

Designing Smallholder-Centric Product And Service Bundles To Incentivise Technology Adoption Using An Affordance Perspective

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Elena Hoffmann

MSc Sustainable Business and Innovation

Supervisor WUR: Paul Ingenbleek, Tamiru Abetu

Supervisor ABC: Sabine Homann

Supervisor IITA: Adane Tufa

Chair Group: Marketing and Consumer Behaviour (MCB)



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Name student(s): Elena Hoffmann

Registration number: 1043944

Course code: MCB80436

Supervisor(s): Paul Ingenbleek (WUR), Tamiru Abetu (WUR), Sabine Homann (ABC) Adane Tufa (IITA)

Professor/Examiner: Phil Flores (WUR)

Abstract

Smallholder farmers in sub-Saharan Africa face complex and interrelated constraints that hinder the adoption of sustainable agricultural practices. Studies have shown that product and service bundles could serve as a solution to overcome multiple barriers smallholders face simultaneously, if designed appropriately. This study aims to design product and service bundles to incentivise the adoption of Mbili Mbili, a maize-legume intercropping practice, in Kasungu, Malawi. Using a smallholder-centric design approach grounded in design thinking and affordance theory, the research followed a three-step qualitative methodology process: identifying driver and barriers to adoption, mapping existing products and services, and co-developing and refining bundle prototypes with farmers. In doing so, this study extends the bundling literature by applying it to the adoption of agricultural practices rather than individual artefacts. Design thinking provided a structured, participatory framework for bundle development, while affordance theory served both as an analytical lens and a design tool, ensuring that bundle components aligned with farmers' resources, constraints, and everyday realities.

The findings reveal that smallholders face a range of key constraints, most notably the impacts of climate change, limited access to inputs, labour shortages, and restricted market access which are also highly interrelated and shaped by the local context. Although a variety of products and services are available, they remain fragmented, poorly coordinated, and in some cases entirely absent, leaving critical gaps. Bundling offers a strategic approach to reconfigure these components into coherent packages that reduce risk, improve accessibility, and increase the perceived feasibility of adopting Mbili Mbili. Farmers consistently valued bundles that included farm inputs, training, and finance mechanisms as essential, with livestock and market access serving as strong enhancers when aligned with their needs.

Overall, the research demonstrates that thoughtfully designed bundles can positively influence farmer perceptions, reduce adoption barriers, and contribute to more inclusive and sustainable agricultural transitions.

Key words: smallholder technology adoption, bundle design, affordance theory, design thinking

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1. INTRODUCTION

Sustainable agriculture is recognised by the UN Sustainable Development Goals (SDGs) as a key driver for ending hunger and achieving food security (SDG 2). Reaching these objectives is particularly pressing in sub-Saharan Africa where, as of 2019, 17.8% of the population were undernourished (FAO, 2019). Smallholder farmers play a critical role in the food systems of sub-Saharan Africa (FAO et al., 2020). They provide about one-third of most food commodities (Lowder et al., 2016; Ricciardi et al., 2018) produced on farms smaller than two hectares, accounting for about 80% of farms in that region (Lowder et al., 2021). Despite their importance in supplying food to rural and urban households, studies have shown that agricultural production in sub-Saharan Africa (SSA) is falling short of its potential, unable to meet current food demand trends (e.g., van Ittersum et al., 2016). As the population of SSA is expected to double by 2050 compared to 2022 (United Nations, 2022), the gap between crop production and consumption will continue to widen, posing serious risks to the region's food security (van Ittersum et al., 2016).

Traditional agricultural intensification measures, which include the expansion of agricultural land and more intensive use of existing cropland, have increased food production but have led to severe environmental degradation affecting climate, biodiversity, and soil health (Petersen and Snapp, 2015). Instead, sustainable intensification (SI) of agriculture is required to increase yields without causing adverse environmental effects (van Ittersum et al., 2016). SI of agriculture is a concept that generally revolves around three underlying principles: (i) increased productivity; (ii) protection and preservation of ecosystem services; and (iii) increased resilience to shocks (Vanlauwe et al., 2016; Pretty et al., 2011; Vanlauwe et al., 2014), thereby aiming to balance the social, environmental, and economic objectives of agriculture. Substantial investments in agricultural research and technological innovations were made to 'accelerate sustainable intensification' (Petersen and Snapp, 2015). Practices and innovations commonly applied in the context of SI involve Green Revolution technologies, e.g., improved seed varieties and inputs, conservation practices enhancing soil health such as crop-livestock integration, cereal-legume intercropping, compost making, crop diversification and agroforestry (Petersen and Snapp, 2015; Guo et al., 2020).

Despite scientific evidence of the benefits of improved agricultural technologies on productivity, income, food security, and household welfare (Arslan et al., 2022; Adams and Jumpah, 2021), adoption rates among smallholder farmers are heterogeneous and unpredictable (Sheahan et al., 2017; Akzar et al., 2022). Extensive research has been conducted to understand the factors that influence farmers' technology adoption (e.g., Guo et al., 2020; D'Souza et al., 1993; Arslan et al., 2022, Meijer et al. 2014). These studies show that technology adoption is influenced by a variety of factors (Arslan et al., 2022) which can be categorised into household and farm characteristics, institutional and access factors (e.g., markets, information, finance, inputs), and biophysical factors such as climate conditions (Abetu, 2022, Arslan et al., 2014). Market failure and imperfection created by weak institutional environment create some of the most pressing challenges, failing to provide access to appropriate input and output markets, road infrastructure, financial services, market and technology information, contract enforcement mechanisms or property rights. If the mechanisms to invest in technologies and ability to market surplus output are not guaranteed, it strongly influences smallholder farmers' ability and decision to adopt new technologies (Ateka et al., 2021; de Janvry et al., 1991). Various private and

public sector initiatives have sought to address these challenges through engaging microfinance institutes, infrastructure development (e.g., roads, storage, energy), agricultural extension services, or the provision of agricultural inputs (Salami et al., 2010). Nevertheless, adoption rates remain inconsistent (Khonje et al., 2015) in part because interventions focus only on the most pressing challenges that impact technology adoption rather than considering the complexity and interconnectedness of existing barriers as well as on the design of agricultural technologies that fail to be adapted to users and local conditions.

In response, the concept of bundling has emerged as a promising approach for tackling multiple barriers simultaneously. Originally a marketing concept, product and service bundling, defined as “the integration and sale of two or more separate products or services at any price” (Stremersch and Tellis, 2002) has found application in the smallholder context as a way to provide farmers with integrated support packages. A number of scientific papers and practical case studies have shown how bundling of agricultural inputs with financial products, information services, and market contracts encourages the uptake of the technologies by addressing a variety of constraints faced by farmers (e.g., Bulte et al., 2020; Ogada et al., 2014; Akter et al., 2016).

However, the current literature on bundling in smallholder agriculture remains limited in various ways. First, studies assess the effectiveness of product bundles e.g., to increase farm investment (Bulte et al. 2020), or to increase farmers’ resilience and productivity (Boucher et al. 2021). Second, although some studies assess the effectiveness of bundling it is unclear whether it applies in the smallholder context such as the study by Reinders et al. (2010) on how bundling supports the adoption of radical innovations. Moreover, most studies on bundling make use of predetermined bundle components. Those bundles often focused on the adoption of technological artefacts such as fertilisers or seeds, rather than agricultural practices, which tend to be more complex, labour-intensive, and context-specific. Few studies focus on the design of bundles to effectively incentivise technology adoption (Stremersch et al., 2002; Tsan et al., 2019). As a result, many companies and development projects have implemented technology dissemination programs following a one-size-fits-all approach, neglecting the complexity and heterogeneity of African agricultural and market systems. A context that is characterized by differences in agroecological and socio-economic contexts (Giller et al. 2011) as well as the unique characteristics of different groups of farmers (e.g., assets, demographics, constraints, needs) (Akzar et al. 2022). Therefore, Tsan et al. (2019) stress the need for greater attention to smallholder farmers’ needs and constraints in designing bundles to effectively address the barriers.

Recent work by Abetu (2024) has started to close this gap by applying a smallholder-centric approach to bundle design, showing that such designs can increase farmers’ intention to adopt productivity-enhancing technologies. Yet, this research focused on the adoption of technological artefacts and follows a predominantly marketing-oriented design process.

This study responds to these gaps by extending the focus of bundling research in smallholder contexts in two important directions. First, this study employs the term ‘technology’ as an agricultural practice rather than a technological artefact, a distinction that is not always explicitly made in the literature of technology adoption by smallholder farmers. Thereby, agricultural practices include e.g., conservation agriculture, maize-legume intercropping or crop rotation, while technical artefacts refer to fertilisers,

machinery, or improved seed varieties. Hence, this study applies a smallholder-centric design approach to encourage adoption of an agricultural practice rather than a technical artifact. Second, it integrates affordance theory (Gibson, 1979; Norman, 2002; Glover et al., 2017) into the bundle design process to better understand how smallholders interact with both the agricultural practice and potential bundle components within their specific socio-economic and agroecological contexts. Affordances are defined as action possibilities emerging from the interaction between the user and the environment, and offer a relational, context-sensitive lens to assess how bundle components may enable or constrain adoption. Moreover, the study contributes to the growing literature on bundling in smallholder agriculture, particularly looking at the context of Malawi.

This research is conducted as part of the Sustainable Intensification of Mixed Farming Systems (SI-MFS) Initiative of CGIAR, in the Kasungu district in central Malawi. Maize is the staple crop of the Malawian population, the production of which has been strongly promoted at the expense of other crops such as groundnuts, soybeans, and other beans. The initiative, therefore, promotes the maize-legume intercropping practice Mbili Mbili as a sustainable agricultural intensification intervention to overcome the over-reliance on maize by stimulating crop diversification without compromising maize production. Thus, Mbili Mbili is the agricultural practice researched in this study. A detailed description of Mbili Mbili is provided in section 3.1.2..

The objective of this thesis is to design smallholder-centric product and service bundles and to assess their potential to incentivize the adoption of the agricultural technology Mbili Mbili using an affordance perspective. In doing so, it contributes to the literature on smallholder technology adoption and bundling by addressing the often-overlooked interplay between bundle design, agricultural practices, and user context. The following research question guides this study:

Main research question:

Which products and services should be incorporated into the design of smallholder-centric product and service bundles to encourage the adoption of the Mbili Mbili agricultural practice among smallholder farmers in the Kasungu district, Malawi?

Sub-questions:

1. What are the drivers and barriers that influence the adoption of the Mbili Mbili technology?
2. What are the potential products and services offered by public and private sector stakeholders that can address the barriers influencing smallholder farmers' decision to adopt the Mbili Mbili technology?
3. Which product and service bundle configurations and components most effectively incentivise smallholder farmers in the Kasungu district, Malawi, to adopt the Mbili Mbili technology?

2. Theoretical Background

Chapter 2 reviews existing literature to guide the design of smallholder-centric bundles and to examine how and why such bundles can support the adoption of agricultural technologies. It begins with an overview of technology adoption literature in the smallholder context, focusing on the key factors that shape farmers' adoption behaviour. This is followed by a discussion of how bundling can address these factors and potentially enhance adoption, while also highlighting gaps in the current literature, particularly with regard to bundle design. To address these gaps, the chapter draws on insights from design thinking and affordance theory as frameworks for developing bundles that are both context-sensitive and user-focused. These theoretical insights provide the foundation for the methodological and analytical approach taken in the following chapters of the thesis.

2.1. Technology adoption: theoretical foundation and smallholder context

The literature on technology adoption is extensive, offering a range of frameworks that explain both the adoption process and the factors influencing it. Understanding the factors that have been found in literature to influence technology adoption can provide valuable insights to inform this research on adoption of Mbili Mbili. For that, this sub-chapter starts looking at the adoption and diffusion models for a more general overview of factors influencing adoption, followed by looking at the extensive literature on smallholder technology adoption which shed light on specific factors that have found to influence adoption behaviour among smallholder farmers.

Adoption is defined as "the mental process an individual passes from first hearing about an innovation to final adoption" (Rogers, 1962). Among the best-known adoption models are the Theory of Reasoned Action (TRA) by Fishbein and Ajzen (1975) and its successor, the Theory of Planned Behaviour (TPB) (Ajzen, 1991). These theories emphasise individual-level psychological and social factors that influence behaviour, including attitudes, subjective norms, and perceived behavioural control, all of which shape an individual's intention to adopt and ultimately their adoption behaviour (Lai, 2017). Similarly, the Technology Acceptance Model (TAM) developed by Davis (1989) highlights perceived usefulness and perceived ease of use as key drivers of technology acceptance. These behavioural models were later synthesized into the Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh et al. (2003), which includes constructs such as performance expectancy, effort expectancy, social influence, and facilitating conditions, along with moderating variables such as age, gender, experience, and voluntariness of use.

Beyond individual-level behavioural models, broader frameworks incorporate external influences and systemic factors. The Diffusion of Innovation (DOI) theory by Rogers (2003) identifies five key characteristics of innovations that influence their adoption: relative advantage, compatibility, complexity, trialability, and observability. This framework is widely applied in agriculture to evaluate both individual adopter characteristics and perceptions of the innovation itself. Meanwhile, institutional theory (DiMaggio & Powell, 1983) emphasises the role of institutional environments, such as regulatory frameworks, market structures, and normative pressures, in shaping adoption decisions. Although originally developed to explain organisational behaviour, institutional theory has since been applied in agriculture to understand how broader systemic conditions either enable or constrain technology uptake.

Building on these theoretical foundations, a large body of literature has examined the context-specific barriers and drivers of technology adoption among smallholder farmers. The majority of which has put greater attention on the effect of extrinsic, environmental factors on smallholder's decisions to adopt improved agricultural technologies (Meijer et al. 2014). Bio-physical factors such as pests and diseases, and rainfall variability causing production risks seem to negatively affect technology adoption (Aslan et al. 2021; Arias et al., 2013). At household and farm level, barriers to adoption include the availability of labour which could limit the farmers' ability to implement labour-intensive agricultural practices and a lack of household capital to invest in new technologies. Further household and farm factors are farm size, age, gender, and the level of education (Arslan et al. 2022). Social capital and social networks including cooperative membership have significantly been associated with technology adoption, particularly in ill-functioning institutional environments. Group formation among farmers supports the information flow about new technologies, enable the access to finance and inputs, and act as informal insurance mechanism for financial institutes (Kassie et al. 2013).

In countries such as Malawi, characterized by weak and ill-functioning institutional environments, institutional voids further exacerbate adoption challenges. Institutions, however, are seen as a necessary prerequisite for markets to exist and function well (Mair and Marti, 2009). Constraints that result from these malfunctions encompass poor infrastructure, insecure land tenure, limited access to financial services, input and output markets as well as poor quality and organisation of these markets, and limited access to information and extension services (Arslan et al., 2022; Abetu 2022). These challenges and their related transaction costs discourage farmers to adopt productivity enhancing technologies if the means to invest are unavailable, inputs are inaccessible, information on market standards and prices, weather, and technology is limited, or investments cannot be recovered due to the inability to market the production surplus in the absence of, or distance to, output markets (Poole, 2017). Hence, the unfavourable enabling environment poses serious barriers for farmers' technology adoption by creating uncertainty, perceived risks, and influencing the technology's value perception.

However, by predominantly focusing on extrinsic and environmental effects that hinder farmers to adopt, research and development programs forget to consider farmers as active decision-makers with individual motivations, attitudes, subjective beliefs, personality traits, and perceptions that might implicate the adoption process (Meijer et al. 2014). Although these individual differences are long recognised in marketing and consumer studies on technology adoption, the focus on 'individual difference factors' (Abetu, 2022) has only recently been added to the literature on technology adoption among smallholder farmers. Therefore, Abetu (2022) calls for a greater user-centric perspective in the adoption process of sustainable agricultural technologies in the smallholder farmer context.

Finally, another critical consideration is the appropriateness and adaptability of the technologies themselves. Technologies like conservation agriculture (CA) for example, while often promoted for their environmental and productivity benefits, have been criticized for being applied as universal solutions without sufficient local adaptation (Coe et al., 2014), with little acknowledgement of farmers' 'agency and capabilities' (Glover et al., 2017). Glover et al. (2019) specifically challenges the idea of treating technologies as a 'black box' that can be seamlessly transferred from one context to another for adoption and implementation. Technologies not only consist of technical artifacts and practices but also 'agency of human actors embedded in a web of social and ecological relationships, expressed in

many different cultural and institutional forms' (Glover et al. 2017). As such, technologies are socio-technical configurations whose adoption is encouraged by their local embeddedness and design in alignment with farmers' needs, capacities, and aspirations (Glover et al. 2019).

2.2. Bundling of products and services and its potential for technology adoption

This research explores the potential of bundling as a tool to address barriers to the adoption of the Mbili Mbili agricultural practice. To assess its suitability, it is first important to examine what bundling entails and how it may benefit smallholder farmers by reviewing existing literature on bundling in the context of technology adoption.

The concept of bundling originates from the field of marketing and is usually used as a sales strategy. Various definitions of the concept exist, the most widely accepted definition coming from Stremersch & Tellis (2002) who define bundling as the 'sale of two or more separate products in one package', whereby separate markets for these separate products exist. A distinction can be made between price bundling and product bundling. Price bundling refers to the 'sale of two or more separate products in a package at a discount' without the integration of the offered products. Product bundling on the other hand is defined as the 'sale of two or more separate products or services at any price' (Stremersch & Tellis, 2002). In this context, the term 'product' considers both goods and services. The focus of this research is, hence, on what Stremersch & Tellis (2002) refer to as product bundling since this research assesses the impact of products rather than of prices on smallholder farmers. In contrast, Barrett et al. (2022) offer a different perspective on bundling compared to the product-centric view in marketing literature. Rather than focusing solely on products and services, they conceptualize bundles as socio-technical innovation packages, co-created with farmers, policymakers, and private actors, where institutional and stakeholder engagement are just as important as the technical components. While this perspective provides a valuable lens on bundling, the present research adopts the definition of bundling as proposed by Stremersch and Tellis (2002).

Bundling can create additional value for customers that encourages them to choose bundled offerings over individual products. The added value appears to be different for price and for product bundles. In price bundling, the bundle itself offers no inherent added value beyond cost savings, hence, a discount is typically required to incentivise purchase. In contrast, product bundling generates value through the integration of complementary goods and services. This integration can reduce perceived risk, enhance performance, offer greater convenience, and provide a relative advantage, making the bundle more attractive to customers (Stremersch & Tellis, 2002). Particularly in subsistence markets characterized by a malfunctioning institutional environment, including input and service markets, product bundling can create added value by overcoming malfunctions. By combining complementary products and services into a single package, bundling reduces the costs associated with searching for, negotiating, and assembling individual components. This not only lowers transaction costs for smallholder farmers but also enhances convenience and accessibility (Abetu, 2024). As a result, bundling can help overcome institutional gaps and factors of market failure while simultaneously reducing transaction costs that significantly impact technology adoption (London et al., 2010; Abetu, 2024).

Bundling is used in marketing as a strategy for launching new products (Stremersch & Tellis, 2002; Shen & Pan, 2009). Especially when bundled with existing products that consumers are already familiar with, bundling can introduce new products to consumers and increase awareness. Introducing new products in product bundles increases the visibility and triability of the new products, reduces uncertainty and risk, and incentivises consumers to try them. In addition, bundling with existing, familiar products can increase the perceived functionality of the new product (Stremersch & Tellis, 2002). Thus, bundling could help with the introduction of new technologies to smallholders and facilitate their adoption and continued use by raising awareness, encouraging trial, and emphasising the functionality of the product. Bulte et al. (2020) demonstrated that the bundling of free insurance and improved seeds enhanced the uptake of additional modern inputs and incentivised farmers to expand their production area. Reinders et al. (2010) have shown that radically new technologies are more likely to be adopted when bundled with products consumers are familiar with. However, these findings are based on general consumer markets and have not yet been empirically tested in the smallholder context.

Moreover, bundling could incentivise smallholder farmers' technology adoption by overcoming barriers related to adoption. Various measures have been implemented by public and private sector actors to stimulate agricultural technology adoption and to overcome identified constraints hindering adoption. This has triggered interventions related to infrastructure e.g., road and communication infrastructure, access to finance through microfinance institutes or the formation of Village Savings and Loan Associations (VSLAs), access to markets by strengthening farmer cooperatives, access to information through the expansion of ICT tools (Misaki et al., 2018). Nonetheless, the interventions have not led to the expected results, showing only partial success (Feder et al., 1985). Most interventions only focus on one or few constraints faced by farmers, thereby ignoring the complexity and interrelation of many constraints (McDonald et al., 2019). Even if solutions are available, they are often not immediately accessible to smallholder farmers or offered by multiple sources in an unbundled way. Therefore, effectively addressing constraints requires an integrative approach through the bundling of resources in partnership with other organisations which London et al. (2010) discuss as a strategy to overcome institutional voids in base-of-the-pyramid markets. Abetu (2024) put forward evidence for the hypothesis, stating that addressing multiple barriers simultaneously increases smallholder adoption of agricultural technologies which could be done by bundling products and services. For example, the uptake of improved seeds can be leveraged if bundled with loans to invest in production activities combined with contracts to ensure the guaranteed sale of the surplus at a set price. Thus, the various constraints in adopting agricultural technologies (e.g., lack of access to finance, poor access to input and output markets) could be addressed by the components of a product bundle.

2.3. The importance of bundle design for smallholder technology adoption

By looking at the studies on bundling in the smallholder context, one shortcoming becomes evident which has also been pointed out by Abetu (2024). Most studies on bundling work with predetermined bundle components (e.g., Reinders et al., 2010) but give little attention to the design of the bundles and its influence on technology adoption with the exception of Abetu (2024). The extent to which bundling incentivises the adoption and diffusion of technologies among smallholder farmers however largely depends on the design of the product and service bundles. Marketing literature suggests the design of bundles to follow a comparable approach used for the development of any new product or

service (Stremersch & Tellis, 2002). Accordingly, in line with traditional marketing literature, the bundling of products and services should follow a consumer-centric approach that considers the context, preferences, and experiences of users (Abetu, 2024). In this view, Abetu (2024) promotes a smallholder-centric bundle design, which includes ‘empathizing’ with farmers and using conjoint analysis to determine optimal bundle configurations.

In contrast, Barrett et al. (2022) take a broader systems-oriented perspective considering bundling as socio-technical innovation packages. These bundles combine technical innovations with supporting institutional, policy, and socio-cultural components, and are designed through multi-stakeholder engagement. For Barrett et al., it is the co-creation process, which includes engaging farmers, policymakers, private actors, and civil society that drives the successful design of bundles. By embedding technical components within a supportive policy and institutional framework, and by involving stakeholders in every step, these bundles reduce adoption barriers and tailor innovations to farmers’ needs. For Barrett et al. (2022), stakeholder engagement is an integral part of how a bundle is assembled and designed.

Despite these conceptual differences, both perspectives emphasise that bundling must be context-sensitive and responsive to smallholder realities. Both also stress the importance of collaboration and co-creation. For example, London et al. (2010) illustrate how eleven ventures partnered with various organisations to assemble product bundles that addressed smallholder constraints, thereby generating mutual value for ventures, partners, and farmers. Bundling often requires collaboration among multiple actors, as a single provider may lack the capacity to offer all relevant bundle components. Barrett et al. (2022) further argue that co-creation helps reveal the diverse motivations and limitations of actors involved in the diffusion of new technologies. Hence, bundling through co-creation processes can accelerate adoption by ensuring the bundle is appropriate, inclusive, and aligned with the local context.

To further explore how bundles can be designed to align with farmers’ realities, needs, and capacities, and to ensure they are developed in a participatory manner, this study draws on design thinking theory. This approach provides tools and principles to support the development of product and service bundles that can facilitate the adoption of Mbili Mbili among smallholder farmers.

2.4. Drawing from design thinking theory for bundle design

The design of bundles cannot only be approached from a marketing perspective as Stremersch & Tellis (2002) suggest. Instead, it can also be viewed from a design theory perspective. The design of product and service bundles to support technology adoption among smallholder farmers goes beyond the simple combination of inputs, services, and support mechanisms, especially from a top-down approach. Instead, it can be understood as a design process that requires careful consideration of how farmers interact with the individual bundle components and how they experience the bundle as a whole. Insights can be drawn from the concepts of design thinking and human-centered design (HCD) which offer useful perspectives for the development and design of product and service bundles that are adapted to the needs, constraints, and realities of smallholder farmers.

Design thinking and HCD have emerged as practical and theoretical frameworks for addressing complex and uncertain challenges in a structured, yet flexible way. Design thinking is defined as “a discipline that uses the designer’s sensibility and methods to match people’s needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity” (Brown, 2009, p. 86). It is guided by three interdependent criteria: desirability (users’ needs), feasibility (technological possibility), and viability (business sense) (Brown, 2009).

At its core, design thinking is human-centered, starting with empathy and a deep understanding of users’ lived realities. HCD emphasises early and continuous engagement with users to understand motivations and constraints (Brown, 2009; IDEO.org, 2015). In agricultural development, this approach counters the limitations of top-down technology dissemination by embedding solutions in local contexts as previously highlighted. As such, Brown (2009) further outlines three iterative stages of the design thinking process: *Inspiration*, involving user engagement to identify needs; *Ideation*, focused on creatively generating and prototyping ideas; and *Implementation*, which brings refined solutions to market. These stages provide a guiding structure for the design of complex innovation challenges, such as the development of product-service bundles.

As already indicated, an integral part of design thinking and HCD is the emphasis on collaboration and co-creation (Brown, 2009; Brown, 2008; IDEO.org, 2015). Both approaches recognise that solutions to complex problems require contributions from multiple actors. By working with users and system stakeholders it enhances the appropriateness of the designed solution and ensures contextual fit. This collaborative approach aligns with the calls in agricultural innovation literature to improve the embeddedness and relevance of interventions through multi-stakeholder engagement as mentioned under 2.3. (Barrett et al., 2022).

2.5. Affordances as a Lens for Context and User Sensitive Design

While design thinking theory provides a co-creative and participatory approach to structure the bundle design process in this study, a closer look at affordance theory may offer further insights into how bundle designs could become even more user-centric and better aligned with the needs and context of smallholder farmers.

While human-centered design (HCD) and design thinking provide insights into the processes of designing inclusive and useful products, services, and bundles that are rooted in users’ needs, motivations, and contexts, the processes can^{2a} further be enriched by making use of the affordance theory as a conceptual lens. Affordance theory, originally introduced by ecological psychologist James Gibson (1979), refers to the action possibilities that an object or environment offers to a specific user, depending on their characteristics and context. Norman (2002) adapted this concept to design, introducing the notion of perceived affordances which considers how users intuitively recognise and act upon functions and opportunities embedded in a product or system. Affordance theory is a relational theory of perception, whereby an affordance ‘is a relationship between the properties of an object (or environment) and the capabilities of the agent that determine just how the object could possibly be used’ (Norman, 2002). By focusing on this relational interaction, affordance theory complements the user-centred orientation of design thinking and HCD, offering a more context-sensitive understanding of how to improve the design of solutions. Thus, affordance theory adds an

additional layer by focusing on how users perceive, interpret, and act upon the possibilities embedded in a solution within their specific environment.

Affordance-based design (ABD), introduced by Maier and Fadel (2009), applies affordance theory to engineering and product design by systematically identifying and shaping affordances to support desired user interactions. Rather than treating affordances as fixed object properties, ABD views them as relational, emerging from the interaction between user capabilities and design features in a specific context. Effective design, according to Maier and Fadel (2009), intentionally promotes desired behaviours while avoiding conflicting or unintended uses. This approach enables the development of solutions, such as product-service bundles, that are not only technically functional but also usable, meaningful, and contextually appropriate. In doing so, it extends human-centered design by embedding a deeper sensitivity to user-design interaction and contextual fit into the design process.

Affordance theory has been extended to the field of agricultural technology adoption by Dominic Glover (2017), who argues that conventional models often overlook the complex, situated nature of technological change. In this view, affordances are “opportunities perceived by an agent to put an object or material to some use” (Glover et al., 2019). Affordances emerge at a specific time and space from the material characteristics of a technology or environment and the characteristics of the people interacting with it, including mental and biophysical properties, as well as their resource endowment (e.g., financial resources, labour, land). They are further shaped by social and cultural rules and norms that govern societies and determine appropriate behavior (Glover et al., 2019). Opportunities arise not alone by the intrinsic properties of the technology nor only the fixed characteristics of the individual, but ‘the specific and dynamic relations and interactions between them’ (Glover et al., 2019). Hence, by definition, affordances call for action when in line with the agency and capabilities of the users. Through the lens of affordances, the agency of farmers is seen as capacities for action that are either enabled or constrained by affordances ‘which arise from contextually specific configurations of material, cultural and socio-economic agrarian relations’ (Glover, 2022).

This perspective has been applied by some papers to assess and incentivise technology adoption. According to Wyche and Steinfeld (2015), people perceive objects in terms of affordances which can influence the adoption of technologies. In their paper, affordance theory provided a lens through which the authors identified the factors that impede the adoption of mobile information services. Pinse and Bohnsack (2021), investigated how affordances stimulate adoption of sustainable products and incentivise consumers to use them sustainably. Hence, these papers indicate that affordances, embedded into the design of an object or technology, can influence the adoption of a specific technology.

3. Theoretical Approach

This research follows the logic that adoption of sustainable agricultural practices among smallholder farmers can be incentivised through thoughtfully designed product and service bundles. Drawing from the marketing concept of product bundling (Stremersch & Tellis, 2002), this study applies bundling not merely as a commercial tactic, but as a tool to overcome the multiple, interlinked barriers that hinder technology adoption. Rather than approaching bundle design from a top-down or generic perspective with pre-defined components, this research follows a smallholder-centric design philosophy, placing farmers' needs, capabilities, and contexts at the centre.

To operationalize this, the study combines the theoretical framework of design thinking with the conceptual lens of affordance theory. Drawing inspiration from design thinking and applying the lens of affordance theory shape the research design, data collection, and analysis by offering complementary insights into how innovations can be made both usable and desirable for smallholder farmers embedded in specific institutional, socio-economic, and agroecological contexts. Hence, in this study, design thinking structures the overall bundle design process, while affordance theory provides the analytical lens to assess the interaction between farmers, the technology (Mbili Mbili) and the environment in which they are embedded.

Design thinking, particularly the stages of *inspiration* and *ideation* (Brown, 2009; Brown, 2008), provides a flexible structure to guide the research process, while not applied as a rigid method. In the *inspiration* phase the research aims for in-depth engagement with farmers to understand their constraints, motivations, and priorities with respect to the Mbili Mbili technology. This understanding then lays the groundwork for the *ideation* phase, in which possible bundle components are identified and assembled in alignment with the expressed needs and challenges. Although the final *implementation* phase of design thinking as laid out by Brown (2008) lies beyond the scope of this study, the approach of this study still helps to ensure that the bundle design is rooted in the realities of smallholder farmers.

Affordance theory forms the central conceptual lens of the study. Thereby, affordances refer to the action possibilities that emerge from the interaction between an agent and their environment. These are not inherent properties of objects or technologies, but relational and context-dependent, shaped by the user's capabilities, perceptions, and the material, social, and institutional environment. This study draws particular inspiration from Glover et al. (2017, 2019, 2022), who introduced affordance theory to the field of agricultural technology adoption. Glover's work reconceptualises technologies not as readymade packages to be transferred, but as propositions that interact with users' social and material realities. He emphasises that affordances can be positive or negative: they may enable action or constrain it, depending on how a technology aligns with the lived experiences, practices, and capacities of smallholder farmers. As such, this study considers that affordances emerge from the interaction between farmers, the technology (Mbili Mbili), and the broader institutional and agroecological environment. This view brings into focus the importance of users' agency, as well as the role of context in shaping how technologies are understood and used.

In this study, affordance theory serves as an overarching lens throughout the design process, during the *inspiration* and *ideation* phases. During the *inspiration* stage, it is used as lens for analysis to shed light on the relational interplay between farmers, the Mbili Mbili practice, and the institutional environment, through which positive and negative affordances emerge. Hence, this lens helps identify both enabling and constraining conditions that shape how farmers perceive and engage with the technology. The overarching idea is to integrate affordances in bundle design that serve as triggers for incentivising adoption of Mbili Mbili. This is in line with how affordances are commonly used in product design, even to incentivise adoption as also applied by Pinkse and Bohnsack (2021) in their paper on sustainable product innovation and sustainability affordances.

In the ideation phase, affordance theory informs the identification of potential products and services that may help address the constraints observed in the first phase. These bundle components are evaluated not only for their function, but also for the affordances they offer, specifically how they align with the affordances previously identified in relation to farmers' needs, capacities, and the broader environment surrounding Mbili Mbili.

Finally, the theory offers a lens that guides the interpretation of how the preliminary bundle prototypes are perceived, by analysing the positive and negative affordances they create in relation to real-world conditions. This supports a deeper understanding of how the bundles may enable or hinder the adoption of Mbili Mbili in practice.

By integrating design thinking with affordance theory, the study combines a structured, user-centred design process with a relational, context-sensitive analysis, ensuring that the resulting bundles are both relevant and appropriate for smallholder farmers.

4. Methodology

3.1. Research Context

3.1.1. Project Description

The present research was conducted in the context of the Sustainable Intensification of Mixed Farming Systems (SI-MFS) Initiative of CGIAR, launched in 2022. The three-year initiative aims to sustainably intensify crop-tree-livestock farming systems and to improve the livelihoods of smallholder farmers who engage in mixed farming systems across the six project countries including Malawi (CGIAR, 2022). To achieve the objective, the initiative builds upon the innovations, tools, and approaches developed by CGIAR. The initiative seeks to analyse the status, trends, and future dynamics of mixed farming systems, to develop methods and tools for sustainable intensification of mixed farming systems, and to co-design socio-technical innovation packages through participatory engagement (CGIAR, 2023).

3.1.2. Mbili Mbili - the technology

One of the technologies selected for the sustainable intensification of mixed farming systems in Malawi was the agricultural practice Mbili Mbili, a cereal-legume intercropping strategy which originates from Tanzania. It involves planting two rows of maize at closer distance followed by two species of legumes with different growth patterns (see Figure 1). In Malawi, legumes that can typically be intercropped with maize are pigeon peas, common beans, soybeans, and groundnuts. The benefits of these legumes include the farmers' familiarity with the crops and their high market value. Mbili Mbili provides more space to legumes, enabling greater light penetration, otherwise shaded by the higher-growing maize. The different growth patterns of the crops reduce the competition for moisture, light, and nutrients, leading to increased crop yields. As such, the Mbili Mbili technology can lead to several benefits such as reduced risk to climate shocks, higher incomes through diversified production and higher yields, improved soil fertility due to the nitrogen fixation capacity of legumes and consequent reduction of required chemical agricultural inputs which leads to a reduction in farming costs. In addition, Mbili Mbili has been chosen as a technology for the sustainable intensification of mixed farming systems because of its ability to feed crop residues to livestock thereby encouraging farmers to include more livestock into their farming activities.

Moreover, intensification without the need for additional land and mechanization makes the technology suitable to farmers with small land sizes, limited expansion potential, and small household capital (Kinyua et al., 2022).

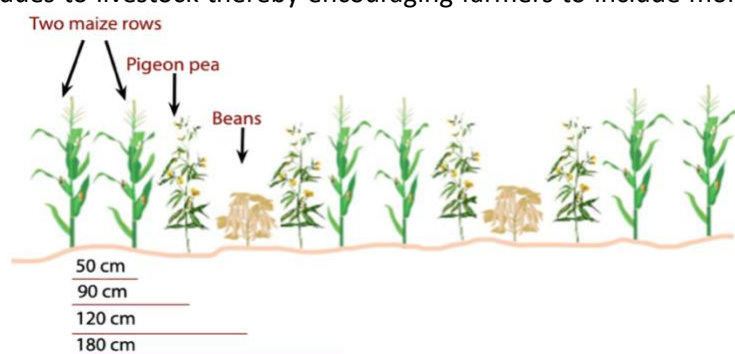


Figure 1: Visualisation of Mbili Mbili technology

3.1.3. Study area

The present study focuses on the Kasungu district in the central region of Malawi, thereby involving farmers from the Chulu Extension Planning Area (EPA). The study targeted the sections of Ksantuwale, Chulu Central, and Mphomwa which are made up of several villages. Previous assessment considered those sections as most suitable for the study whereby multiple factors were taken into consideration namely stakeholders and projects in the area, duration of the establishment of Mbili Mbili trials, and familiarity of farmers with the technology. Thus, 3 out of the 4 sections were selected in which Mbili Mbili trials are taking place within Chulu EPA.

The economy of Malawi, as well as in the Kasungu district primarily relies on its agricultural sector, which employs 80% of the population and is dominated by smallholder farmers (World Bank, n.d.). As a result of population growth, agricultural land available per person has gradually decreased from 0.35 ha in 1961 to 0.2 ha in 2016 (Chimonyo et al., 2023). Over half the population in Kasungu own land of less than one hectare, which reduces their capacity to diversify their cropping system (Chimonyo et al., 2023). Maize is the staple crop of the Malawian population, covering 70% of the agricultural land. Maize production has been strongly promoted by the Agricultural Input Program (AIP) to alleviate poverty among rural communities but has been criticized to simultaneously simplifying crop production. More land has been allocated to the cultivation of maize at the expense of other crops such as groundnuts, soybeans, and other beans. The over-reliance on maize is now tackled by encouraging farmers to diversify their crop production with legumes to improve incomes and soil health and reduce climate risks among other reasons (Franke et al., 2014). Still, farmers in Kasungu grow maize often alongside soybeans, groundnuts, tobacco, and sunflower which are considered cash crops for the households. Farmers in Malawi including the Kasungu district face a number of challenges. Climate shocks, structural challenges such as poor road infrastructure, limited access to inputs and output markets, price controls, and trade restrictions, among others, impact the productivity of the agricultural sector and influence the income potential of the country's population (World Bank, n.d.). The social context also has a significant influence on agricultural activities in the district. Gender inequality prevails in most of Malawi including in the Kasungu district. Despite gender empowerment efforts by NGOs, men control and own the household assets such as agricultural land. The gender gap in agricultural productivity is a result of unequal access to education, inputs, finance, information, and property rights for women. For both men and women, literacy levels in rural areas are very low, so most farmers rely on local extension officers, of which there are few, to obtain information about agricultural production. To improve their bargaining power, most farmers are part of cooperatives and associations through which they sell their farm output. Women often find themselves in leadership positions responsible for the management of village-level structures (Chimonyo et al., 2023).

3.2. Research Approach

The present research is a qualitative study which follows a phenomenological approach. It aimed to explore the lived experience of smallholder farmers involved in the Mbili Mbili trials concerning the technology and how bundling could influence the adoption of Mbili Mbili. A qualitative study was hence deemed appropriate to obtain the smallholder farmers' descriptive explanation of their

experiences and points of view concerning the technology and the product bundles which are best captured using qualitative methods. Moreover, the nascent nature of literature concerning bundling and particularly the design of product bundles in the agricultural sector in developing countries as well as the application of the affordance theory in this field resulted in qualitative research being an appropriate methodology to expand insights into the phenomenon (Edmondson & Mcmanus, 2007). The research follows a three-step research approach with the aim to:

- i. to understand the positive and negative affordances of Mbili Mbili by applying a smallholder-centric perspective (step 1).
- ii. to identify the current and potential products and services offered by stakeholders in the enabling environment to design product bundles that address the negative affordances of Mbili Mbili (step 2).
- iii. to understand the affordances of the suggested product and service bundles and the extent to which they address the negative affordances of Mbili Mbili (step 3).

To achieve the objectives and answer to the research questions, the present research followed a three-step methodology.

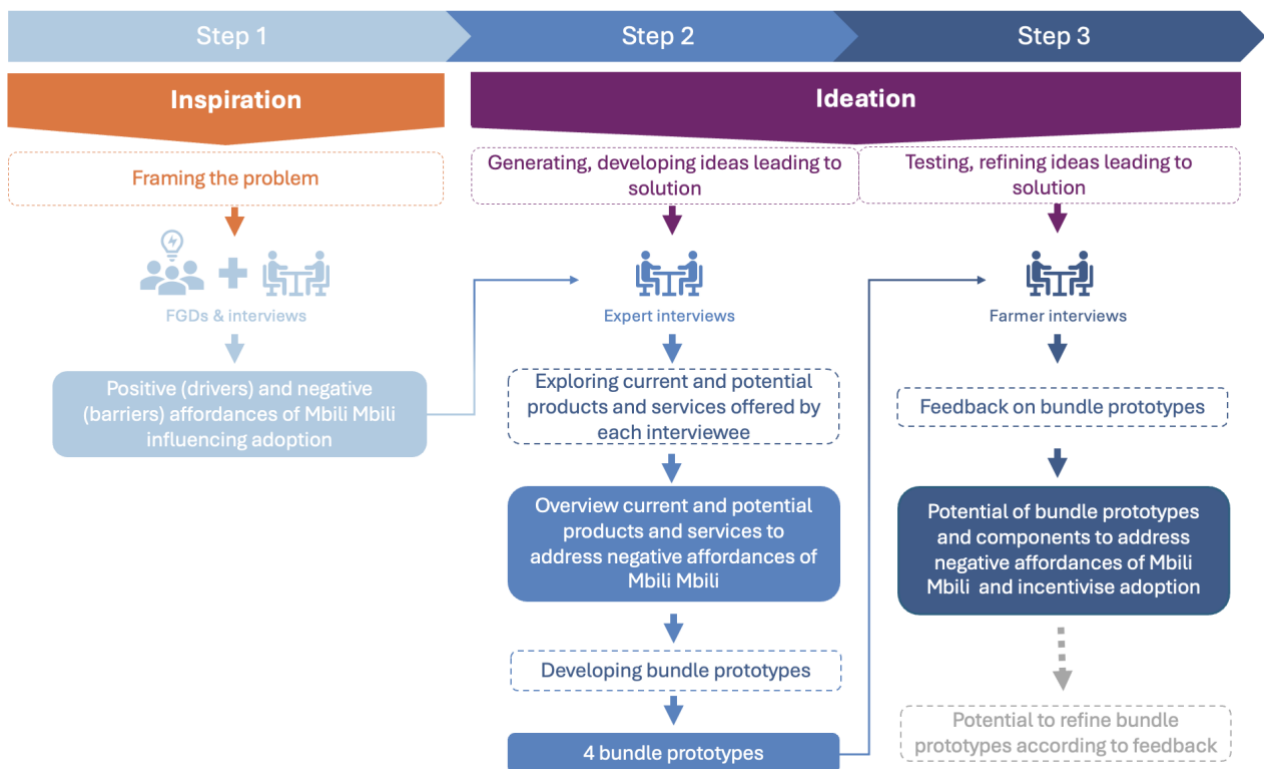


Figure 2: Research Methodology Outline

3.2.1. Step 1

The first step of the methodology focused on answering the first sub-research question aiming to understand the positive and negative affordances of Mbili Mbili from the perspective of the smallholder farmers participating in the Mbili Mbili trial. Data was collected using focus group discussions.

Sampling Strategy

The research participants were selected using a purposive sampling approach (Douglas, 2022). Thereby, the study included male, female, and young ‘baby trial’ farmers from three sections, namely Chulu Central, Ksantuwale, and Mphomwa, as well as a mixed group of mother trial farmers which are located all over Chulu EPA. The selection of research participants aimed to provide variance in geographical location, and in terms of gender and age. The exact research participants were selected randomly from a list of farmers participating in the trial. A total of 34 farmers were invited to participate in the study. Due to unavailability, some farmers got replaced by the subsequent randomly selected farmer of the list, while 4 farmers participated based on self-selection.

Section	Men	Women
Mphomwa (baby trial)	2	3
Chulu Central (baby trial)	4	9
Ksantuwale (baby trial)	7	5
Mother trial	4	2

Data Collection

In this first step of the methodology, data was collected through focus group discussions (FGDs). A total of 6 focus group discussions were held with an average number of 6 participants per focus group (FG), whereby men and women were placed in separate groups, while two focus groups were organised with a mixed group of mother trial farmers and young ‘baby trial’ farmers due to their limited number. The separation according to gender and age was made to take cultural differences and power relations among gender and age groups in Malawi into account (Chimonyo et al., 2023). Thus, the division according to gender and age allowed to create a comfortable environment for the research participants and to better capture differing results (Islam et al., 2022). Prior to the start of the FGD, each participant was asked to fill in and agree to the consent form, which was explained to them in their local language. The FGDs were facilitated by a Chichewa-speaking facilitator and recorded for transcription and translation to English. For each FGD, an agricultural extension officer was present to provide real-time translation from Chichewa to English, allowing the researcher to follow the discussion and ask questions when needed. An FGD was deemed an appropriate method of collecting data to capture the perceived challenges and benefits of the group of Mbili Mbili trial farmers in a timely and resource-efficient manner. Furthermore, the participatory set-up of the FGD allowed for rich interaction between participants to discuss the topics and offered farmers a more stimulating research experience (Islam et al., 2022). The FGD included an individual exercise in which farmers used a numerical rating scale to assess the importance of a predefined set of challenges to themselves. This individual exercise complemented the group discussion by capturing personal perspectives without group influence (Islam et al., 2022). This rating exercise offers the opportunity to give equal value to the challenges without forcing participants to choose one challenge over

another. The rest of the FGD integrated several interactive and participatory exercises with the farmers including a problem tree analysis which originates from Participatory Action Research (Brouwer et al., 2019), and a social net map (Schiffer, 2007) to understand the stakeholder environment and the relation between the farmers and those stakeholders which served as input for step 2 of the methodology. The data was collected inductively, with predefined themes from the initial literature review incorporated into the FG preparation to guide the discussion. Thus, first open-ended questions were asked to explore the drivers and barriers of Mbili Mbili adoption. Answers were compared to the list of preliminary factors that were identified in literature to influence the adoption of technologies among smallholder farmers. More specific questions on the remaining factors were asked if they had not been mentioned by the farmers to confirm whether they play a role in the adoption or not.

Before conducting the FG, the layout and exercises were shared with the local supervisors to obtain feedback and align with project objectives. Subsequently, it was reviewed by the local facilitator to create mutual understanding of what is being researched and to adapt the format to the local context as needed. A trial was conducted to ensure the farmers' understanding of the questions and exercises and adjusted accordingly (Islam et al., 2022).

Table 1: List of preliminary factors found in literature to influence adoption of technologies among smallholders

Category	Factors and References
Biophysical factors	Rainfall variability (Arslan et al., 2022; Kassie et al., 2013; Marenya et al., 2020)
	Pests and diseases (Kassie et al. 2013)
	Soil fertility (Arslan et al., 2014; Kotu et al., 2017)
Household and farm level factors	Gender (Guo et al., 2020; Ndiritu et al., 2014)
	Farm size (Guo et al., 2020; Arslan et al., 2022; Jones-Garcia & Krishna, 2021)
	Household labour (Guo et al., 2020; Arslan et al., 2022)
	Age (Guo et al., 2020; Kotu et al., 2017; Jones-Garcia & Krishna, 2021)
	Household income (Guo et al., 2020; Jones-Garcia & Krishna, 2021)
	Household nutrition (Jambo et al., 2019)
Institutional factors	Access to finances (Guo et al., 2020; Kassie et al., 2013; Arslan et al., 2021)
	Access to inputs (seeds, fertilisers, pesticides)
	Access to labour (Arslan et al., 2022)
	Access to (profitable) output markets (Kassie et al., 2013)
	Extension services (Guo et al., 2020; Arslan et al., 2022)
	Access to knowledge and information (Arslan et al., 2022)
Social factors	Social networks (Arslan et al., 2022; Kassie et al., 2013)
	Network relations (Kassie et al., 2013)
Technological factors	Perceived relative advantage (Rogers, 1995)

	Compatibility (Rogers, 1995)
	Perceived complexity (Rogers, 1995)
	Triability (Rogers, 1995)
	Observability (Rogers, 1995)

3.2.2. Step 2

Step 2 of the research methodology aimed to answer the second sub-research question aiming to identify stakeholders and the products and services they offer to address the negative affordances that were identified in the first step of the methodology. Data was collected through in-depth interviews (Islam et al., 2022).

Sampling Strategy

The research participants were selected using a purposive, convenience sampling approach (Douglas, 2022). Initial identification of stakeholders was conducted through internet research on private and public sector actors involved in Malawi's agricultural sector, particularly those connected to the key crops of Mbili Mbili. Additionally, the social net map exercise in step 1 of the methodology served to identify relevant stakeholders working in the Kasungu district of Chulu EPA and helped to obtain an understanding of the products and services they are currently offering to smallholder farmers as well as their reputation among smallholders. Furthermore, the agricultural extension officers and fellow researchers at CGIAR were consulted to obtain further recommendations. A snowball sampling approach was adopted by asking interviewees to be referred to further contacts. This approach particularly helps to contact 'hard-to-reach' professionals of certain companies and NGOs (Kirchherr & Charles, 2018). Although the main focus has been on stakeholders active in the Kasungu district, it was not solely limited to that geographical area, since the objective was to find promising products and services that can address negative affordances of Mbili Mbili, independent of their geographical location within Malawi. Further criteria included the involvement of these actors with key crops included in Mbili Mbili namely maize, groundnuts, common beans, pigeon peas, or alternatively soybean since it is considered a potential crop to be included. The selection also considered the stakeholders' general participation in the agricultural sector and their work on critical themes identified as challenges in the FGD, such as finance. A total of 26 interviews were conducted with government officials, private sector companies including off-takers and input providers, and public sector actors such as NGOs and research institutes. The list of interviewees can be found in Annex 1.

Data Collection

Data was collected inductively using a semi-structured interview guide which was adjusted to the expertise and focus themes of the respective interviewee. The objectives of the interviews were to obtain an understanding of the activities of the stakeholders, the products and services that they are offering that respond to the challenges faced by the Mbili Mbili trial farmers, and the opportunities and challenges the stakeholders themselves perceive when it comes to their products and services. Finally, the relationship between stakeholders as well as existing collaborations were discussed to explore potential and already existing bundling efforts. The semi-structured format of the interviews served as a guide for the discussion while allowing enough flexibility to explore certain themes and allowing the conversation to flow naturally (Islam et al., 2022). The interviews were conducted either

online or in person depending on the geographical location of the respondents and their personal preference. The interviews were recorded for transcription, with prior approval obtained from each respondent.

3.2.3. Step 3

Step 3 was the final step of the methodology and aimed to answer the third sub-research question to identify the positive and negative affordances that emerge from product and service bundles and how those influence the adoption of Mbili Mbili by smallholder farmers. The final step of the methodology was based on the insights created from the first and second steps considering the positive and negative affordances of Mbili Mbili as well as the products and services offered by stakeholders in the enabling environment, in line with the objectives of the Mbili Mbili technology. The data was collected through in-depth interviews with Mbili Mbili trial farmers.

Sampling Strategy

The third step of the research methodology selected its respondents from the list of participants involved in the focus groups conducted during the first step of the study. The aim was to ensure representation from each focus group, with specific interviewees selected through a random sampling process. A total of 21 trial farmers have been interviewed including four (4) young 'baby trial' farmers of mixed gender, six (6) men and five (5) women from Ksantuwale and Chulu Central, and five (5) mother trial farmers of mixed gender. While the first step of the methodology asked about their perceived challenges and benefits of Mbili Mbili, the third step aimed to come back to the same respondents to suggest bundles as potential solutions to address these challenges and to capture their perceptions of these bundles.

Data Collection

Data was collected inductively with the use of product bundles. Four bundles were developed based on insights gathered during the first two steps of the methodology and in consultation with a lead ABC researcher responsible for the Mbili Mbili trials. These bundles were designed to include products and services that support the adoption of Mbili Mbili and its key objectives, specifically the integration of crop-livestock systems into the farmers' agricultural practices. The interviews were conducted with individual farmers and took place at a central location of the section accessible to each respondent. No physical bundles were provided to the respondents for review; instead, the bundles were represented and described on individual paper sheets. To support the farmers' understanding, especially considering the relatively low literacy rate, the Chichewa-speaking facilitator provided a detailed explanation of the bundle components, along with a graphic representation. Each sheet stated the bundle components, the stakeholder(s) offering the bundle, and the requirements to obtain the bundle. The bundles were presented to the farmers in subsequent order to capture the farmers' perception of each bundle individually. An interview guide with semi-structured questions guided the conversations to capture the farmers' perception of the bundles, how the bundle could help them address their farming challenges, the incentives of the bundle to integrate livestock into their farming activities, and the bundle's influence on the adoption of Mbili Mbili. After the bundles were presented, the farmers were invited to rank four the bundles from the most to the least preferred bundle and the reasons behind their choice. Thus, the ranking added some quantitative information to the methodology to complement the qualitative data. Finally, the farmers were asked to name five

products and services they would include in their own personalised bundle. This activity allowed the farmers to design their own bundle and helped the researcher to identify the most important bundle components.

Figure 3: Illustration of Bundle 1



Bundle 1 is a low-risk package designed for farmer groups with the aim to increase self-management and capacities, aiming to address household cash-flow gaps while strengthening climate resilience. It combines training on climate-smart agricultural practices, the use of organic inputs, tree planting, and crop diversification with the provision of starter legume seed for community-based multiplication. Seeds are provided on loan basis to be paid back with harvest. Group membership is a prerequisite. In parallel, the bundle supports the strengthening and formal registration of VSLAs with financial institutions to facilitate access to larger, timely loans for input purchases. The bundle does not include market-linkage components, only training and input support, minimizing dependence on external actors.

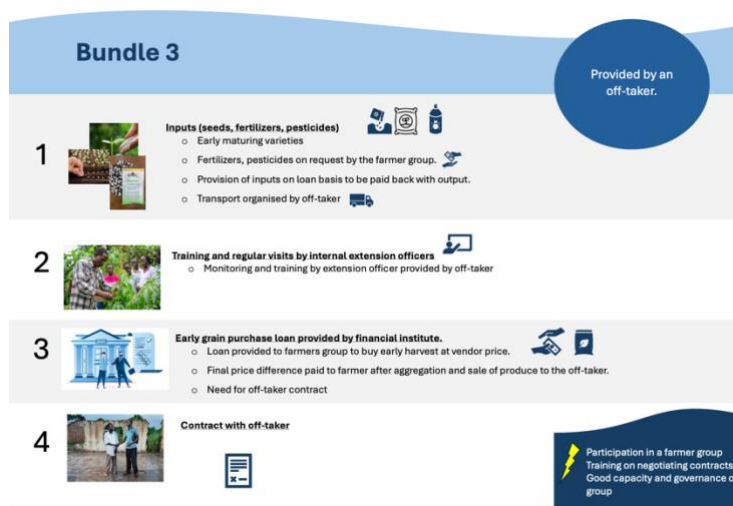
Figure 4: Illustration of Bundle 2



Bundle 2 is an input-focused package tailored specifically to support the Mbili Mbili farming system. It provides farmer groups with the full set of inputs needed to implement Mbili Mbili effectively, including early-maturing seed varieties (with flexibility to choose preferred legumes), NPK fertiliser for maize, and inoculants for legumes to enhance nutrient uptake. Since all inputs in the bundle are offered on a loan basis, repayable in cash after harvest, with a 10% deposit required upfront, the bundle poses a higher financial risk than the others.

To support proper implementation, the bundle includes a manual detailing Mbili Mbili practices, crop-livestock integration, and the use of organic inputs such as crop residues and manure. A ridge ruler is also provided to ensure proper spacing and reduce technical complexity. While it contains minor elements for improving climate resilience through organic practices, the bundle does not include any market access components. Group membership is mandatory.

Figure 5: Illustration of Bundle 3



Bundle 3 is a structured contract farming arrangement led by an off taker, designed to address a wide range of barriers to adopting Mbili Mbili, such as limited access to inputs, technical complexity, distance to markets, delayed payments, and household liquidity constraints. It provides a complete input package (early maturing seeds, fertiliser, and pesticides on demand, all delivered on loan and repaid in-kind after harvest. Inoculants are not included. The off taker also organizes the transport of inputs to the cooperative.

To overcome technical knowledge gaps and lack of extension access, off-taker field officers provide regular training and farm visits. A key feature is the early grain purchase loan, facilitated by a signed off-take agreement. This enables cooperatives to pay farmers promptly at the point of delivery, reducing reliance on delayed payments and improving household liquidity.

Participation in a farmer group is required, alongside mandatory training on contract negotiation and strong group governance. The bundle offers clear market access, but is relatively inflexible, with high dependence on external actors and increased financial risk if yields are low or crops fail.

Figure 6: Illustration of Bundle 4



Bundle 4 adds a livestock component aimed at enhancing household resilience and enabling income diversification. Provided by an off-taker and an input provider, the bundle combines crop and livestock support to strengthen the crop-livestock integration ambition of the Mbili Mbili. It includes early maturing seeds for food and forage, with fertilisers and pesticides available on request, all provided on loan.

Training is delivered by off-taker extension officers and covers both Mbili Mbili practices and livestock management, including feeding, composting, manure use, and marketing. In addition to inputs, the bundle offers goats on loan to farmer groups, with guaranteed buy-back access to a quality-based goat market. Goats serve as a flexible asset to help farmers cope with household emergencies, diversify their income sources, or as insurance mechanism to cover for crop failure. Group participation, strong governance, and prior training on contract negotiation are required. The bundle provides both input and market access as well as technical assistance, with livestock differentiating this bundle from others. Nonetheless, it involves reliance on external actors due to the dual focus on crop-livestock integration and contract-linked services.

3.3. Data Analysis

This research applies a three-step methodology whereby each step built upon the previous one. Each step had a different focus and different objectives of analysis, nonetheless the methods of analysis were the same. Thereby, the data analysis of one step was antecedent to the data collection of the subsequent step.

As previously mentioned, focus group discussions, key informant interviews, and in-depth interviews were recorded. Focus group discussions and in-depth interviews with farmers were translated and transcribed by a local, Chichewa-speaking facilitator, while the key informant interviews were transcribed by the researcher, supported by Notta.ai, an AI tool specialized on transcribing recordings. Due to flawed transcription by the AI tool, the researcher cross-checked each recording and adjusted the transcripts accordingly.

Transcripts were subsequently analysed through thematic analysis (Braun & Clarke, 2006) using Atlas.ti, which is a qualitative coding program. Thematic analysis is described as ‘the identification and reporting of patterns in a data set, which are then interpreted for their inherent meaning’ (Naeem et al., 2023). As such, a thematic analysis is in line with an inductive research approach through which theories are developed from the data. To ensure a thorough understanding of the text before coding, the transcripts were read multiple times. This was followed by several rounds of coding, during which relevant sections of the text were assigned codes aligned with the research questions, and some findings from the literature review. Key concepts and themes were then identified and recurring or related codes were merged into overarching themes e.g., market access, finance, biophysical factors.

Although a thematic analysis approach was applied across all three steps, each step had a distinct analytical focus based on its specific objective. In step 1, the primary aim was to identify the *drivers* and *barriers*, conceptualised as positive and negative *affordances*, that influence the adoption of Mbili Mbili. This analysis provided a foundation for understanding which types of products and services, and which specific characteristics, would be needed to design effective bundle options that enhance adoption.

The insights gathered in step 1, particularly the important *negative affordances* hindering the adoption of Mbili Mbili, served as critical input for step 2. These findings guided the selection of relevant organisations to interview and the types of products and services to investigate, focusing specifically on those with the potential to address the identified negative affordances. For example, while some NGOs may be active in women’s empowerment programs, such interventions would not contribute to resolving the core challenges associated with Mbili Mbili adoption. Therefore, the results of step 1 functioned as a lens for the analysis in step 2. In addition, the focus was on those products and services that help address the negative affordances best. This analysis helped determine which offerings could be meaningfully incorporated into potential product and service bundles.

By integrating insights from both steps 1 and 2, the researcher was able to design preliminary product and service bundles in step 3. These bundles were then refined with smallholder farmers to gather feedback on their relevance and the positive affordances they generate for the Mbili Mbili adoption. As such, step 3 focused on validating and refining the bundle design based on farmers' perspectives.

Throughout the entire data analysis, affordance theory served as an analytical lens. It was used to identify both positive and negative affordances of Mbili Mbili in step 1, forming the conceptual basis for understanding the factors that enable or hinder adoption. These affordances directly informed the analysis in step 2 by guiding the assessment of whether existing or potential products and services addressed the previously identified barriers. In step 3, affordance theory was again applied to evaluate whether the designed bundles, and the individual products and services within them, had the potential to create positive affordances that support smallholders in adopting Mbili Mbili. In this way, affordance theory not only structured the interpretation of qualitative data but also connected the three analytical steps into a coherent, theory-driven process.

5. Results

The results chapter is divided into three main sub-chapters. The first presents the results on step 1, the positive and negative affordances of Mbili Mbili. The second sub-chapter presents the findings on step 2, thus the products and services currently offered in by stakeholders that could help address the negative affordances in step 1, while also assessing shortcomings in current product and service landscape, as well as potential bundle initiatives already available. Finally, the last sub-chapter reveals the feedback provided on the bundle prototypes that were designed with the findings from step 2 and captures bundle and bundle component preferences among smallholders to further refine the bundle designs to incentivise the adoption of Mbili Mbili.

5.1. Positive and negative affordances of Mbili Mbili

This first sub-chapter of the results presents the findings for sub-research question 1 on the drivers (positive affordances) and barriers (negative affordances) of smallholder farmers within the project were facing that influence their adoption decision regarding Mbili Mbili. An overview of the interrelated challenges identified can also be found in annex 2.

5.1.1. Climate and Biophysical Conditions

During the production season, Mbili Mbili trial plots in Kasungu were significantly affected by erratic climate conditions. Farmers described rainfall variability, prolonged dry spells during critical stages of crop development, coupled with increased pest outbreaks, as major challenges. The impact was widespread; nearly all participants reported stunted crop growth, and in several cases, complete crop failure.

'Climate change which affected most of crop growth through prolonged dry spells. The dry spells also led to high infestation of pests on the crops i.e. termites. (Chulu Central – Men)'

Legumes, particularly beans, were the most severely affected. In both male and female focus groups from Chulu Central, farmers questioned the suitability of beans for their area, citing poor soil conditions and high sensitivity to weather extremes. These environmental factors, combined with the temporal unavailability of alternative legume seed, left some farmers without a choice of more resilient crops.

"This area, we cannot benefit from beans farming, they don't grow well due to our soils." (Chulu Central – Women)

As a result, farmers emphasised the importance of shifting to early-maturing and drought-tolerant crop varieties that are better adapted to local conditions. For them, the adoption of Mbili Mbili depends heavily on whether it could offer resilience against climate shocks and help secure yields. The lack of climate resilience, particularly of legumes, was therefore perceived as a negative affordance for its adoption. Farmers' responses suggest that adoption may require the inclusion of locally suitable legumes, drought-tolerant varieties, or climate-smart practices to reduce risks to food supply and expected income.

Despite these challenges, many focus group participants recognised the long-term benefits of Mbili Mbili for soil health. Several focus groups noted that soil fertility had declined due to continuous maize monocropping, the lack of manure application, and ridge-making practices. Through participation in the Mbili Mbili trials, farmers became more aware of how intercropping maize with nitrogen-fixing legumes can improve soil health and fertility. The improved understanding of soil processes can be considered a positive affordance for the adoption of Mbili Mbili and indirectly contribute to greater climate resilience.

“Mixing of legumes contributes to nitrogen fixation in the soil, thereby improving soil health.” (Kantuwale – Men)

5.1.2. Input Affordability and Access

While the Mbili Mbili trials temporarily mitigate key barriers to adoption by providing seeds, fertilisers, and pesticides, these conditions do not reflect the realities faced by most smallholder farmers. The trials positively afford implementation by removing financial and access challenges, while also influencing farmers’ perception of Mbili Mbili as a viable and productive system. However, once support is withdrawn, the real-world constraints of input affordability and accessibility pose significant negative affordances to continued adoption.

Across the focus groups, the high upfront cash required to purchase agricultural inputs emerged as a major constraint. Affordability of essential inputs, especially seeds and fertilisers, poses a significant challenge, exacerbated by the sharp price increases following the devaluation of the kwacha in 2023 (FAO, 2023). Most farmers, who have already been living close to the poverty line, found themselves unable to purchase inputs, particularly fertilisers, to adequately manage their farm. Although focus group participants reported difficulties in affording agricultural inputs, this was further substantiated through the rating exercise, in which access to seeds and fertilisers ranked as the second and fourth most pressing challenges, respectively, these constraints are especially acute for farmers with smaller land sizes, poor yields from previous seasons, and limited financial resources. In addition, the timing of cash availability often does not align with the period when farmers need to invest in inputs for the upcoming season, further compounding the problem.

‘We can adopt mbili mbili but fertiliser is the challenge because on the trials we were being provided with fertiliser and instructions on how to apply. So on our own we cannot afford fertiliser due to low income levels.’ (Chulu Central – women)

Next to affordability of inputs, access presents an additional challenge. Even when sufficient financial resources are available to purchase inputs, they are not consistently available at local agro-dealer shops. Particularly certified seed varieties for legumes, and specialized inputs like lime, pesticides, or inoculants might not be available at every agro-dealer shop or at the right time. This creates uncertainty around planning and reduces farmers’ confidence in investing Mbili Mbili, particularly when their production windows are narrow and time sensitive.

Moreover, the diversity and quantity of inputs required for Mbili Mbili, such as multiple seed types, lime, pesticides, increase the perception of farmers that the practice is input-intensive and therefore financially risky. These input demands raise the perceived cost and complexity of the practice. Social

norms exacerbate these concerns. For example, pesticide use on legumes is not common, and many farmers rely on recycled or informally exchanged seeds rather than purchasing certified ones.

Across all focus groups, these challenges were identified as universal, affecting men, women, and youth alike due to household-level decision-making in agriculture. Nonetheless, the challenges might be greater hindrances to already resource-constrained households. In sum, while input provision during trials enhances the short-term adoption of Mbili Mbili, the real-world context of high input costs, uncertain availability, and perceived complexity of the technology undermines creates negative affordances for its adoption. Without broader interventions to improve both affordability and structural access to inputs, it might be difficult to sustain Mbili Mbili beyond the scope of externally supported trials.

5.1.3. Technical complexity and labour requirement

Several focus groups described Mbili Mbili as labour-intensive, particularly during the land preparation and planting period. The reduced ridge spacing from 75 cm to 60 cm, to add additional ridges for intercropping, was considered labour-demanding and time-consuming. Moreover, while farmers spread their tasks across several days, the Mbili Mbili trials required simultaneous ridge-making, planting of multiple crops, and fertiliser application within a narrow timeframe. This compressed workload led many to rely on hired labour, which was not affordable for all households. Despite the perception of labour intensity, others pointed to labour savings during the crop maintenance phase. Instead of taking care of multiple plots where maize and legumes are cultivated separately, they only have to focus on one plot, whereby activities such as weeding and applying fertilisers, can be combined. As such, the labour intensity contributes to the perceived complexity of Mbili Mbili.

“The ridge-making is very labour demanding, and we needed to plant everything on the same day. It was hard work.” (Chulu Central – Women)

Technical complexity further limits the technology’s ease of use. Several farmers struggled to maintain correct ridge spacing without ropes or measuring tools, and a lack of repeated training created uncertainty. Even mother-trial farmers, tasked with giving advice to baby trial farmers, expressed that they had received only one training session and felt insecure to support others appropriately. They highlighted the need for regular trainings. This constraint is further exacerbated by institutional weaknesses in the agricultural support system, particularly the limited reach and capacity of public extension services or access to farmer field schools to provide to prospective adopters of Mbili Mbili.

‘[if you have not been trained] You will not be able to practice mbili mbili following all its measurements. If you have not been trained it will be hard for you to teach other farmers on mbili mbili technology.’ (Mother trial farmers)

However, this perception of technical complexity was not shared by all farmers in the focus group. Some mother-trial and young farmers reported that Mbili Mbili became manageable over time, particularly with experience and technical support. This suggests that trialability help reduce perceived complexity when given the opportunity to experiment with it first. Otherwise, labour and

technical complexity of Mbili Mbili pose a relative disadvantage compared to their conventional way of farming affecting its adoption.

To sum up, many farmers considered the labour intensive and technical complexity of Mbili Mbili as negative affordances, especially for households with limited resources or labour availability. Positive affordances could be created, as recommended by the farmers, through the access to low-cost, labour-saving tools, repeated training opportunities, and possibly labour-sharing mechanisms.

5.1.4. Cashflow pressure and market limitations

Across all focus groups, farmers consistently complained about the lack of **access** to profitable markets as a major constraint affecting not only their household income but also their capacity to reinvest in farming. The primary market outlet for the majority of farmers are local vendors who operate directly within or near the villages. The vendors are valued for their immediate payment when selling produce, and their accessibility. However, they are widely regarded as exploitative, offering low prices or using tampered scales.

“We grow crops with plans... but with lack of good markets the vendors steal from us, we fail to do all the plans we had.” (Chulu Central – Women)

“You take the soya to the vendor, they say it’s K800, but then they buy at K500 and mix it with other bags. You can’t take it back.” (Chulu Central – Women)

Despite minimum farm-gate prices announced by the government, farmers described to be forced to sell early, often even before harvest, due to urgent household needs such as food, school fees, or debt repayment. As a result, they accept lower prices in exchange for fast liquidity, which vendors are aware of and exploit. In these moments, timing of payment outweighs potential profit, offering greater value to farmers.

In view of this situation, the relative advantage of adopting input-intensive technologies like Mbili Mbili is relatively low. Without fair and reliable markets for their harvests, the effort and costs of producing marketable, particularly with expensive inputs might not offer sufficient return. Thus, lack of price transparency, lack of diversity of buyers, and weak institutions, increases the perceived risk of investment into Mbili Mbili, and represent significant negative affordances for its adoption.

Other factors further create constraints to access better markets. Many smallholders produce primarily for household consumption, leaving only small volumes for sale. Small land sizes, low yields, and high transaction costs for transport to market limit farmers to reach more profitable markets. Furthermore, many farmers lack awareness of alternative markets or the negotiation skills to obtain better conditions.

While collective marketing through cooperatives or farmer groups was viewed by some as a solution, others expressed mistrust. Collective marketing can overcome transaction costs and increase bargaining power of individual farmers. While many farmers recognise the benefits of collective action, others expressed mistrust due to previous experiences or hearsay of delayed payments, failure to deliver on agreed prices, or lack of capital to pay farmers upon delivery. In many cases, farmers

agreed to sell collectively but default and sell to vendors to cover urgent household needs. Consequently, even selling to cooperatives does not provide certainty to access larger buyers if required volumes can't be reached due to defaulting farmers. This highlights the importance of timely payment, and enough financial savings.

"We took the soya to the cooperative, but it took two months to get paid. In that time, we needed food and money for school." (Mother trial farmers)

"Some agree to group selling but then don't show up. Everyone ends up going back to the vendor." (Kantuwale – Women)

Thus, the absence of reliable and trustworthy market outlets, offering fair prices at the right time creates negative affordances for the adoption of Mbili Mbili. Urgent need of cash pushes farmers to sell produce at low prices, limiting their ability to reinvest in inputs for the next season. This cashflow constraint reinforces a cycle of low investment in production and dependency on loans, influencing the perceived value of input-intensive practices.

5.1.5. Household liquidity and access to finance

Access to affordable and reliable agricultural finance was a major constraint across all focus groups. While both public and private financial institutions offer loans, most farmers explained that loans are often inaccessible or even unappealing due to unfavorable terms such as required collateral, high interest rates, or short-repayment periods. In some cases, the application process is too complex considering the level of education and literacy, and experience with formal systems of some farmers. Individual loans were mainly given to wealthier, large-scale farmers. Smallholders could often only apply as a group, which raised other challenges such as trust, social pressure, and risk of default of group members. Consequently, the perceived risk of being unable to pay back loans discouraged some farmers to take loans in the first place.

'To get a loan you need to be in a group as an individual farmer you cannot get a loan. Because one of the conditions of accessing a loan is being in a group which acts as collateral. [we are] not interested in these other institutions because of high interest rates and short repayment period' (Ksantuwale – Men)

As a result, many farmers rely on informal financial systems, particularly Village Savings and Loan Associations (VSLAs). While VSLAs afford adoption through their accessibility and trust, their loans are primarily used for non-agricultural needs such as food, school fees, or emergencies. Their limited capital base constrains their ability to support larger expenses such as purchase of agricultural inputs for Mbili Mbili. This highlights an institutional gap in the rural financial landscape. Moreover, many farmers struggle with saving which not only limits the functioning of VSLAs but also reduces their own financial resilience and ability to invest in production.

Rather than alleviating financial constraints, loans often create a cycle of dependency. This is particularly true when repayments are required in the form of harvest rather than cash, which is the primary source of both income and food for farming households. Repaying loans with harvest affects

household food security and undermines farmers' ability to generate income and to reinvest in the upcoming season placing them at a significant disadvantage.

Hence, farmers reported a lack of viable, flexible financing options to support investment in agricultural production including Mbili Mbili, while savings is almost non-existent. The lack of liquidity and unfavorable rural financial systems represent significant negative affordances for the adoption of Mbili Mbili. While VSLAs are the most accessible source of loans, their limited capacity restricted their use for agricultural investment. These constraints suggest that the adoption of Mbili Mbili requires farmers to be able to access low-risk financial tools with favorable terms and conditions, the strengthening and support of VSLAs, or other innovative financial models.

5.1.6. Social and household factors influencing adoption

Social capital and collective action structures influence the adoption potential of Mbili Mbili. As already touched upon in some previous sub-chapters, collective action enables the access to profitable markets, to receive loans from formal financial institutions, or to access training. While some respondents appreciated being part of cooperatives, farmer associations and clubs, or VSLAs, others expressed mistrust due to past experiences with delayed payments, broken promises, or poor coordination. Farmers in the focus groups, valued group mechanisms when functioning well, but easily undermined by low participation or weak leadership. Therefore, some farmers had a strong preference for individual action, limiting their ability to create positive affordances for the implementation of Mbili Mbili.

Household-level trade-offs also shaped adoption decisions. Many farmers described how the need for immediate cash and food shortage forced them, especially women, to work as *ganyu* (short-term labour) at the expense of their own fieldwork. This strategy delayed their own planting, weeding, or fertiliser application, and reduced their own yields, further worsening their financial situation and limiting their ability to invest in practices like Mbili Mbili. Competing household priorities and limited labour thus created context-specific barriers (negative affordances) that reinforced the cycle of low productivity and poverty.

“By the time you want to plant, the rain is gone.” (Kantuwale – Women)

At the same time, the inherent characteristics of Mbili Mbili were perceived as strong positive affordances supporting its adoption. Farmers valued its efficient use of land, as it enables the cultivation of maize, beans, and soya on a single plot, thereby saving land, reducing labour requirements, and lowering input costs. Additionally, they appreciated the nutritional advantages of Mbili Mbili, as it allows the production of diverse crops needed for a balanced diet within the same space. These combined spatial and nutritional benefits made the system particularly appealing to smallholders with limited land, even in the absence of external support. As such, these characteristics don't need to be implemented as bundle components since they are already provided by Mbili Mbili itself and can be emphasised as such.

“We have plenty of food; maize is nsima, beans are relish and soya bean are porridge for our children. We have enough food at once; breakfast, lunch and dinner.”
(Mphomwa Youth)

Table 2: Overview of positive (drivers) and negative (barriers) affordances of Mbili Mbili

Theme	Positive affordances (drivers)	Negative affordances (barriers)
1. Climate and biophysical conditions	<ul style="list-style-type: none"> - Legume inter-cropping improves soil fertility (nitrogen fixation) - Raised awareness about importance of soil fertility 	<ul style="list-style-type: none"> - Rainfall variability, prolonged dry spells, and pest outbreaks - Unsuitability of some legumes (e.g., beans) to local soils and climate - Perceived lack of climate resilience of Mbili Mbili
2. Input affordability and access	<ul style="list-style-type: none"> - Input provision during trials (seeds, fertiliser, pesticides) reduced adoption barriers temporarily 	<ul style="list-style-type: none"> - High input costs (fertilisers, seeds) - Poor access to certified seeds, lime, inoculants, and pesticides at local shops - Perceived input-intensity of Mbili Mbili increases perceived financial risk & complexity - Social norms favour recycled seed and minimal pesticide use
3. Technical complexity and labour requirements	<ul style="list-style-type: none"> - Single-plot management can cut labour during weeding/fertiliser application. - Triability - experience and training reduces perceived complexity 	<ul style="list-style-type: none"> - Labour-intensive land preparation and planting - Perceived complexity of Mbili Mbili practices e.g., difficulty in maintaining ridge spacing - Limited and one-off training impacting scaling - Weak public extension services
4. Cashflow pressure and market limitations	<ul style="list-style-type: none"> - Immediate payment by local vendors 	<ul style="list-style-type: none"> - Exploitative local vendors with low prices and tampered scales - Urgent household needs force early sales limiting profits - Limited access to transparent, reliable, profitable output markets - Weak collective marketing mechanisms due to mistrust and defaulting - Delayed payments by cooperatives and buyers, need for immediate payout - High transaction costs and low production volumes - Perceived market risk lowers the relative advantage of an input-intensive practice
5. Household liquidity and access to finance	<ul style="list-style-type: none"> - Access to loans through VSLAs 	<ul style="list-style-type: none"> - Limited access to formal loans due to high interest, collateral requirements, short repayment cycles - Complexity of loan application processes - Group loans create social pressure and risk

		<ul style="list-style-type: none"> - Low capital of VSLAs limits size of possible loans (e.g., for inputs) - Weak savings culture
6. Social and household dynamics	<ul style="list-style-type: none"> - Collective action e.g., cooperatives, clubs or VSLAs, enable market access, finance and training - Intrinsic features of Mbili Mbili (land-saving through intercropping on one plot, coverage of dietary needs, resource efficiency) are highly valued. 	<ul style="list-style-type: none"> - Mistrust in cooperatives due to bad past experiences - Labour diverted to ganyu work delays own fieldwork, impacting yield and income - Competing household priorities limit investment in new practices

5.2. Products and services to overcome negative affordances of Mbili Mbili

This sub-chapter builds upon the findings from step 1 elaborated in the previous sub-chapter and presents the findings to answer sub-research question 2 as part of the second step (step 2) of the methodology. As such, it presents the identified products and services offered by stakeholders in the institutional environment, from input providers, off-takers, processors, NGOs, agricultural research institutes, to address the negative affordances of Mbili Mbili. The results present an overview of potential solutions (products and services) that are already developed, and to what extent gaps in product and service offers still exist.

Table 3: Overview of products and services offered by stakeholders

Theme	Products / services offered	Negative affordances addressed	Source
Input provision & affordability	<ul style="list-style-type: none"> - Reduced input prices through bulk purchase - Certified and basic seeds (early-maturing, drought-resistant, biofortified) - Organic/synthetic fertilisers, organic/synthetic pesticides, inoculants - Tailored fertiliser blends - Input packages (e.g., seed + fertiliser; seed + inoculants) - Community-managed seed multiplication - Input provision on loan basis, repaid in cash or harvest 	<ul style="list-style-type: none"> - High input costs and (timely) availability - Climate variability, pest outbreaks, and soil degradation - Low yields - Low household liquidity to purchase inputs upfront - Perceived input intensity and financial risk of Mbili Mbili 	aQysta, NASFAM, CADECOM, Lusito, Perisha Agro, CAP, Fairway, Chunga, Kakonje, HarvestPlus, Kulima Gold, Community Finance, Meridian Group, K2Taso
Climate resilience	<ul style="list-style-type: none"> - Manure and compost promotion & training - Mbeya production promotion & training - Tree nurseries & agroforestry - Water harvesting, cover crops, minimum tillage - Pest & disease management training - Early-maturing, drought-tolerant seed varieties - Irrigation schemes (solar pumps, drip kits, watering cans) and related services e.g., loans, maintenance training 	<ul style="list-style-type: none"> - Climate variability, pest outbreaks, and soil degradation - Perceived lack of climate resilience of Mbili Mbili - Unsuitability of some legumes to local conditions - Availability and access to inputs 	aQysta, CADECOM, NASFAM, MoA, CAP, Perisha Agro, Total Land Care, Heifer & Green Livelihoods, K2Taso, HarvestPlus
Technical & agronomic support	<ul style="list-style-type: none"> - Farmer Field Schools - Coaching by own field officers/ agronomists - Demonstration plots & field days - Post-harvest handling training - Agribusiness & natural resource management 	<ul style="list-style-type: none"> - Technical complexity of Mbili Mbili - Labour-intensive land preparation - Limited access to continuous support and training - Weak public extension services 	CADECOM, MoA, aQysta, CAP, Fairway, IITA, HarvestPlus, Heifer, K2Taso

	- Composting & integrated soil fertility		
Labour & mechanisation	<ul style="list-style-type: none"> - Tractor and implement rental (e.g., shellers, sprayers) - Promotion of small-scale equipment - Access via coops or MoA schemes - Equipment loans for small-scale machinery, solar pumps, drip kits etc. 	<ul style="list-style-type: none"> - Labour shortage - Time-sensitive farm activities - Limited access to equipment & mechanisation 	Chunga Coop, Government (MoA), Community Finance
Output market access & aggregation	<ul style="list-style-type: none"> - Collective marketing through coops - Contract farming - Contract negotiation skills training - Pre-season contracts with guaranteed floor prices (coops) - Farm-gate pick-up or at local collection points - Premiums for quality - Higher prices than official farm gate price set by government to avoid side-selling - Market information and price transparency - Trade fairs 	<ul style="list-style-type: none"> - Low prices of vendors - Cashflow pressure - Delayed or inconsistent payment - Limited access to profitable markets 	aQysta, Fairway, Chunga, Lusito, Sunflower Coop, NASFAM, CAP, CADECOM, Government (MoA), Heifer & Green Livelihoods, Meridian Group, World Vision
Financial services & liquidity	<ul style="list-style-type: none"> - Promotion and support of VSLAs - Input loans (cash or in-kind) - Early grain-purchase loans for coops - Seed loans (repay with harvest) - Life and health insurance through VSLAs - Weather-index crop insurance (pilot) - Financial literacy training - Facilitation of bank/MFI linkages e.g., of VSLAs, coops 	<ul style="list-style-type: none"> - Liquidity constraints - Input affordability - Low capital of VSLAs to access inputs - Delayed or inconsistent payment - Lack of access to formal finance (collateral, high interest rates etc) - Weak saving culture 	NASFAM, CAP, CADECOM, Chunga, Fairway, aQysta, Community Finance, Meridian Group, Heifer & Green livelihoods
Institutional & social structures	<ul style="list-style-type: none"> - Formation and strengthening of cooperatives, farmer clubs - Governance and leadership training - Record-keeping training 	<ul style="list-style-type: none"> - Mistrust in coops due to past experience - Weak institutional structures - Side-selling due to poor governance 	CADECOM, CAP, Fairway, MoA, NASFAM
Infrastructure & logistics	<ul style="list-style-type: none"> - Warehouse storage (coops) 	<ul style="list-style-type: none"> - Market access to profitable outlets - Inability to delay sale for better prices 	CADECOM, Fairway, MoA
Income diversification	<ul style="list-style-type: none"> - Support for non-farm business activities (soap-making, oil pressing, flour milling, beekeeping) - Livestock pass on program 	<ul style="list-style-type: none"> - Household cashflow instability and food insecurity 	NASFAM, CADECOM, Perisha Agro

- Training on processing and value addition

- Limited resilience to seasonal shocks and lack of diversified income sources

5.2.1. Fragmentation and complementarity of products and services

The analysis of the products and services offered by stakeholders reveals a fragmented and weakly coordinated product and service landscape. While a wide range of services is available, ranging from input loans, and technical training, to capacity building of cooperative and output market access, limited coordination presents missed opportunities for synergies, where some products and services can support each other in their complementary e.g., inputs, input loans, and technical support, or cash loans and off-take contracts. No single actor addresses the full spectrum of barriers (negative affordances) that affect the potential adoption of Mbili Mbili.

For example, input providers such as Kulima Gold and Meridian Group focus on improving access to certified seeds and fertilisers, sometimes bundled with finance. However, this is rarely coordinated with agronomic support from NGOs like CADECOM or Fairway, who run Farmer Field Schools and demonstration plots. Similarly, financial actors such as Community Finance and VSLAs offer credit, but this is often not aligned with market access support such as guaranteed off-take, or greater support from banks to enable the access to larger loans. In some cases, inputs are provided without ensuring that farmers have timely training or a viable buyer, which limits the value of the service and increases adoption risk. Moreover, actors working on institutional support, such as cooperative governance or group formation, do not consistently coordinate with those offering finance or marketing services.

While examples of collaboration exist, for example off-takers partnering with input suppliers or NGOs aligning with public extension systems, these efforts remain isolated or rarely organised into concrete and comprehensive bundle options. As a result, services that are logically complementary remain disconnected. For example, irrigation support from Total Land Care is not consistently bundled with training on drought-resilient legume varieties, and cooperative strengthening often occurs without being linked to financial literacy or marketing structures. For bundle design, this fragmentation means that both the components (products and services) and the contributors (stakeholders) must be deliberately orchestrated if a coherent support package for Mbili Mbili farmers is to emerge.

5.2.2. Existing forms of bundling

Despite the fragmentation and often lack of coordination, interviews revealed that some forms of bundling, especially within, but also across, organisations do exist. Bundling is understood as the offering of multiple, complementary products and services, even if not always labelled as such. Some actors have a more structured bundling approach that aligns with the definition of Stremersch and Tellis (2002) of bundling as the 'sale of two or more separate products in one package'. Typical examples are input packages consisting of seeds, fertilisers, and inoculants, often combined with technical assistance. Contract farming has become prevalent and is another form of bundling, where input provision is bundled with an off-take agreement to secure market access for farmers provided for example by Fairway, aQysta, or arranged by NGOs such as CADECOM and Heifer.

Beyond these formal bundles, many stakeholders also offer additional services that are not directly sold but serve to support their core operations. These may include agronomic advice, price information or training of farmer groups. For example, Fairway, although primarily an off taker, also provides technical guidance and market price updates to strengthen relationships with farmers and improve

the reliability of supply. These services are not explicitly packaged as a commercial bundle to be sold but serve to support their core activity. They help improve yields, reduce farmer default risks, and build trust between actors.

According to one interviewee, experienced with the topic of bundling, bundling of inputs does not represent a significant challenge, but rather the bundling of products and services on the market-side to overcome challenges of side-selling and incentivising farmers to adhere to contracts.

5.2.3. Misalignment with farmer's realities

Many of the products and services appear, at first glance, to address the barriers that hinder the adoption of Mbili Mbili. However, findings from the interviews suggest that they often fail to do so in practice, as many interviewees continue to report challenges. The issues lie in the details: while these products and services are often designed from a technical, and sometimes even a social, perspective, they rarely reflect farmers' actual needs, constraints, and realities. For example, contract farming may present a holistic solution to input access and market connectivity, but its effectiveness is limited if buyers delay payments or input loans come with high interest rates. Critical aspects such as timing of delivery, labour availability, cashflow cycles, farmers' seasonal and financial realities, or trust in local actors are frequently overlooked. As a result, even well-intentioned interventions fail to achieve their intended impact.

What matters, therefore, is not only *what* is offered, but *how* it is offered. Meeting farmers where they are requires not just technical, but also social innovation. Unless delivery models are adapted to better align with farmers' realities, many products and services will continue to fall short of their goals.

Moreover, across all interviews, there was a clear sense that context matters in determining which products and services are effective and of relevance. Certain components, such as irrigation, inoculants, or mechanization heavily depend on local agroecological and socioeconomic conditions. Total Land Care, for example, explained that irrigation schemes must be designed at the community level to be effective. Similarly, HarvestPlus emphasised that even affordable technologies like inoculants are often underused due to a lack of awareness and perceived irrelevance in the local context.

5.2.4. Key challenges of product and service providers

Interviews with stakeholders revealed several recurring challenges that limit the ability of service providers to deliver products and services effectively and sustainably. A key issue mentioned by actors such as Community Finance, Kulima Gold, and CAP is the high risk of loan default. Farmers often fail to repay input loans, either due to weather-related shocks or because they sell their harvest to informal vendors offering immediate cash. To reduce this risk, providers frequently channel services through cooperatives or groups, but this model is fragile when trust or internal governance is weak.

Closely related is the issue of side-selling, which providers like Fairway and Chunga highlighted as a major threat to structured market arrangements. Even when contract farming is in place, farmers often break agreements in favour of better offers from outside buyers. This unpredictability discourages off-takers from engaging in pre-season contracting or bundling inputs with guaranteed market access.

In addition, infrastructure and logistical constraints remain a barrier, particularly for services involving mechanisation, irrigation, or collective marketing. Providers such as CADECOM and Total Land Care noted that such services are often project-dependent and decline after funding ends, due to unclear ownership or high maintenance costs. Beyond these structural barriers, providers also face challenges linked to farmer behaviour. Products and services that are relevant such as inoculants or soil fertility training are often underutilised because farmers perceive them as risky, unfamiliar, or unnecessary.

These challenges illustrate that service delivery is not only shaped by infrastructure or funding, but also by behavioural, institutional, and market-related factors that must be addressed for more effective and sustainable support.

5.2.5. Remaining gaps in product and service offerings

The analysis further shows that even though some key services such as input provision, input loans, contract farming, and collective marketing are widely offered, several critical gaps remain. Inputs like certified seed and fertiliser are commonly offered, often in packages and on credit, and many cooperatives facilitate market access through pre-season contracts and price transparency. However, challenges related to labour, climate risks, post-harvest losses, and financial inclusion remain insufficiently addressed.

Labour-saving tools and mechanisation for land preparation, planting, or weeding are still limited, despite widespread labour constraints. Irrigation schemes exist but are often unaffordable, with limited financial support, thus not overcoming the impact of climate variability. Post-harvest support is limited towards infrastructure at cooperative level, with few solutions at farm-level. In particular, service challenges are still insufficiently addressed. While VSLAs and input loans are widespread, longer-term, higher-value, or bundled credit options are rare. Insurance products are largely absent, exposing farmers to significant climate and price risks. In addition, soil health services such as soil testing or lime provision are available to some extent but often out of reach for small-scale farmers, despite being essential in degraded areas.

These gaps are often interconnected. For instance, limited access to finance constrains investment in irrigation or mechanisation. As a result, while farmers may access inputs and markets, they often lack the enabling services that are needed to make these investments effective and low risk. This leaves key barriers (negative affordances) such as labour constraints, climate impacts, repayment constraints, largely unresolved, limiting broader adoption of improved practices.

Moreover, the fact that some products and services are offered by multiple actors does not necessarily mean they reach a wide base of farmers. In many cases, access is limited to contracted farmers or those who meet specific criteria, for example, farmer groups that have existed for at least five years and demonstrate strong governance structures. As such, the design of input and service bundles must carefully consider not only what is included, but also whether these components are accessible, inclusive, and scalable for a broader range of smallholders.

5.2.6. Unsustainability of project-based solutions

A further challenge is that many of the solutions are currently offered within the scope of a project, subsidized and dependent on external funding. Services provided by actors such as CADECOM, Heifer, Green Livelihoods, World Vision are often tied to donor-funded initiatives with limited geographic scope and offering within a short time frame. While these efforts can be impactful during implementation, they often lack the development of sustainable structures in which the continuation of these solutions is embedded, once the project has ended. This is particularly evident in areas such as mechanisation support or irrigation schemes which are often provided to farmers for free within the project but fail to be adopted without subsidies. The absence of sustainable, embedded support structures undermines the potential of otherwise promising interventions and highlights the need for models that are financially and institutionally sustainable beyond the project cycle.

5.2.7. The importance of enabling structures

While many products and services can be delivered through commercial, market-based bundles by private sector actors such as input providers or off-takers, interviews highlight the essential role of enabling conditions that are typically supported by NGOs and public institutions. These include services that are not readily commercialisable, such as farmer group formation, governance training and capacity building, VSLA facilitation, and infrastructure. NGOs like CADECOM, Heifer, and others fill this institutional gap by offering the soft infrastructure that allows commercial products and services to be adopted in the first place. Without these enabling conditions even well-structured bundles cannot be implemented effectively.

Collective action emerges as a key enabling condition for the provision of most products and services. Farmers need to organise in groups to receive trainings, to access inputs in bulk, to qualify for input loans, to access profitable markets, or to engage with financial institutions. Yet the existence of a group alone is not sufficient, but the functioning of these groups is essential. Interviews showed that weak leadership, poor governance and record-keeping, limited inclusivity, or mistrust among members, inhibit the implementation of products and services, as well as bundles. Cases of defaulted loans, side-selling, or leadership turnover were mentioned by actors such as Fairway, Chunga, and Community Agribusiness Partners. As a result, organisations like CADECOM and Heifer increasingly invest in strengthening governance through various trainings and coaching.

Those findings highlight the crucial role of the public sector. Bundles that aim to support the adoption of Mbili Mbili will only succeed if they are grounded in strong enabling structures. As such, collective action and related services such as capacity building, group governance, trust-building should be treated as essential elements of any bundling effort. Without those enabling conditions, even well-designed bundles risk failing to be adopted.

5.3. Feedback on the bundle prototypes

This sub-chapter builds upon the findings from step 2 elaborated in the previous sub-chapter and presents the findings to answer sub-research question 3 as part of the third step (step 3) of the methodology. It presents the findings on the feedback given by smallholder farmers on the designed bundle prototypes as well as their perception of the components included in the bundles and the extent to which they address the negative affordances or even create negative affordances themselves.

5.3.1. Feedback on individual bundles through an affordance lens

Table 4: Drivers and barriers of bundle 1

	What farmers liked	What farmers disliked
BUNDLE 1	<p>Training on agricultural practices was the most appreciated component of the bundle. Farmers saw it as helpful for practicing Mbili Mbili and improving yields.</p> <p><i>“Training will enable me to practice Mbili Mbili without a problem.”</i></p>	<p>VSLA component was viewed by some with suspicion because of risk of debt and administrative complexity. Others appreciated it for the provision of informal finance.</p> <p><i>“I don’t want any form of loan because of the risks.”</i></p>
	<p>Legume seed multiplication would support intercropping and self-reliance. Farmers saw it as a sustainable source of quality seed.</p>	<p>Tree seedlings were seen as growing too slow to yield benefits. Some farmers felt it wouldn’t help with urgent farming needs.</p> <p><i>“Trees take time to grow, but we need help now.”</i></p>
	<p>Training on composting and Mbeya for improving degraded soils.</p> <p><i>“I used Mbeya and harvested 6 bags of maize from a small plot.”</i></p>	<p>Lack of fertiliser and maize seed made the bundle feel incomplete for some.</p> <p><i>“It doesn’t have fertiliser or maize seed, so it won’t help us right now.”</i></p>
	<p>Environmental restoration through tree planting was supported when linked to manure and livestock feed.</p> <p><i>“We plant trees to make manure and feed animals.”</i></p>	

Bundle 1 was consistently valued for its training and long-term support measures (composting, legume seed, trees), which many farmers linked to better skills, soil improvement, and gradual self-sufficiency. The training component was especially important for overcoming technical complexity and knowledge gaps around Mbili Mbili techniques such as ridge spacing and organic fertiliser application. The bundle also contributed to addressing soil fertility constraints and climate resilience through manure and Mbeya composting and supported the system’s intercropping requirement via legume seed multiplication. However, it was overall ranked lowest (4th) because it lacked immediate inputs like

fertiliser and maize seed and market access, while some farmers were overall concerned about the risk involved with loans, even from VSLAs. Overall, this bundle was often seen as ‘too soft and slow’. Its focus on knowledge, savings, capacity building, and environmental concerns wasn’t enough to drive adoption of Mbili Mbili without core inputs.

Table 5: Drivers and barriers of bundle 2

	What farmers liked	What farmers disliked
BUNDLE 2	<p>Provision of fertiliser and early maturing seed was seen as the most crucial benefit. Farmers directly linked it to increased yields, food security, and resilience to climate change.</p> <p><i>“Without fertiliser you can’t harvest anything.”</i> <i>“Hybrid seed gives higher yield even with short rains.”</i></p>	<p>Farm input loan was appreciated by many but viewed by some as risky due to climate uncertainty. Concerns centred about the risk to be unable to pay back the loan.</p> <p><i>“The loan is risky—if the rains fail, I can’t repay.”</i></p>
	<p>Farm input loan was praised by most farmers as a way to overcome capital constraints and access inputs at the right time.</p> <p><i>“With the loan I can buy inputs and increase yield.”</i></p>	<p>Ridge-spacing ruler was seen as unnecessary by a few who felt confident in their own skills.</p> <p><i>“I can easily make ridges myself.”</i></p>
	<p>Manual book would help guide Mbili Mbili and was valued as a practical reference.</p> <p><i>“The manual will guide me on Mbili Mbili.”</i></p>	
	<p>Inoculants were viewed positively when offered in a bundle as otherwise often being unavailable in shops. It can further reduce the need for chemical fertiliser and was mentioned to lead to healthier crops and better yields for groundnuts and soybeans.</p> <p><i>“Soybean grows healthy and fast with inoculant—like it had fertiliser.”</i></p>	
	<p>Completeness of the bundle was often highlighted. Farmers liked that everything needed for Mbili Mbili was included.</p> <p><i>“This bundle has everything I need to practice Mbili Mbili.”</i></p>	

Bundle 2 was widely appreciated by farmers as a complete, practical, and results-oriented package that directly supported Mbili Mbili adoption. It was frequently described as containing “everything needed,” due to the inclusion of fertiliser, early-maturing varieties, pesticides, and inoculants. As such, the bundle helps to overcome key constraints such as access to inputs, low yields, and climate stress. The input loan was generally welcomed as a solution to capital limitations, especially when repayable

in cash, though a few farmers expressed concern about the risk of loans. The manual book was also valued for building confidence in implementing Mbili Mbili correctly. Overall, Bundle 2 was viewed as the most complete and actionable option for adoption, particularly because it addressed the high-input concerns of Mbili Mbili, with only minor concerns about perceived redundancy in some components (e.g., ridge rulers).

Table 6: Drivers and barriers of bundle 3

	What farmers liked	What farmers disliked
Bundle 3	<p>Contract market/off-taker was widely appreciated if higher prices were offered, avoiding vendor exploitation, but only if paid directly at delivery.</p> <p>“With this market, we’ll not be exploited by vendors.” – <i>Fabiano Chisi, Kamtwale</i> “You get the payment at once.” – <i>Jacob, Mphomwa</i></p>	<p>Loan repayment in harvest (in-kind) was disliked by some farmers due to perceived risk of default.</p> <p>“Bundle 3 talks about repayment with harvest; I prefer cash repayment.” – <i>Masiye, Mother</i></p>
	<p>Farm inputs (fertiliser, seeds, pesticides) were praised as essential for increasing yield and enabling Mbili Mbili.</p> <p>“All the farm inputs are available—this will help me harvest more.” – <i>Maggie, Mphomwa</i> “This bundle has everything needed for Mbili Mbili to succeed.” – <i>Ernest, Mother trial</i></p>	<p>Trust issues with contract markets were raised by one farmer, preferring the freedom to sell produce on their own terms.</p> <p>“I don’t want contract market so I can sell to whoever I want.” – <i>Masiye, Mother</i></p>
	<p>Extension support and frequent training visits were valued for improving technical knowledge and giving ongoing guidance.</p> <p>“Normally we don’t get visited, but this would give us the help we need.” – <i>Ernest, Mother trial</i> “Extension services will help me continue with Mbili Mbili.” – <i>Gladys Phiri, Mphomwa</i></p>	
	<p>Early grain purchase loan would help farmers avoid selling at low post-harvest prices to vendors.</p> <p>“With the loan, we can sell at better prices instead of being exploited.” – <i>Madise, Mother</i></p>	
	<p>Bundle completeness and alignment with Mbili Mbili’s requirements (inputs, market, training) were frequently emphasised.</p> <p>“This bundle has everything I need for Mbili Mbili.” – <i>Dorica, Chulu Central</i> “Everything in this bundle is spot on.” – <i>Kondwani Chikalema, Mother trial</i></p>	

Bundle 3 was highly appreciated by farmers for its integration of farm inputs, guaranteed market access through contract farming, and regular extension support. These components were widely seen as addressing the most critical constraints to Mbili Mbili adoption, namely, lack of quality inputs, price exploitation by vendors, and inadequate technical support. The inclusion of fertiliser, seeds, and pesticides helped farmers overcome input-related negative affordances, while the off-taker contract gave them greater confidence in selling their surplus at fair prices. Frequent visits by extension workers and training were especially valued by those who felt underserved by public services, as they would provide regular knowledge and check-ups on Mbili Mbili implementation. The early grain purchase loan was also seen as a way to stabilise income and avoid urgent sales. Nonetheless, some farmers expressed concerns about in-kind loan repayment and preferred loans that are repaid in cash rather than in-kind. Others preferred market freedom, but the majority saw the bundle as “complete” and strongly enabling Mbili Mbili.

Table 7: Drivers and barriers of bundle 4

	What farmers liked	What farmers disliked
Bundle 4	Training on livestock and crop management was widely valued. Many farmers emphasised they lacked knowledge, especially on livestock care, feeding, and housing.	Some farmers distrusted livestock loans due to past experiences with animal loss or loan pressure.
	“We need to be trained on how to feed and care for livestock.” – Fabiano	“Some goats received died and others were stolen... I don’t take loans unless I’m freely given the inputs.” – Taona
	Integration of livestock provided economic diversification , manure, and flexibility in resource use.	A few farmers who already had livestock found the provision redundant.
	“Livestock can be sold to pay school fees or buy inputs.” – Dorica	“Goat provision because I already have goats.” – Dennis
	Provision of farm inputs (seeds, fertiliser, pesticides) was critical for boosting yields and enabling Mbili Mbili.	
	“This bundle could address challenges... With farm inputs I will harvest more.” – Lucy	
	Livestock market access was seen as a game-changer. Farmers said it could reduce dependency on vendors and lead to fairer prices.	
	“If we can have reliable markets, our living standards will improve.” – Elizabeth	
Use of crop residues and willingness to grow fodder showed strong alignment with Mbili Mbili principles.		
“When we grow crops, livestock will feed on residues and livestock will give us manure.” – Masije		

Bundle 4 was recognised for its potential to promote integrated crop-livestock farming, a key pillar of Mbili Mbili’s sustainability. Farmers particularly appreciated the training on livestock management, and the provision of goats as a secondary income source and as a source of manure. The inclusion of inputs like early-maturing seeds and fertiliser reinforced Mbili Mbili’s feasibility, especially in the face of climate challenges. The livestock market was another welcomed feature, enabling farmers to sell at better prices. However, concerns were raised about the risk of livestock loans, especially among those with negative past experiences or those who already owned animals. Ultimately, the bundle’s strength lay in the diversification of income streams and increased resilience. Moreover, livestock was valued by farmers because for the ability to sell goats when in need of urgent cash. As such, livestock can represent some sort of savings account for urgent expenses or even as insurance or safety net when crops fail.

5.3.2. Bundle ranking and preferences of bundle components

The ranking exercise provided a comparative perspective on farmers’ bundle preferences. Bundle 4 received the highest overall score, followed by bundle 2, then bundle 3, and finally bundle 1. The strong appeal of bundle 4 was primarily driven by the inclusion of livestock and farm inputs, which was repeatedly mentioned as a key incentive. Combined with the provision of training, bundle 4 was said to address both short-term productivity and long-term resilience. Bundle 2 was appreciated for its strong emphasis on farm inputs, particularly those offered on a cash basis, which were perceived as less risky and more reliable than in-kind provision. Bundle 1 gained traction for its training components and support for VSLAs, whereas bundle 3, although ranked as the top choice only once, was consistently placed as a second or third option.

Taken together, the rankings help to contextualise the detailed feedback provided on individual bundles and reveal patterns of what farmers considered critical versus supportive components. Most notably, farmers repeatedly identified farm inputs, training, and a simple finance mechanism (e.g., cash loan for inputs) as non-negotiable core components. These were followed by livestock and market access, which acted as strong enhancers depending on farmers’ circumstances and priorities. Finally, elements such as manuals, ridge rulers, tree seedlings, and group services were seen as useful but non-essential add-ons. This was further confirmed through the bundle self-design exercise, where nearly all farmers constructed bundles beginning with inputs (seed, fertiliser, pesticides), followed by training, livestock, market access, and financing mechanisms such as cash loans or VSLA. Inoculants were mentioned less frequently, often due to concerns about availability.

Table 8: Preferred products and services

Rank	Component	Rationale
1.	Farm inputs (seed, fertiliser, pesticides)	Inputs were seen as the foundation of production and directly linked to higher yields. They were declared as the most crucial element.
2.	Training (on both crops and livestock)	Seen as crucial for correct application of practices (Mbili Mbili, livestock care, composting).
3.	Livestock (goats, cattle, sometimes pigs)	Valued for income diversification, manure, and emergency liquidity (school fees, food).

4.	Market access via contract	Viewed as essential for better prices and avoiding exploitation by vendors. However, terms and conditions are important.
5.	Cash loans or financial support through VSLA	Some preferred cash to choose their own inputs or cover other pressing needs.
6.	Inoculants	Aware of the benefits but often noted challenges around availability.

Table 9: Categorisation in critical, essential, add-ons

Component	
Critical	
1.	Farm inputs (seed, fertiliser, pesticides)
2.	Training & extension (on both crops and livestock)
3.	Finance mechanism for inputs (simple loan on cash basis)
Strong enhancers depending on farmers	
3.	Livestock (goats, cattle, sometimes pigs)
4.	Market access via contract
Nice-add ons	
5.	Manuals, ridge rulers, tree seedlings, group services transport and storage

5.3.3. Affordances of the bundles for Mbili Mbili adoption

The product and service bundles offered different affordances that either enabled or constrained smallholder farmers in their adoption of Mbili Mbili. Positive affordances emerged from products and services addressing barriers of adoption, aligned with their capacities. In contrast, negative affordances appeared where the bundle's design still failed to meet critical needs or even introduced new risks or complications.

Across the bundles, farmers identified a range of positive affordances. Training or knowledge sharing mechanisms which were present in all bundles, were consistently seen as a key enabler to strengthen skills, build confidence in the ability to implement Mbili Mbili, and reducing the technical complexity associated with it. Moreover, farmers did recognise the intended benefits of training in creating climate resilience and reducing input costs e.g., by the increased application of organic inputs. Inputs such as fertiliser, seed, and pesticides, particularly when offered on a cash-loan basis (bundles 2, 3, 4), were also experienced as highly actionable components that addressed barriers to timely access and availability of input to increase productivity. Similarly, livestock (bundle 4) and market access through contract buyers (bundle 3) were perceived by many as powerful tools to manage income risk, improve resilience, and expand the value of farming beyond the crop itself.

However, several design features also led to negative affordances. Farmers expressed concern when bundles lacked essential components (e.g., fertiliser in Bundle 1), making it difficult to properly implement Mbili Mbili. Financial components such as VSLAs or in-kind repayment were sometimes

perceived as risky, especially for those with past difficulties repaying loans. In addition, a frequently mentioned constraint was the requirement that bundles could only be accessed through organised farmer groups. While intended to reduce risk and transaction costs, this group-based delivery model was experienced as a barrier by farmers who mistrusted cooperatives or preferred to operate independently. However, no feedback or affordances were associated with the provider of the bundles, which differed across the four bundle options. Thus, even well-designed bundles could become inaccessible or unattractive when the delivery mechanism conflicted with farmers' preferences or social realities. These examples highlight that affordances are not determined by the presence of a component alone, they also depend on how farmers perceive its usability, reliability, and alignment with their own situation.

Importantly, it was not only the presence of individual components that shaped adoption, but also how they were combined, which strongly influenced the positive affordances that emerged. For example, combining farm inputs on a cash-loan basis with livestock was seen as especially useful, as livestock could be sold to repay the loan if crops failed. Farmers also valued the link between crops and livestock whereby crop residues could feed animals, and manure improved soil fertility. These combinations made bundles feel more practical and better suited to their farming realities.

At the same time, affordances were shaped by farmers' individual situations. The same component could be experienced as enabling or constraining, depending on context. For instance, farmers who already owned livestock did not view receiving more animals as useful, while others were hesitant about any loan-based components due to past difficulties with repayment. Similarly, while some appreciated contract markets for offering stable prices, others preferred the freedom to choose their own buyers. These examples show that affordances are not fixed, they depend on how bundle components interact with farmers' resources, experiences, and perceptions of risk.

5.3.4. Affordances of the bundling concept

Overall, farmers responded positively to the concept of bundling products and services. Several positive affordances emerged from product and service bundles themselves, as they enabled farmers to overcome a range of barriers that typically limit the adoption of new practices like Mbili Mbili. Bundles were experienced by farmers as '*convenient*', especially because they addressed challenges related to the availability and accessibility of products and services. Inputs such as inoculants, which are often unavailable at local agro-dealers, and training or extension support, which is frequently absent, were made accessible through bundled delivery. Farmers explained that by offering all essential components in one package, bundling afforded action by reducing the burden of sourcing each element individually.

"It is good to have things in a bundle because they are easily accessible."– Nelson,
Mphomwa

Bundling was further praised for making planning and decision-making easier, being a 'practical planning tool', since all components were already present in a coherent package. This made it easier for farmers to make farm-related decisions based on their own needs and circumstances.

“I have observed that it is easier to plan around the bundles since everything is in one place.”
– Macduff, Kamtuwale

In addition, bundles offered confidence and motivation to farmers. In particular, bundles that included training, inputs, and follow-up support made farmers feel more confident about the implementation of Mbili Mbili, as they created a sense of structured support, especially important when trying something new. Thus, bundling could incentivise the adoption of Mbili Mbili, especially for more inexperienced and risk-averse farmers.

6. Discussion

6.1. Relational and interrelated constraints

The findings contribute to a broader debate in the literature over whether technology adoption is primarily shaped by external factor constraints or by behavioral and perception-based factors of individuals. While much of the smallholder literature emphasises external factors like markets and institutions (e.g., Arslan et al., 2022), scholars such as Meijer et al. (2014) call for more attention to individual factors, farmers' perceptions, and agency. The affordance lens in this study shows that these dimensions are deeply interconnected. As Glover et al. (2019) argue, affordances are relational and context-dependent, shaped by both the user's capabilities and their environment. External factors like access to finance or weak extension services influence how farmers perceive the risks, feasibility, and value of adopting Mbili Mbili. This supports Glover et al.'s (2017, 2019) argument that adoption is influenced by the context-specific interactions between user capabilities and environmental conditions, bridging structural and behavioral explanations.

Importantly, the results also show that the perception of Mbili Mbili as a viable practice is highly context-dependent. During the trials, temporary access to inputs and technical guidance created positive affordances and enhanced adoption potential. However, the withdrawal of this support quickly exposed persistent issues of affordability and accessibility, revealing the fragility of adoption when enabling conditions are absent. This aligns with Rogers' (2003) concept of trialability, that innovations are more adoptable when they can be tested under low-risk conditions. From an affordance perspective, it shows that risk and feasibility are not fixed qualities of a technology but emerge from farmers' interactions with their environment. Without financial and institutional support, Mbili Mbili's affordances shifted from enabling to constraining, underscoring the importance of a supporting enabling environment.

6.2. The Role and Limits of Bundling in Enabling Adoption

This section engages with the literature on bundling as both a marketing strategy and a component of socio-technical innovation systems in development contexts. This study has shown that product bundling, as defined by Stremersch and Tellis (2002) and adapted to smallholder contexts by Abetu (2024), offers a promising approach to address multiple constraints that hinder the adoption of agricultural technologies. In theory, many of the products and services already present in Kasungu, such as certified seeds, fertiliser, farmer training, group structures, and market linkages, could be combined to create synergistic bundles that reduce transaction costs, reduce perceived risk and uncertainty.

Farmers expressed a clear preference for such bundles, recognizing the complementarity of the components and valuing the convenience of a 'one-stop' solution. This reinforces earlier findings from marketing literature (Estelami, 1999; Yadav & Monroe, 1993) and Abetu (2024), which show that bundling complementary products increases perceived customer value, an effect that also extends to smallholder farming contexts. Furthermore, consistent with Stremersch and Tellis (2002), this study found that bundling unfamiliar with familiar products can facilitate the adoption of the former. For instance, including inoculants, recommended for implementing Mbili Mbili, within the bundle

increased farmers' willingness to adopt this unfamiliar input, thereby supporting the implementation of Mbili Mbili.

However, the findings also highlight that the delivery mechanism of the bundle is just as important as its content. Factors such as timing of delivery, payment structures, and whether the bundle is accessed collectively or individually significantly shape its perceived usefulness and accessibility. Finally, the nature of the most in-demand components, such as inputs, market contracts, information, and financial services, points to the need for a broader supply chain approach (Gereffi, 2018). Effective bundling in this context requires coordinated collaboration among multiple actors, including input suppliers, financial institutions, extension services, and output market actors.

This study broadens the way bundling is applied so far in the smallholder context. Previous research (e.g., Reinders et al., 2010; Boucher et al., 2021; Abetu, 2024) has focused on bundling as a strategy to promote the adoption of technological artefacts like improved seeds or fertilisers. However, Mbili Mbili is not a single product, but an agricultural practice requiring coordinated changes in land preparation, labour use, and crop planning. The findings of this study show that bundles can create incentives for the potential adoption of such complex agricultural practices by addressing the surrounding systemic constraints. In this light, bundling becomes not merely a commercial tool, but a strategy for enabling more holistic and sustainable shifts in farming systems.

Despite the findings that product and service bundling addresses multiple, interrelated barriers of smallholder farmers, influencing their adoption decision towards a certain agricultural practice, it was also found that bundling might not be a suitable tool for resolving deeply embedded structural issues. Hence, this study agrees that product bundling according to marketing literature can help mitigate certain institutional voids, such as poor market access or the unavailability of timely inputs. Importantly, the study concludes that product bundles alone are insufficient to address the full spectrum of constraints smallholders face. Problems such as unreliable pricing enforcement, weak extension systems, or governance vacuums require broader institutional reform. Following Barrett et al. (2022), bundling should be seen as one component within a wider socio-technical strategy, a way to complement formal institutions and, in some cases, overcome institutional voids. For bundling to effectively support adoption, it must be embedded in a supportive ecosystem rather than be expected to replace it.

6.3. A Smallholder-Centric Design Approach

The findings of this study also engage with the wider debate that agricultural interventions should not follow a top-down approach but rather be co-created with farmers to ensure contextual fit. The use of design thinking in this research, combined with the participatory evaluation of bundle prototypes, demonstrated that co-creation is not merely an added value but a critical condition for effective, context-sensitive innovation (Brown, 2009; IDEO.org, 2015). Farmers acted not as passive recipients but as co-designers, ranking bundles, stating preferences, provides reasons thereof. This process revealed that adoption potential increased when bundles were tailored to farmers' realities. This aligns with Barrett et al.'s (2022) framing of bundles as socio-technical packages that must be co-developed with users to address institutional and contextual barriers.

While the concept of bundling was broadly appreciated by farmers, this study also confirmed that smallholders are not a homogenous group. Preferences varied significantly depending on household characteristics such as land size, livestock ownership, labour availability, and even personal taste. For instance, some farmers valued beans in the intercropping system, while others preferred groundnuts, and goats were seen by some as useful assets. These variations underline the importance of segmentation for effective bundle design, as emphasized in the marketing literature (Kotler & Armstrong, 2010). A one-size-fits-all approach risks excluding farmers whose specific needs and constraints deviate from the average. Instead, bundles should allow for flexibility, through modular components or differentiated targeting, to respond to this diversity and improve adoption potential.

The combined methodological use of design thinking and affordance theory proved valuable not only for academic analysis but for generating an actionable design approach. Affordance theory, in particular, was essential in uncovering how the same bundle could be perceived differently depending on the farmer's social, economic, and environmental context, as suggested by Glover (2022). It helped explain why certain bundles were perceived as enabling, for example, when they allowed for cash loan repayment or incorporated training, while others, requiring upfront payment or binding contracts, were seen as constraining. This reinforces the view of Glover et al. (2019) and Wyche and Steinfeld (2015), who argue that adoption is shaped not only by the technical functionality of a solution but by how well it fits within the user's lived experience.

Affordance theory also challenges the "black box" view of agricultural technologies as criticized by Glover (2019), pushing designers to move beyond generalized assumptions about value or utility of an agricultural practice across contexts. In the context of smallholder farming, where decisions are shaped by a complex mix of constraints, risks, and cultural norms, affordances offer a more context-sensitive way to understand how and why farmers engage, or not, with a given innovation such as Mbili Mbili. They are not fixed properties of the technology, bundles, and bundles components themselves, but relational and conditional possibilities for action, which only emerge when the intervention aligns with a farmer's capabilities, resources, and social and institutional environment. Thus, affordance theory enhanced the human-centered design of bundles by going beyond empathy as part of design thinking (Brown, 2008) to analytically reveal why specific practices or bundle components may remain inaccessible or unattractive, even when they appear beneficial from a technical standpoint.

6.4. Methodological Reflections and Limitations

While this study contributes new insights into the design of smallholder-centric product and service to incentivise the adoption of agricultural practices such as Mbili Mbili, using an affordance lens, several methodological limitations must be acknowledged.

To begin with, the research adopted a qualitative, exploratory single-case study design, conducted in Kasungu District, Malawi. This approach allowed for in-depth engagement with the context and participants, the findings are not statistically generalizable (Yin, 2017; Stake, 1995). Thematic saturation was achieved yet the sample may not fully capture the diversity of perspectives across different agro-ecological, gendered, or institutional settings in Malawi. In qualitative research, the aim

is not generalisability like in quantitative research but transferability, leaving the readers assess the relevance of findings to other contexts (Creswell & Poth, 2018).

A second limitation relates to language and translation. All farmer interactions were conducted in Chichewa and translated into English by a local facilitator. Given that affordances are deeply relational and often conveyed through subtle contextual cues, translation may have altered meanings or introduced interpretive biases. This challenge is widely recognized in cross-language qualitative research, where even minor shifts in phrasing can lead to the loss or distortion of participant meaning (van Nes et al., 2010; Temple & Young, 2004). The absence of transcript validation or bilingual back-checking may have limited the analytical depth of some findings.

Additionally, while this research applied a farmer-centric perspective and incorporated farmers' feedback into the evaluation of bundle prototypes, it fell short of a full participatory co-design process. Budget and time constraints limited the scope of engagement, meaning that farmers responded to pre-structured bundle options rather than collaboratively designing them through multiple design cycles. This departs from the idea of design thinking and may have constrained the design of more tailored or innovative bundle configurations. Furthermore, the study did not include an assessment of the institutional feasibility of scaling these bundles, nor did it implement the final phase of the design process, which consists of a real-world piloting and long-term monitoring. As a result, the likelihood of sustained adoption remains untested.

Taken together, these limitations suggest that while the findings provide meaningful contributions to the theory and practice of affordance-based bundle design and bundling to incentivize the adoption of agricultural technologies, they must be interpreted with caution. Future research should aim to validate these insights across different contexts, incorporate a full co-design approach, and evaluate the actual implementation of the bundles to better understand their feasibility and long-term impact.

6.5. Future Research

This study highlights the value of using an affordance lens to design product and service bundles to incentivize the adoption of agricultural practices among smallholder farmers. However, several areas require further research.

First, future research should test bundle prototypes under real-world conditions to assess actual adoption behaviour beyond expressed preferences. Researchers could implement longitudinal or experimental studies to assess the real-world impact of the bundles on the adoption behavior of Mbili Mbili. Moreover, a real-world setting would give a deeper perspective into the affordances of bundle prototypes and to improve the identification of factors influencing sustained uptake and therefore help prototype development.

Second, further research could be conducted to expand insights across different contexts and samples, as well as diverse agricultural practices, to provide more diverse insights whether bundling can really support the uptake of agricultural practices, such as regenerative agricultural practices.

More detailed analysis is also needed at the level of individual bundle components. Elements such as input packaging, repayment terms, or group involvement can strongly shape perceived value of bundles. This study did not go into detail in those regards, thus, once the components are identified further research could be conducted into the specifics of delivery, size of packaging, and especially pricing of the bundles.

In addition, social dynamics such as gender roles, power relations, and institutional trust influence how bundles are perceived and used. Segment-specific research, particularly focusing on women, youth, or resource-constrained households, could generate more inclusive insights, and further refine the bundle design.

Finally, future studies should examine the institutional and organisational conditions for implementing bundles at scale. This includes identifying suitable orchestrators, exploring public-private collaboration, and designing financing models that ensure sustainability, particularly when bundles aim to promote an agricultural practice, not just a product.

In sum, future research should deepen the use of the affordance lens, expand to diverse contexts and user groups, and explore how bundles can be scaled in practice.

7. Conclusion

This study explored the design of products and service bundles to incentivise the adoption of Mbili Mbili among smallholder farmers in Kasungu, Malawi, using an affordance lens and a smallholder-centric design approach grounded in design-thinking.

Findings show that bundles must be designed to address the identified key adoption barriers of Mbili Mbili, namely biophysical conditions, access and affordability of inputs, technical complexity, and access to extension, information, profitable markets, and inclusive finance. Feedback on bundle prototypes revealed that bundling is generally well-received by smallholder farmers, particularly due to its perceived convenience, value creation, and ability to reduce both risk and transaction costs. Moreover, a clear distinction between critical components and supportive add-ons were visible. Bundles that included quality inputs, inclusive finance, and practical training were widely valued amongst research participants by to overcoming key adoption constraints and seen as essential. Additional services, such as market contracts or livestock enhanced bundle appeal for specific farmers, highlighting the importance of modular, flexible designs tailored to farmers' diverse contexts, needs, and resources which became visible through the affordance lens. Alternatively, bundle design could benefit from prior farmer segmentation for further tailoring to specific needs. Just as important as the bundle components was the mode of delivery: timing of delivery, repayment terms, and the mode of delivery strongly shape perceived usefulness of bundles. The findings also shed light on the gaps in product and service offerings that are often addressed by project-based initiatives that are limited in scale and lack long-term sustainability. As such, bundles are no silver bullets, they must be integrated into an enabling and supportive environment since they are unable to address all adoption barriers and overcome all institutional voids that smallholder farmers face.

Theoretically, this study contributes to adoption and bundling literature by extending the use of bundling in the context of agricultural practices rather than technical artifacts. It shows that bundles can be strategically designed to shape how farmers perceive an agricultural practice's feasibility, value, and risk. By using affordance theory not only as an analytical lens but also as a design tool, the study guided the design of bundles that align with farmers' capacities, needs, and contexts. Thereby enhancing the positive perceptions of Mbili Mbili. Combined with design thinking, this approach offers a structured yet participatory method for supporting a practice's adoption.

Despite limitations of this study, such as geographic limitation, insights from one case study, reliance on translated qualitative data, and lack of real-world implementation, this study offers practitioners and policymakers a replicable framework and approach for designing context-sensitive bundles that support smallholder uptake of sustainable agricultural practices to strengthen food security and livelihoods. Nonetheless, this study calls for further research on how bundling can support the adoption of agricultural practices by extending research to other practices to expand evidence.

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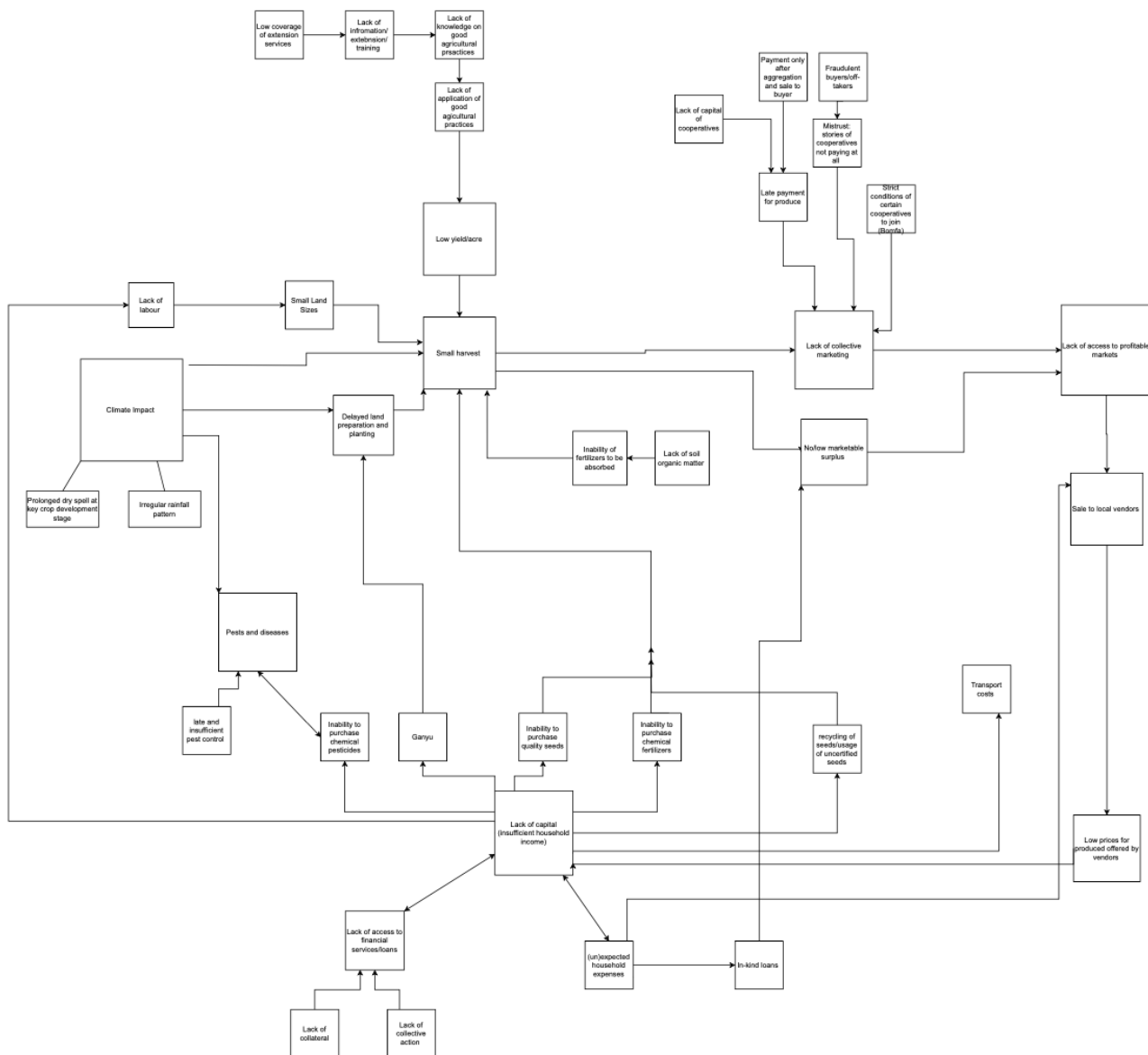
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ANNEX

ANNEX 1: List of expert interviewees for step 2

Type	Name
NGO	CADECOM
	World Vision
	Heifer
	Green Livelihoods
	K2Taso
	Community Agribusiness Partners
	Total Land Care
Finance	Vision Fund Malawi
	Community Finance Ltd
Cooperatives	NASFAM Kasungu
	Kakonje cooperative
	Matandani cooperative
	Changu cooperative
	Lusito cooperative
Government	Extension Methodology Officer
	Irrigation And Farm Mechanization Officer
Research Institutes	IITA
	Local extension officers
	Harvest Plus
	CIAT
	CIMMYT
Private sector actors	Fairway
	aQysta
	Farmers World
	Kulima Gold (local store)
	Perisha Agro

ANNEX 2: Overview of interrelated constraints faced by farmers



ANNEX 3: The use of AI in this study

This study made use of Artificial Intelligence for the correction and rephrasing of sentences. Hence, some paragraphs were formulated with the help of AI. Nonetheless, original ideas stem from the researcher and were originally written down by the researcher before being put into the AI tool ChatGPT to provide support on better sentence formulation, structure, and improve the logical flow of my paragraph. For that purpose, the following approach was used: 1. the paragraph was written by the researcher, 2. put in AI 3. The question was asked to 'Please rephrase'. The results were carefully reviewed and compared to the original piece to ensure the key ideas come across. Changes were implemented in case original ideas were modified and falsely understood by AI. For the qualitative part of the thesis, AI was further used to extract quotes from the transcripts, since it provided a cleaner layout and could filter for most suitable quotes. These parts were cross checked with the actual transcripts to ensure nothing has been modified. In addition, AI was used to clean up the references and ensure they are all in APA format.