, together with improvements in land tenure security and market infrastructure, helped generate critical feedback loops reinforcing economic and social subsystems that underpin more sustained behavioural changes (McGinnis and Ostrom 2014). These outcomes align with the understanding that food system improvements require integrated approaches targeting multiple system components while considering trade-offs and synergies beyond productivity alone (Blundo-Canto et al. 2023; Knickel et al. 2009; Leeuwis, Klerkx, and Schut 2018). Our findings resonate with literature positioning AIPs as social learning processes that foster reflexivity and collaboration among diverse actors, enabling the co-design of socially and contextually embedded solutions essential to disrupting entrenched path dependencies and advancing socio-technical innovations in food systems (Cadilhon 2013; Davis et al. 2015; Folke et al. 2010; Hall and Dijkman 2019; Kilelu, Klerkx, and Leeuwis 2013; Swaans et al. 2013; Turner et al. 2017).

Regarding our second research objective, the study demonstrates the value of a mixed methods approach to address challenges of evaluating AIPs, which include the absence of a predefined theory of change, the complexity of interrelated multi-level system changes, non-linear development dynamics, and participant self-selection biases complicating clear attribution (Abson et al. 2017; Schut et al. 2018; Wigboldus et al. 2016). To navigate these complexities, we complemented propensity score matching with regression adjustments and incorporated outcome harvesting as a participatory, retrospective evaluation method. Outcome harvesting is particularly suited for AIPs because it accommodates open, demand-driven interventions where outcomes emerge dynamically and cannot be fully pre-specified (Beardmore, Jones, and Seal 2023; Wilson-Grau and Britt 2012). Through an iterative process of defining outcomes, substantiating outcome claims, and formulating outcome statements with active stakeholder participation, we captured emergent changes unfolding across multiple levels of the agri-food system. This mixed methods framework importantly facilitated ongoing reflexivity and continuous refinement of the theory of change, a critical feature for evaluating participatory multi-actor innovation processes navigating complex adaptive

systems (Schut et al. 2016; Wigboldus and Brouwers 2016). On a practical level, outcome harvesting enriched AIP facilitation documentation and interpretation by integrating qualitative sources, including workshop reports, field notes, and stakeholder interviews, alongside quantitative survey data. Bridging retrospective qualitative insights with quantitative analyses helped mitigate limitations related to self-selection and imperfect counterfactuals, thereby providing a more credible assessment of the AIP's contributions. Our experience underscores that evaluation of complex, adaptive innovation platforms benefits greatly from methodological pluralism and the active involvement of diverse actors throughout the process – lessons that can inform and strengthen future agricultural innovation and extension initiatives (Klerkx, Van Mierlo, and Leeuwis 2012; Leach et al. 2012; Njuki et al. 2023).

6. Conclusions

Our study responds to calls for deeper understanding of the outcomes of participatory, open, and flexible multi-actor innovation in complex environments. Process participants, system actors, and development agents want to understand what returns can be expected from AIPs. We present an approach for assessing outcomes of such processes and shared evidence on the fruitful role of AIPs in transforming food systems. Nurturing dialogue and reflection among all actors around the process of diagnosis and visioning, planning, and review of interventions fosters mutual understanding and momentum for collective improvement and adaptation to change, thus altering values and beliefs at the collective level. We hope that our results increase extension agents' confidence in applying AIPs at a larger scale.

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Ethics, and data access

All aspects of the research have been conducted in an ethical and responsible manner in accordance with the principles stated in the Declaration of Helsinki. All study participants have given their informed consent to participate in the research. Anonymised data are made available on request by the corresponding author.

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References

Abson, David J., Joern Fischer, Julia Leventon, Jens Newig, Thomas Schomerus, Ulli Vilsmaier, Henrik Von Wehrden, Paivi Abernethy, Christopher D. Ives, and Nicolas W. Jager. 2017. "Leverage Points for Sustainability Transformation." *Ambio* 46:30–39. https://doi.org/10.1007/s13280-016-0800-y.

Austin, Peter C. 2011. "An Introduction to Propensity Score Methods for Reducing the Effects of Confounding in Observational Studies." *Multivariate Behavioral Research* 46 (3): 399–424. https://doi.org/10.1080/00273171.2011.568786.

Beardmore, Amy, Matthew Jones, and Joanne Seal. 2023. "Outcome Harvesting as a Methodology for the Retrospective Evaluation of Small-Scale Community Development Interventions." *Evaluation and Program Planning* 97:102235. https://doi.org/10.1016/j.evalprogplan.2023.102235.

Bisseleua, D. H. B., L. Idrissou, P. Olurotimi, A. Ogunniyi, Djana Mignouna, and S. A. Bamire. 2018. "Multi-stakeholder Process Strengthens Agricultural Innovations and Sustainable Livelihoods of Farmers in Southern Nigeria." *The Journal of Agricultural Education and Extension* 24 (1): 29–49. https://doi.org/10.1080/1389224X.2017.1392992.

Blundo-Canto, Genowefa, Gonzalo Rodríguez-Borray, Ángela-Rocío Vásquez-Urriago, María-Margarita Ramírez-Gómez, Gregorio Zambrano-Moreno, Leidy Tibaduiza-Castañeda, Bellanid Huertas-Carranza, Adriana Santacruz-Castro, Beatriz-Elena Agudelo-Chocontá, and Guillaume Soullier. 2023. "Impact Weaving: An Approach to Strengthening the Plausibility of Anticipated AR4D Impact Pathways." *The European Journal of Development Research* 35 (2): 402–425. https://doi.org/10.1057/s41287-022-00566-6.

Cadilhon, Joseph J. 2013. *A Conceptual Framework to Evaluate the Impact of Innovation Platforms on Agrifood Value Chains Development*, September 11–13. European Association of Agricultural Economists, Ghent.

Davis, Rachel, Rona Campbell, Zoe Hildon, Lorna Hobbs, and Susan Michie. 2015. "Theories of Behaviour and Behaviour Change across the Social and Behavioural Sciences: A Scoping Review." *Health Psychology Review*9 (3): 323–344. https://doi.org/10.1080/17437199.2014.941722.

Duru, Michel, Olivier Therond, and M'hand Fares. 2015. "Designing Agroecological Transitions: A Review." *Agronomy for Sustainable Development* 35:1237–1257. https://doi.org/10.1007/s13593-015-0318-x.

Folke, Carl, Stephen R. Carpenter, Brian Walker, Marten Scheffer, Terry Chapin, and Johan Rockström. 2010. "Resilience Thinking: Integrating Resilience, Adaptability and Transformability." *Ecology and Society* 15 (4). https://doi.org/10.5751/ES-03610-150420.

Freed, Sarah, Rachel C. Voss, Thomas Falk, Anne M Rietveld, Véronique Alary, Vimbayi GP Chimonyo, Aymen Frija, Nadia Guettou-Djurfeldt, Guillaume Lestrelin, and Sonali Singh. 2025. "Agency and Behavior Change in Agricultural Research for Development: New Directions for Guiding Agri-Food System Transformations." *Agricultural Systems* 228:104399. https://doi.org/10.1016/j.agsy.2025.104399.

Garrity, Dennis, John Dixon, and Jean-Marc Boffa. 2012. "Understanding African Farming Systems." *Food Security in Africa: Bridging Research and Practise*: 1–50.

Geels, Frank W., and Johan Schot. 2007. "Typology of Sociotechnical Transition Pathways." *Research Policy* 36 (3): 399–417. https://doi.org/10.1016/j.respol.2007.01.003.

Giller, Ken E., Pablo Tittonell, Mariana C. Rufino, Mark T. Van Wijk, Shamie Zingore, Paul Mapfumo, Samuel Adjei-Nsiah, M. Herrero, Régis Chikowo, and Marc Corbeels. 2011. "Communicating Complexity: Integrated Assessment of Trade-Offs concerning Soil Fertility Management within African Farming Systems to Support Innovation and Development." *Agricultural Systems* 104 (2): 191–203. https://doi.org/10.1016/j.agsy.2010.07.002.

Hall, Andrew, and Norman Clark. 2010. "What Do Complex Adaptive Systems Look Like and What Are the Implications for Innovation Policy?" *Journal of International Development* 22 (3): 308–324. https://doi.org/10.1002/jid.1690.

Hall, Andrew, and Jeroen Dijkman. 2019. "Public Agricultural Research in an Era of Transformation: The Challenge of Agri-food System Innovation." In *Rome and Canberra: CGIAR Independent Science and Partnership Council (ISPC) Secretariat and Commonwealth Scientific and Industrial Research Organisation (CSIRO)*, 67.

Homann-Kee Tui, Sabine. 2015. *MOREP II: Nudging Sustainability Transitions Using Innovation Platforms and Market-Oriented Development in Mozambique - Inception workshop report*, October 2–3. International Crops Research Institute for the Semi-arid Tropics (Bulawayo/ Zimbabwe).

Homann-Kee Tui, Sabine, E. Bandason, F. Maute, D. Nkomboni, N. Mpofu, J. Tanganyika, A. F. Van Rooyen, T. Gondwe, P. Dias, and S. Ncube. 2013. "Optimizing Livelihood and Environmental Benefits from Crop Residues in Smallholder Crop-Livestock Systems in Southern Africa." *ICRISAT Socio-economics Discussion Paper Series. Series Paper* 11.

Homann-Kee Tui, Sabine, M. Hauser, C. Quembo, C. Gule, F. Assane, F. Mazuze, J. Rainde, and C. Sixpence. 2014. "Towards Resilient and Profitable Farming Systems in Central Mozambique using an Open Innovation Platform Approach." In *RUFORUM 4th Biennial Conference, Maputo*, July 19–24.

Kabeer, Naila. 1999. "Resources, Agency, Achievements: Reflections on the Measurement of Women's Empowerment." *Development and Change* 30 (3): 435–464. https://doi.org/10.1111/1467-7660.00125.

Kilelu, Catherine W., Laurens Klerkx, and Cees Leeuwis. 2013. "Unravelling the Role of Innovation Platforms in Supporting co-evolution of Innovation: Contributions and Tensions in a Smallholder Dairy Development Programme." *Agricultural Systems* 118:65–77. https://doi.org/10.1016/j.agsy.2013.03.003.

Klerkx, Laurens, Marc Schut, Cees Leeuwis, and Catherine Kilelu. 2012. "Advances in Knowledge Brokering in the Agricultural Sector: Towards Innovation System Facilitation." *Ids Bulletin* 43 (5): 53–60. https://doi.org/10.1111/j.1759-5436.2012.00363.x.

Klerkx, Laurens, Barbara Van Mierlo, and Cees Leeuwis. 2012. "Evolution of Systems Approaches to Agricultural Innovation: Concepts, Analysis and Interventions." In *Farming Systems Research into the 21st century: The New Dynamic*, 457–483.

Knickel, Karlheinz, Gianluca Brunori, Sigrid Rand, and Jet Proost. 2009. "Towards a Better Conceptual Framework for Innovation Processes in Agriculture and Rural Development: From Linear Models to Systemic Approaches." *The Journal of Agricultural Education and Extension* 15 (2): 131–146. https://doi.org/10.1080/13892240902909064.

Leach, Melissa, Johan Rockström, Paul Raskin, Ian Scoones, Andy C Stirling, Adrian Smith, John Thompson, Erik Millstone, Adrian Ely, and Elisa Arond. 2012. "Transforming Innovation for Sustainability." *Ecology and Society* 17 (2). https://doi.org/10.5751/ES-04933-170211.

Leeuwis, Cees, Laurens Klerkx, and Marc Schut. 2018. "Reforming the Research Policy and Impact Culture in the CGIAR: Integrating Science and Systemic Capacity Development." *Global Food Security* 16:17–21. https://doi.org/10.1016/j.gfs.2017.06.002.

Logan, Robert K. 2012. "What Is Information? Why Is it Relativistic and What Is Its Relationship to Materiality, Meaning and Organization." *Information* 3 (1): 68–91. https://doi.org/10.3390/info3010068.

Loorbach, Derk, Niki Frantzeskaki, and Flor Avelino. 2017. "Sustainability Transitions Research: Transforming Science and Practice for Societal Change." *Annual Review of Environment and Resources* 42:599–626. https://doi.org/10.1146/annurev-environ-102014-021340.

Max-Neef, Manfred A., Antonio Elizalde, and Martin Hopenhayn. 1991. *Human Scale Development: Conception, Application and Further Reflections.(No Title)*. New York: Apex Press.

McGinnis, Michael D., and Elinor Ostrom. 2014. "Social-ecological System Framework: Initial Changes and Continuing Challenges." *Ecology and Society* 19 (2). https://doi.org/10.5751/ES-06387-190230.

Meinzen-Dick, Ruth, and Bryan Bruns. 2024. "Crafting Combinations to Govern Groundwater: Knowledge, Motivation, and Agency." *International Journal of the Commons* 18 (1): 585–600. https://doi.org/10.5334/ijc.1473.

Michie, Susan, Maartje M. Van Stralen, and Robert West. 2011. "The Behaviour Change Wheel: A new Method for Characterising and Designing Behaviour Change Interventions." *Implementation Science* 6 (1): 1–12. https://doi.org/10.1186/1748-5908-6-42.

Nelson, Donald R., W. Neil Adger, and Katrina Brown. 2007. "Adaptation to Environmental Change: Contributions of a Resilience Framework." *Annual Review of Environment and Resources* 32:395–419. https://doi.org/10.1146/annurev.energy.32.051807.090348.

Njuki, Jemimah, Martha Melesse, Chaitali Sinha, Ruhiya Seward, Marie Renaud, Shannon Sutton, Tavinder Nijhawan, Katie Clancy, Ramata Thioune, and Dominique Charron. 2023. "Meeting the Challenge of Gender Inequality through Gender Transformative Research: Lessons from Research in Africa, Asia, and Latin America." *Canadian Journal of Development Studies / Revue Canadienne D'études du Développement* 44 (2): 206–228. https://doi.org/10.1080/02255189.2022.2099356.

Ostrom, Elinor. 2011. "Background on the Institutional Analysis and Development Framework." *Policy Studies Journal* 39 (1): 7–27. https://doi.org/10.1111/j.1541-0072.2010.00394.x.

Pahl-Wostl, Claudia, Georg Holtz, Britta Kastens, and Christian Knieper. 2010. "Analyzing Complex Water Governance Regimes: The Management and Transition Framework." *Environmental Science & Policy* 13 (7): 571–581. https://doi.org/10.1016/j.envsci.2010.08.006.

Pigford, Ashlee-Ann E., Gordon M. Hickey, and Laurens Klerkx. 2018. "Beyond Agricultural Innovation Systems? Exploring an Agricultural Innovation Ecosystems Approach for Niche Design and Development in Sustainability Transitions." *Agricultural Systems* 164:116–121. https://doi.org/10.1016/j.agsy.2018.04.007.

Poteete, Amy R., Marco A. Janssen, and Elinor Ostrom. 2010. *Working Together: Collective Action, the Commons, and Multiple Methods in Practice*. Princeton: Princeton University Press.

Sartas, Murat, Marc Schut, Claudio Proietti, Graham Thiele, and Cees Leeuwis. 2020. "Scaling Readiness: Science and Practice of an Approach to Enhance Impact of Research for Development." *Agricultural Systems* 183:102874. https://doi.org/10.1016/j.agsy.2020.102874.

Schut, Marc, Jean-Joseph Cadilhon, Michael Misiko, and Iddo Dror. 2018. "Do Mature Innovation Platforms Make a Difference in Agricultural Research for Development? A Meta-analysis of Case Studies." *Experimental Agriculture* 54 (1): 96–119. https://doi.org/10.1017/S0014479716000752.

Schut, Marc, Josey Kamanda, Andreas Gramzow, Thomas Dubois, Dietmar Stoian, Jens A Andersson, Iddo Dror, Murat Sartas, Remco Mur, and Shinan Kassam. 2019. "Innovation Platforms in Agricultural Research for Development: Ex-ante Appraisal of the Purposes and Conditions under which Innovation Platforms can Contribute to Agricultural Development Outcomes." *Experimental Agriculture* 55 (4): 575–596. https://doi.org/10.1017/S0014479718000200.

Schut, Marc, Laurens Klerkx, Murat Sartas, Dieuwke Lamers, Mariette Mc Campbell, Ifeyinwa Ogbonna, Pawandeep Kaushik, Kwesi Atta-Krah, and Cees Leeuwis. 2016. "Innovation Platforms: Experiences with Their Institutional Embedding in Agricultural Research for Development." *Experimental Agriculture* 52 (4): 537–561. https://doi.org/10.1017/S001447971500023X.

Schut, Marc, Cees Leeuwis, and Annemarie Van Paassen. 2013. "Ex Ante Scale Dynamics Analysis in the Policy Debate on Sustainable Biofuels in Mozambique." *Ecology and Society* 18 (1). https://doi.org/10.5751/ES-05310-180120.

Swaans, Kees, Beth Cullen, André Van Rooyen, Adewale Adekunle, Hlami Ngwenya, Zelalem Lema, and Suzanne Nederlof. 2013. "Dealing with Critical Challenges in African Innovation Platforms: Lessons for Facilitation." *Knowledge Management for Development Journal* 9 (3): 116–135.

Turner, James A., Tracy Williams, Graeme Nicholas, Jeff Foote, Kelly Rijswijk, Tim Barnard, Sam Beechener, and Akiko Horita. 2017. "Triggering System Innovation in Agricultural Innovation Systems: Initial Insights from a Community for Change in New Zealand." *Outlook on Agriculture* 46 (2): 125–130. https://doi.org/10.1177/0030727017708500.

Van Rooyen, André F., Peter Ramshaw, Martin Moyo, Richard Stirzaker, and Henning Bjornlund. 2017. "Theory and Application of Agricultural Innovation Platforms for Improved Irrigation Scheme Management in Southern Africa." *International Journal of Water Resources Development* 33 (5): 804–823. https://doi.org/10.1080/07900627.2017.1321530.

Weber, K Matthias, and Harald Rohracher. 2012. "Legitimizing Research, Technology and Innovation Policies for Transformative Change: Combining Insights from Innovation Systems and Multi-level Perspective in a Comprehensive 'Failures' Framework." *Research Policy* 41 (6): 1037–1047. https://doi.org/10.1016/j.respol.2011.10.015.

Wigboldus, Seerp, and Jan Brouwers. 2016. *Using a Theory of Scaling to Guide Decision Making: Towards a Structured Approach to Support Responsible Scaling of Innovations in the Context of Agrifood Systems*. Wageningen University & Research.

Wigboldus, Seerp, Laurens Klerkx, Cees Leeuwis, Marc Schut, Sander Muilerman, and Henk Jochemsen. 2016. "Systemic Perspectives on Scaling Agricultural Innovations. A Review." *Agronomy for Sustainable Development* 36 (46): 1–20. https://doi.org/10.1007/s13593-016-0380-z.

Wilson-Grau, Ricardo, and Heather Britt. 2012. *Outcome Harvesting.* Cairo: Ford Foundation.