DIGITALISING AFRICAN AGRICULTURAL VALUE CHAINS
The Role of ICT Platforms in smallholders’ uptake of agricultural inputs in Uganda

Connetie Ayesiga
**Propositions**

1. The expected decline of ICT platforms for smallholders will benefit agricultural development in Uganda. (this thesis)

2. Building loyalty between value chain actors makes ICT platforms more effective. (this thesis)

3. Locally-perceived development indicators are more important than internationally recognized sustainable development ones.

4. Researchers who disregard interdisciplinarity hinder sustainable development.

5. The concept of ‘Ceteris Paribus’ is detrimental to achieving the sustainable development agenda.

6. Interventions offering free support have rendered poor smallholder farmers poorer.

7. Family is a more important concern for PhD candidates and their supervisors than a completed PhD thesis.

Propositions belonging to the thesis, entitled

**Digitalising African agricultural value chains: The role of ICT platforms in smallholders’ uptake of agricultural inputs in Uganda**

Connetie Ayesiga,
Wageningen, 1st December 2023
Digitalising African agricultural value chains: The role of ICT platforms in smallholders' uptake of agricultural inputs in Uganda

Connetie Ayesiga
Thesis Committee

Promotors
Dr P.T.M. Ingenbleek
Associate Professor, Marketing and Consumer Behaviour Group
Wageningen University & Research

Prof. Dr K.E. Giller
Personal chair, Plant Production Systems
Wageningen University & Research

Co-promoters
Dr Esther Ronner
Researcher, Plant Production Systems
Wageningen University & Research

Other members
Prof. Dr Bedir Tekinerdogan, Wageningen University & Research
Dr Marcia Kwaramba, University of Colorado Boulder, United States of America
Dr Maria Annosi, Wageningen University & Research
Dr Rico Lie, Wageningen University & Research

This research was conducted under the auspices of the Graduate School Wageningen School of Social Sciences (WASS).
Digitalising African agricultural value chains:
The role of ICT platforms in smallholders' uptake of agricultural inputs in Uganda

Connetie Ayesiga

Thesis
submitted in fulfilment of the requirements for the degree of doctor
at Wageningen University
by the authority of the Rector Magnificus,
Prof. Dr A.P.J. Mol,
in the presence of the
Thesis Committee appointed by the Academic Board
to be defended in public
on Friday 1 December 2023
at 1.30 p.m. in the Omnia Auditorium.
Connetie Ayesiga

Digitalising African agricultural value chains: The role of ICT platforms in smallholders’ uptake of agricultural inputs in Uganda,

240 pages.

PhD thesis, Wageningen University, Wageningen, the Netherlands (2023).

With references, with summary in English


DOI: https://doi.org/10.18174/636465
### Table of contents

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>General Introduction</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>The evolving role of ICT platforms as value chain coordinators for smallholder farmers: A comparative case study in Uganda</td>
<td>23</td>
</tr>
<tr>
<td>3</td>
<td>Actor needs in ICT platforms for smallholder-based agricultural value chains</td>
<td>64</td>
</tr>
<tr>
<td>4</td>
<td>Effect of information and communication technology-based loyalty incentives on farmers’ use of agricultural inputs and productivity: Evidence from a field experiment in Uganda</td>
<td>104</td>
</tr>
<tr>
<td>5</td>
<td>Marketing Innovations in Rural Markets in Emerging Economies: Strengthening loyalty through an ICT Platform in Uganda</td>
<td>134</td>
</tr>
<tr>
<td>6</td>
<td>General Discussion and Conclusions</td>
<td>171</td>
</tr>
<tr>
<td></td>
<td>References</td>
<td>188</td>
</tr>
<tr>
<td></td>
<td>Summary</td>
<td>226</td>
</tr>
<tr>
<td></td>
<td>Acknowledgements</td>
<td>230</td>
</tr>
<tr>
<td></td>
<td>About the Author</td>
<td>236</td>
</tr>
<tr>
<td></td>
<td>Completed training and supervision plan</td>
<td>238</td>
</tr>
</tbody>
</table>
Abstract

To address low yields and contribute to food security in sub-Saharan Africa, policy-makers encourage smallholders to use productivity-enhancing agricultural inputs. Despite the wide promotion of agricultural inputs, the uptake of such technologies remains low, among others, due to limited access to input and output markets. Information and communication technology (ICT) platforms are seen as promising tools for ‘pushing’ information on input use, providing links to input suppliers, or ‘pulling’ input use through improved information on and links to output markets. Researchers nevertheless disagree on how ICT platforms can best fulfill their role. More specifically, there are disagreements concerning whether the main role of ICT platforms should be limited to providing information on input or output markets or whether they should play a coordinating role within the value chain. In addition, it remains unclear whether supply push or market pull is more effective in increasing input use.

To provide empirical evidence to reconcile the different arguments in the literature, we first employed case study methods to compare four case studies of ICT platforms. We explored the motivations and actions of ICT platforms to understand the strategies used by the four ICT platforms in improving the uptake of agricultural inputs among smallholders and their future strategic directions. The study revealed that ICT platforms are moving away from an exclusive focus on providing information towards the coordination of value chains and from an exclusive concentration on either input or output markets to include both markets. Thus, they are moving towards taking on a role as full value-chain coordinators to address the multiple barriers to uptake farmers face.

In the next step, we zoomed into one of the ICT platforms in the previous study that had adopted a business-ecosystems approach to reach out to other actors within the value chain (e.g. agrico-insurance companies, microcredit organizations and related service providers) to address the many challenges faced by farmers. In addition, the platform had interacted with farmers in...
in what could be referred to as ‘experience-led evolution’. We explored ICT service needs and preferences for interface design features in a small holder-based value chain context involving key actors using focus group discussions and key informant interviews to derive potential synergies, trade-offs, and solutions. The findings of this study show that many value chain actors have similar needs for ICT services such as coordination of the entire value chain, buyer-seller loyalty building, digital literacy and multifaceted interface tools. Results also showed trade-offs in the preferences for interface design features related to reach versus efficiency and inclusion versus exclusion such as between actors, and, in some cases, they even contradict each other. In light of these contradictions, the study highlights the need for ICT platform managers must first prioritise needs that cut across all value chain actors and make trade-offs concerning whose needs they consider most important.

Following insights from the previous study, the lack of loyalty between farmers and produce buyers was one of the key design challenges hampering farmers’ access to output markets, resulting in low incomes earned by farmers, which in turn forms a negative self-reinforcing loop that further constrains their use of agricultural inputs and productivity. We therefore implemented and examined the effects of loyalty incentives shared by an Information and Communication Technology (ICT) platform on farmers’ use of improved seed and fertilizer and soybean yields using survey data from 234 farmers in Northern Uganda. The study results indicate a significant ($P < 0.001$) influence of financial and non-financial loyalty incentives on farmers’ compared with no incentives. Average soybean yields significantly increased above the control (619 kg ha$^{-1}$) by 525, 747 and 854 kg ha$^{-1}$ for non-financial, financial, and a combination of financial and non-financial incentives, respectively.
This thesis suggests that loyalty incentives are effective instruments in removing market uncertainties, resulting in increased adoption of agricultural inputs and consequent farm yields.

La s t l y , th e g rowi n g p res en ce o f mo b il e p ho n es i n d i st a n t r u r a l a r e a s o f e m e r g i n g e c o n o mi e s o p e n s n e w o p p o r tu n i t i e s t o o v e r c o me c h a l l e n g e s t h a t h i n d e r m a r k e t i n g r e l a t i o n s h i p s t h a t a r e i m p o r t a n t t o p r o v i d e s u f f i c i e n t f o o d f o r r a p i d l y g r o wi n g p o p u l a t i o n s . Th i s s t u d y p r e s e n t s r e s u l t s f r o m a f i e l d e x p e r i me n t o n I C T-b a s e d l o y a l t y i n c e n t i v e s a s a r e l a t i o n s h i p-b u i l di ng m e c h a n i s m b e t we e n f a r me rs a n d a b u y i n g c o mp a n y i n U g a n d a . Bo t h f i n a n c i a l a n d n o f i n a n c i a l l o y a l t y i n c e n t i v e s a p p e a r t o a f f e c t ( P < 0 . 0 0 1 ) f a r me rs’ loyalty positively. Affective and calculative c o m mi t m e n t m e d i a t e ( P < 0 . 0 0 1 ) t h e s e r e l a t i o n s h i p s . Th e e f f e c t s a p p e a r t o b e s t r o n g e r f o r f a r me rs t h a t h a v e g r e a t e r t r u s t i n t h e I C T p l a t f o r ms . P r e s u m p t io n s f r o m o t h e r b u y e r s n e g a t i v e l y a f f e c t ( P < 0 . 0 0 1 ) f a r me rs’ loyalty intentions, but the effect is weaker than that of loyalty i n c e n t i v e s . Th e s e f i n d i n g s s u g g e s t t h a t l o y a l t y i n c e n t i v e s a r e e ff e c t i v e i n n o v a t i o n s f o r v a l u e c h a i n d e v e l o p me n t i n r u r a l m a r k e t s o f e m e r g i n g e c o n o mi e s .

Th i s t h e s i s p r o v i d e s s o m e m a i n i n s i g h t s . Ch a p t e r 2 s h o w s h o w I C T p l a t f o r ms i n s ma l l h o l d e r-b a s e d a g r i c u l t u r a l v a l u e c h a i n s s t a r t c o n v e r g i n g t o w a r d s b e c o mi n g c o o r d i n a t o r s o f v a l u e-c h a i n e c o s y s t e ms t o s o l v e t h e m a n y v a l u e-c h a i n c h a l l e n g e s s ma l l h o l d e r f a r me rs f a c e. Ch a p t e r 3 e mp h a s i s e s t h e n e e d f o r I C T p l a t f o r ms t o f i r s t p r i o r i t i s e n e e d s t h a t c u t a c r o s s a l l v a l u e c h a i n a c t o r s a n d m a k e t r a d e-o f f s a b o u t w h o s e n e e d s t h e y c o n s i d e r m o s t i m p o r t a n t, i f t h e y a r e t o i m p r o v e a c c e s s a n d u s e o f I C T-b a s e d s e r v i c e s a m o n g k e y v a l u e c h a i n a c t o r s .

Ch a p t e r 4 s h o w e d t h a t l o y a l t y i n c e n t i v e s (c o m m o n w i t h l a r g e r f i r m s ) a r e a l s o e f f e c t i v e i n s ma l l h o l d e r-b a s e d v a l u e c h a i n s , a n d t h a t f a r m e r s’ access to output m a r k e t s l i n k a g e s w i t h c o m p e t i t i v e p r i c e s a r e n e e s s a r y f o r e n h a n c i n g f a r m e r s’ i n v e s t m e n t i n a g r i c u l t u r a l i n p u t s .

Ch a p t e r 5 p r o v i d e s i n s i g h t s a s t o w h y l o y a l t y i n s t r u me n t s e v e n t u a l l y i n f l u e n c e l o y a l t y , s u g g e s t i n g t h a t r e l a t i o n s h i p s i n a g r i c u l t u r a l v a l u e c h a i n s a r e s t r e n g t h e n e d m o r e e f f e c t i v e l y w h e n t h e n e w I C T i n s t i t u t i o n s a r e a l s o t r u s t w o r t h y .
Finally, this thesis has some key implications. First, addressing the low use of inputs and low yields among smallholder farmers necessitates improving farmers' physical linkages to inputs through input loans, quality inputs within their localities and knowledge about the benefits and use of the inputs. Second, business models for input markets such as fertiliser and rhizobial inoculants need to be redesigned to allow greater access by farmers in rural areas. Third, ICT platforms should develop multi-faceted interfaces that integrate tools for both simple-feature phones and smartphones, customised to different languages, types of access (on-demand, online and offline) and the capabilities of different value chain actors. Fourth, to play multiple roles, including input demand articulation, network building, and knowledge brokering ICT platforms must develop their capacity in terms of human resources, as well as the capacity of those on whom they rely to provide this range of services (e.g. village agents). Fifth, in collaboration with NGOs and input and output companies, ICT platforms should design loyalty-building interventions that enhance buyer-seller relationships, increase transparency and exchange of credible information (e.g. bulk alert and price information), to increase market certainty for both farmers and output buyers, thereby enhancing the use of ICT services among both categories of actors. Sixth, with the advent of technological advancements in smallholder agricultural markets, policymakers should partner with ICT platforms as potential partners that can stimulate smallholders’ food production to increase food security for the growing population. Intervention should involve engaging with existing platforms to integrate and strengthen relationships between market actors to increase smallholders’ farm productivity. Last, this thesis recommends a one-stop centre ICT platform to ensure a well-functioning and coordinated value chain between the demand and supply of agricultural markets (inputs, outputs, microcredit, and associated services) across value chain actors. This will ensure that farmers access all the required farming-related services without the need to register and navigate different platforms that cause digital fatigue.

Abstract
1
Chapter 1

General Introduction
1.1 Food security and uptake of agricultural technologies by smallholders

Despite the development and wide promotion of agricultural inputs to boost productivity in smallholder farming systems and meet the increasing food demands in Africa, uptake of these inputs by farmers remains low. Various factors contribute to farmers’ low uptake, including limited access to input, output and financial markets, production risks, high operation costs and knowledge and information gaps (Dannenberg et al., 2018; FAO et al., 2020; Simtowe et al., 2019a; Van Campenhout et al., 2021). The rapid development and deployment of Information and Communication Technologies (ICTs) in smallholder agriculture can help overcome some obstacles and ‘push’ inputs through information on input and links to input suppliers or ‘pull’ input use through improved information on and links to output markets. Researchers nevertheless disagree on whether the main role of ICT platforms should be limited to providing information on input or should play a coordinating role within the value chain. In increasing smallholders’ uptake of agricultural inputs. This thesis aims to explore and analyse the roles of ICT platforms on farmers’ uptake of agricultural input technologies points for improved functioning of ICT platforms on Uganda as a case.

Due to population growth, growing incomes and rapid urbanisation. However, crop
Saharan Africa re...
inputs and good agronomic practices to increase small holders’ farm productivity and income. However, barriers remain that constrain the uptake of such technologies. The economics literature largely attributes these constraints to the information asymmetry problem. Some studies argue that the lack of production information makes it hard for farmers to assess the suitability of agricultural inputs for use on their farms and the potential associated risks.

For instance, the input market system in Uganda has been characterized by counterfeit, making it difficult for farmers to differentiate genuine and fake inputs, thereby hampering uptake decisions (Shiferaw, 2016). The awareness of the technology, its benefits, and usability or application, farmers are unlikely to use it. Other studies indicate that the lack of information makes rural farmers vulnerable to the already poorly developed markets, making it difficult for farmers to forecast the output demand, which in turn limits their use of inputs to increase productivity.

Saharan Africa is a major opportunity to improve access to agricultural information and overcome the information-related deficiencies. ICTs are digital tools on which multiple interfaces and applications are integrated for users (Baryamureeba, 2014), including farmers and other value chain actors. Through ICTs, low-cost and real-time agricultural information across the entire production cycle can be generated, stored, analyzed, disseminated to farmers and other value chain actors. This is now possible as access to and use of mobile phones in sub-Saharan Africa has increased to about 66 percent coverage (ITU, 2018). With increased access and use of mobile phones, it is possible to reach many farmers with information on new varieties, weather forecasts, prices, and markets.
enhancing uptake decisions through greater inputs access.

1.2 Roles of ICTs in smallholder-based value chains

Various studies have explored how the application of ICT platforms could potentially improve the uptake of agricultural input technologies in smallholder agriculture in sub-Saharan Africa. In this regard, many ICT tools have been developed to provide farmers with information on issues such as weather forecasting, crop variety selection and management practices, among others. For example, some authors show how videos and audiovisual extension information and SMS messages increased farmers’ knowledge and use of inputs (seed purchases) and improved farm practices (Cole and Fernando, 2016; Fabregas et al., 2019; Larochelle et al., 2019; Van Campenhout, 2017; Vandevelde et al., 2021). Other authors show positive effects of ICT-based market information services on farmers’ market access, sales income, input allocation decisions and use of inputs (purchased seed and fertilisers) (Aker and Fafchamps, 2015; Aker et al., 2016; Aker and Ksoll, 2016; Baumüller, 2018; Courtois and Subervie, 2015; Minkoua Nzie et al., 2018; Ogutu et al., 2014; Okello et al., 2020). However, others found no positive effects of ICT-based extension information or market information on use of inputs among farmers (Voss et al., 2021; Van Campenhout et al., 2021; Maredia et al., 2021).

Based on the above mixed evidence of impacts of ICT platforms on smallholders’ uptake of agricultural technologies, questions remain on whether ICT platforms might fulfil their promise, bringing the research frontier at two questions. The first question concerns what market(s) should be prioritised by ICT platforms: input markets, output markets, or perhaps both, to create transparency on the incentives for farmers invest in inputs.
Next to the provision of information, the relationships between value chain actors to create output market certainty are crucial for uptake of inputs stemming from reliable produce markets and better prices for farmers. Relationship building has been discussed in the relationship marketing literature through loyalty interventions to improve business relationships, while allowing customers to earn future benefits or rewards from their engagement and relationship with the firm (Kwiatek and Thanassi-Dimitriou, 2018). Thus, improved loyalty between buyers and sellers could have beneficial effects on their relationships to create output market certainty that could pull farmers’ use of inputs. Studies that address the ICT design challenges largely focus on the design of a single set of service needs and preferences for interface design features for all actors, which is yet to be among other things (Agyekumhene et al., 2020; Chiputwa et al., 2022; Ortiz-Crespo et al., 2020). Yet, ICT platforms for smallholder value chains require understanding of ICT
1.3 Theoretical approach

To explore and analyse the roles of ICT platforms on farmers’ uptake of agricultural input technologies, this thesis draws on perspectives from economics, actor network and marketing literature. In economic theory, the significance of information for adequate functioning of markets has been a prominent concern, with this being a key topic since Stigler’s seminal work on the economics of information (1961). Several authors in the economics literature on smallholder agriculture argue that information asymmetry is the largest barrier faced by smallholders (Aker and Ksoll, 2016; Barrett, 2008; Chavas and Nauges, 2020; Qiu et al., 2013).These studies argue that access to information can correct market uncertainties by increasing market transparency which would increase the functioning of agricultural markets, thereby reducing transaction costs.

The focus on ICT platforms in smallholder agriculture is driven by the role they can play in facilitating access to information in a timely manner to increase transparency in input and output markets. Transparency in agricultural markets can enhance linkages to agro-input dealers, credit providers and produce buyers, and reduce transaction costs among participating farmers, thereby creating incentives, such as higher produce prices which could stimulate investment in agriculture including uptake of productivity enhancing inputs (Ayalew and Belay, 2020; Okello et al., 2020).
markets but as hybrid forms in between markets and organizations (Fafchamps, 2003), namely as networks in which actors are connected in the form of a value chain or other structural network forms. Such networks are described under different concepts, like business ecosystems (Graca and Camarinha-Matos, 2017), service ecosystems, or market systems (Masa and Ng’ombe, 2019). This perspective does not reject the idea posited by economics that information provision can smooth the functioning of markets and increase adoption of inputs. Yet it further recognizes that collaborative networks can leverage the benefits of sharing and collaborating among individuals and organizations.

By obtaining information from various actors and making it of value to others, ICT platforms typically co-create value for parties involved (Fry, 2021).

Following the business ecosystem approaches specifically on actor networks, strengthening of relationships to build trust and commitment among various actors in the network is crucial. For ICT platforms, this implies that successful collaboration between input and output market actors requires the integration of key actors’ challenges and needs in the design of ICT services.

However, there is only a handful of studies that look into the design needs for one user group. There is limited guidance on how to design ICT services encompassing different value chain actors, and how to build the actor relationships that are crucial for stabilizing agricultural input and/or output markets.

To design ICT services encompassing different value chain actors and to strengthen value chain actor relationships, this thesis uses the marketing literature, specifically a user orientation (Sklyar et al., 2019; Vargo and Lusch, 2016) and relational marketing literature, particularly on loyalty programs (Agarwal, 2018; Kapoor, 2018; Sako, 2018).
Chapter 1

Mehrotra, 2018; Kwiatek et al., 2020; Viswanathan et al., 2022), respectively. With regard to the New Service Design process, this involves understanding the experiences of users and using this information to systematically improve the attributes and features of the services offered, resulting in successful new services (Edman et al. (2014, p. 109)). Such design thinking has led to the use of user-driven and participatory approaches in service development (Edman et al., 2018). One example of a user-driven approach is ‘user-centric design’, which guides the design of services that match the needs and context of users. Within the context of smallholder-based value chains, smallholder-centred design could be regarded as a specific case of the user-centric design approach that places the perspectives of smallholders and the actors with whom they interact with at the centre of service design (Graham, 2019; Steinke et al., 2021). In this regard, two aspects of design appear central to a user-centric design approach: (1) understanding the needs of value-chain actors for ICT services that address their challenges; and (2) identifying preferences for interface design features that enable actors to access and use ICT services.

With regard to relational marketing literature, particularly on loyalty programmes, improving farmers’ use of agricultural technologies requires proper coordination of the value chain such that farmers can access and are informed about inputs as well as buyers (Chavas and Nauges, 2020). Value chain coordination thus help remove market uncertainty for farmers to persuade them to participate by purchasing and using the inputs (Minkoua Nzie et al., 2018; Minten et al., 2016). To do this, loyalty incentives may help. To date, loyalty incentives for smallholders have only been offered as part of contract farming arrangements (Arouna et al., 2021; Bellemare, 2018). Implementing loyalty incentives through contracts comes, however, with high transaction costs to reach individual farmers or farmer groups through extension or buyer agents. With the rapid development of ICT platforms in agricultural value chains, implementation of loyalty incentives is becoming more feasible (Tong et al., 2020).
explore and analyse the roles of ICT platforms on farmers’ uptake of agricultural inputs and find entry points for improved functioning of ICT platforms in smallholder-based value chains. To address the general aim, the following research questions were answered:

1. What strategies do different types of ICT platforms use to improve the uptake of agricultural input technologies among smallholder farmers?
2. What are the needs of farmers and other key actors in smallholder-based value chains for ICT services, and what are their preferences for interface design features?
3. What is the effect of an ICT-coordinated loyalty intervention with an assured produce market on farmers’ use of agricultural inputs and crop yields?
4. What is the effect of ICT-based loyalty incentives on farmers’ loyalty intentions to output buyers?

1.4 Thesis Structure and research methods

1.1 Figure
collaborating amongst individuals and organisations (Kapoor, 2018; Sako, 2018). The actor network perspective has also been useful in studying other platforms such as Alibaba and Amazon (Jindal et al., 2021; Wu and Gereffi, 2018). This chapter adopts the network perspective to investigate the strategies of ICT platforms for increasing farmers’ use of agricultural inputs in terms of market systems value co-created and future strategic directions. By taking the ICT platforms as the objects of investigation and using key informant interviews, desk reviews and observations, this chapter reconciles the different views on the two dimensions within which ICT platforms can operate: the market dimension (information provision vs. coordination) and the intervention dimension

Chapter 3, entitled “Actor needs in ICT platforms for smallholder agricultural value chains: A case in Uganda”, builds on findings from Chapter two to focus on one ICT platform that stood out because of its business ecosystems approach to reach out to other value chain actors such as smallholder farmers. The chapter uses the marketing literature, particularly ICT service needs and preferences for design features through key informant interviews with key value chain actors and focus group discussions with farmers, to gain insights into the ICT service design process that can integrate smallholders and other value chain actors. It identifies the synergies and trade-offs in needs and preferences for ICT interface design of key actors in the agricultural value chains. It also identifies some actions for ICT platforms to solve the trade-offs in needs, to keep all value chain actors on board and contribute to the development of smallholder-based agricultural value chains.
Chapter 4, entitled “Effect of an ICT-based loyalty programme on farmers’ use of agricultural inputs and productivity: Evidence from a field experiment in rural Uganda”, addresses the third research question by further extending the insights from Chapter 3 and building on the relational marketing literature. Using a cluster randomized controlled trial (CRT) experiment involving 234 farmers, this chapter assesses the effects of financial and non-financial benefits of an ICT-based loyalty programme with output market linkage on farmers’ use of agricultural inputs and soybean yields.

Chapter 5, entitled “Marketing innovations in rural markets in emerging economies: strengthening loyalty through an ICT platform in Uganda”, addresses the fourth research question by further extending the insights from Chapter 3 and building on the relational marketing literature to understand the effects of loyalty benefits on farmers’ loyalty intentions.

Figure 1.1: Thesis outlines showing how the chapters are linked.
Chapter 6 with "General conclusions and implications" discusses the outcomes of the four research chapters in the light of the broader literature. Some general conclusions are drawn and the implications for ICT developers, businesses, and policy makers are discussed. The chapter also reflects on the limitations of the approaches used in the thesis and proposes directions for future research.
2
Chapter 2

The evolving role of ICT platforms as value chain coordinators for smallholder farmers: A comparative case study in Uganda

This chapter will be submitted as Connetie Ayesiga, Esther Ronner, and Paul T.M. Ingenbleek. The evolving role of ICT platforms as value chain coordinators for smallholders: A comparative case study in Uganda
Abstract

Despite the development and wide promotion of agricultural inputs to boost productivity in smallholder farming systems, the uptake of such technologies remains low. Platforms for information communication and technology (ICT) are seen as promising tools for ‘pushing’ information on input use, providing links to input suppliers, or ‘pulling’ input use through improved information on and links to output markets. Researchers nevertheless disagree on how ICT platforms can best fulfill their role. More specifically, there are disagreements concerning whether the main role of ICT platforms should be limited to providing information on input or output markets or whether they should play a coordinating role within the value chain. In addition, it remains unclear whether supply push or market pull is more effective in increasing input use. To provide empirical evidence to reconcile the different arguments in the literature, this study draws on lessons learned by ICT platforms in practice by comparing four case studies of ICT platforms. The findings indicate that ICT platforms are moving away from an exclusive focus on providing information towards the coordination of value chains and from an exclusive concentration on either input or output markets to include both markets. Thus, they are moving towards taking on a role as full value-chain coordinators to address the multiple barriers to uptake farmers face. These insights call for researchers to approach ICT platforms from a systems perspective rather than a traditional information perspective.

Keywords: ICT platforms, organizational strategies, agricultural value chains, technology adoption, market access, coordination, smallholder farmers.
2.1 Introduction

By 2050, the demand for food in Africa will double due to population growth, increasing incomes and rapid urbanisation (FAO, 2017; Van Ittersum et al., 2016). At the same time, however, food production is impaired by the reliance of smallholder farmers on rain-fed subsistence agriculture, declining soil fertility (World Bank, 2017) and decreasing farm size (Lowder et al., 2021). While various agricultural technologies (e.g., improved seed varieties, fertiliser and farm practices) could increase smallholders’ farm productivity and income, the uptake of such technologies has generally been low (Macours, 2019b; Sheahan and Barrett, 2017). Smallholders have been reluctant to invest in agricultural input technologies due to various factors, including limited access to input, output and financial markets, high transaction costs, risks and uncertainty (Simtowe et al., 2019a). These constraints are barriers to the adoption of technologies and innovations that will improve access to agricultural information and overcome the information asymmetry problem among smallholder farmers (Abdulai et al., 2023; Deichmann et al., 2016; Mohammed and Abdulai, 2022; Van Campenhout et al., 2021).

In light of the points outlined above, the recent proliferation of platforms for information communication and technology (ICT) in sub-Saharan Africa is being welcomed as a major tool to address the challenges facing smallholders. An ICT platform is a mobile or web-based application that enables multiple interfaces and applications to be integrated for users to access agricultural information at low cost and in real-time in order to correct market failures and reduce transaction costs, risks and uncertainties (Zahedi and Zahedi, 2012) including farmers and other actors within the value chain. Such platforms enable the provision of a range of services to farmers and other actors along the value chain (Aker et al., 2016; Duncombe, 2018; Ezeomah and Duncombe, 2019; Orr, 2018). This ultimately enhances access to and use of agricultural information...
ICT platforms can fulfil their promise. This disagreement raises two questions for the research field. The first concerns which markets should be prioritised by ICT platforms: input markets or output markets (Ayime et al., 2022), while others suggest that output market information is used to create transparency on the incentives for farmers to ‘pull’ investments in inputs (Aker and Fafchamps, 2015; Aker et al., 2016; Courtois and Subervie, 2015; Nakasone et al., 2014). The second question concerns whether the provision of market information alone is sufficient to ensure the functioning of markets within the African context, where market players (e.g. output buyers and input providers) may be few and, in some cases, non-existent (e.g. Dorward et al., 2009; Ingenbleek et al., 2013). While many studies rely on information provision as the main intervention of an ICT platform (e.g. Courtois and Subervie, 2015), others have started to advocate for ICT platforms to coordinate linkages across input and output markets (Chavas and Nauges, 2020; Ezeomah and Duncombe, 2019). Proponents of the different views rely primarily on theoretical arguments and impact studies. Within this debate, the voices of organisations behind ICT platforms concerning the lessons they have learnt in their markets and the directions they will take based on these insights are largely absent. For this reason, the current study focuses on ICT platforms as the object of investigation. By exploring the motivations and actions of ICT platforms, we aim to reconcile the different views on the two dimensions within which ICT platforms can operate: the market dimension (input versus output markets) and the intervention dimension (information provision versus coordination). Based on these two dimensions, we identify four types of ICT platforms, which we compare systematically in a qualitative case study intended to address...
Three research questions: 1) How do the four types of ICT platforms help to improve the uptake of agricultural input technologies by smallholder farmers? 2) What strategies do the different types of ICT platforms use to improve smallholder farmers' uptake of agricultural input technologies? 3) In which direction are these strategies developing towards the future?

Table 2.1

<table>
<thead>
<tr>
<th>Main focus of interventions by ICT platforms:</th>
<th>Main focus of ICT platforms in the smallholder-based value chain:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information Coordination</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Input markets</td>
</tr>
<tr>
<td></td>
<td>Output markets</td>
</tr>
</tbody>
</table>

By answering these questions, this study contributes in-depth insight into the strategies that ICT platforms can use to increase the uptake of productive inputs by smallholders. Adopting the perspective of ICT platforms makes it possible to identify the directions in which they are heading and why. We thus provide comprehensive empirical insight into the different pathways—the alternative steps and actions towards different strategic directions (WERNER et al., 2021)—of the different ICT platforms. The results indicate that ICT platforms have started converging towards becoming coordinators of value-chain ecosystems in order to solve many value-chain challenges faced by smallholder farmers.

The rest of the paper is organized as follows. We start by reviewing the existing literature on ICT platforms for smallholders and introduce the theoretical perspective adopted in our study. In the Methods section, we indicate how we selected and examined four cases for systematic comparison to answer our research questions. We report the most important insights from these cases in the Results section, followed by implications and conclusions.
2.2 Literature review

2.2.1 Uptake of new technologies by smallholders

As indicated by several studies, ICT platforms can help to eliminate barriers that smallholders encounter in the uptake of agricultural input technologies (Cole and Fernando, 2021; Krone and Dannenberg, 2018; Maredia et al., 2018; Steinke et al., 2021). With this context, uptake— or adoption— refers to a decision made by a smallholder to substitute existing techniques, artefacts and practices with newer and better ones. This acknowledges that uptake is not a straightforward yes/no decision— given the possibility of adopting only some parts of available technology— and adoption decisions are subject to change. (Glover et al., 2016). As suggested by Glover et al. (2019) networks (e.g. input/output markets and providers of support services) that can eliminate barriers, such as poor extension services, poor infrastructure, limited credit access and ineffective policy frameworks value chain actors needed in order to supply inputs or buy produce are few or nonexistent, and the distances between farmers and other actors are often large. One possible solution is for ICT platforms to position themselves to eliminate barriers by connecting to and intervening in the socio-technical barriers that hinder the adoption of technology.

2.2.2 Economic studies on ICT and uptake

As mentioned above, ICT platforms can be used to share information with smallholders. In (Aker and Ksoll, 2016; Chavas and Nauges, 2020). Vannevelde et al. (2021) to information on inputs through videos increased potato farmers' use of these inputs (e.g., seed
ICT Platforms as agricultural value-chain coordinators

In addition, La Rochelle et al. (2019) found that an SMS-based programme increased knowledge and self-reported adoption of integrated soil management practices for potato farmers in Ecuador. In other examples, Van Campenhout et al. (2021) and Mareida et al. (2018) found that audio-visual extension messages enhanced knowledge among farmers in Uganda and Burkina Faso, respectively, with the use of recommended practices and fertilizers increasing in Uganda, but not in Burkina Faso. Comparably, Voss et al. (2021) found no evidence that an ICT-enabled extension using radio and mobile-phone services affected farmers’ use of certified improved seeds and fertilizers across Senegal.

In a meta-analysis, Fabregas et al. (2019) found that, in general, digital extension information increased the odds of adopting recommended inputs by 22% while increasing yields by 4%.

On the output market side, ICT platforms can be used to increase transparency. Improving the functioning of the output market can create incentives (e.g., higher prices) for smallholders to adopt productive inputs. In a study conducted in Kenya, Okele et al. (2020) found that ICT-based market information services increased farmers’ share of output sold and sales income, increasing their likelihood to invest in farm inputs. Likewise, Belay and Ayalew (2020) found that output-price information provided by the ICT-based commodity exchange intervention influenced the crop choices and input-allocation decisions of farmers in Ethiopia. In a comparable study conducted in Kenya, Okele et al. (2020) found that ICT-based market information increased farmers’ use of purchased seeds and fertilizers.

2.2.3 ICT platforms from a network perspective

Information services increased farmers’ share of output sold and sales income,
et al., 2021; Vargo and Lusch, 2016) and services (Masasi and Ng’ombe, 2019).

This perspective acknowledges that information flows within networks can become distorted or interrupted (Burt, 1992). As such, it does not reject the idea posited by economists that information provision can smooth the functioning of a market and increase adoption. In addition, this perspective recognizes that collaborative networks can leverage the benefits of sharing and collaborating among individuals and organizations.

Exchange is coordinated not only by a price mechanism but also by other aspects, including value co-creation and delivery mechanisms (in most cases, at the organizational level).

For instance, Ayeku et al. (2018) found that credit accessed by digital platforms helped to create awareness and coordinated responsiveness to agroecological farm conditions among maize farmers in Ghana. In that case study, the digital platform co-created value with farmers and maize traders to overcome uncertainties related to credit and information asymmetries in maize production. In a study conducted in Kenya, Duncome (2018) found that digital technology empowered farmers to access information, collective output markets, and inputs. In that case study, the author demonstrates a transition from intermediary-based transactions to collaborative action (a more organized, market-oriented approach), in which farmers collaborate to access better input and output markets.

By stabilizing agricultural input or output markets, ICT platforms may contribute to smallholders' initial trials of inputs and their repeated and consistent use.

2.2.4 Theoretical approach

Given that the network/ecosystem approach to examining ICT platforms covers interventions aimed at coordination and information provision, we adopt this perspective for our investigation of the strategies of ICT platforms. This approach has also been employed in examining the

Chapter 2
ICT Platforms as agricultural value-chain coordinators

Strategies are long-term goals and objectives that a company adopts by aligning required resources, skills and opportunities to attain benefits for the company and to fulfill stakeholders’ expectations (Johnson and Scholes, 2012). The current study draws on four concepts to concretize the strategies of ICT platforms from the network/ecosystems approach guiding the research (Yin, 2018).

First, proceeding from the social network perspective, as Opara (2016) demonstrated, ICT platforms carve out their own niches within existing networks. They forge connections with specific actors by establishing direct links, serving as intermediaries to connect others or creating indirect links. Therefore, they must decide how to position themselves within the market system by establishing links to other actors within the network to achieve their objectives. Second, as advocated by Vargo and Lusch (2017), studies that view networks as service systems emphasize that networks exist for actors to provide services to one another. In this respect, service is the application of resources to the benefit of others (Vargo and Lusch, 2017), and it is regarded as the basic unit of exchange, often taking the form of physical products or intangible services that are exchanged for payment (Vargo et al., 2017). For ICT platforms, these services typically include the provision of information, as well as additional offerings, including awareness campaigns on behalf of companies in the value chain, researcher questionnaires, input-demand aggregation, microloans, contracts for the purchase and delivery of farm inputs, crop insurance, and contracts with buyers (Park et al., 2016).

Third, ICT platforms obtain the resources underlying their services from various actors within the value chain. ICT platforms typically co-create value by obtaining information from these actors and making it of value to others. Within the domain (Cusumano et al., 2020; Stallkamp and Schotter, 2021),
2019; Lember et al., 2019; Wajid et al., 2019). In this regard, value is s

(Vargo and Lusch, 2016)—rather than in terms of ‘exchange value’ (i.e. price). For instance, the value of fertiliser is the

displayed it in the store, an ICT platform that notified the farmer that the fertiliser was available

as organisations may need to adjust them to achieve future success (Mirabeau and Maguire, 2014). The positions of ICT platforms within the market system, their services to other actors
technologies by farmers. These strategies are not fixed and dynamic and subject to change based on the needs and preferences of actors and competitive

services also evolve as ICT platforms lead new integration, reinforce existing relationships, abandon them, engage in new co-creation activities, provide additional services and enhance their own skills and resources (Giesler and Fischer, 2017; Layton, 2011).

Consequently, the strategies employed by ICT platforms are likely to be adaptive and subject to change over time.
2.3 Methodology

2.3.1 Research design and case selection

We applied a purposeful approach to select fitting cases for the four types of ICT platforms (Miles and Huberman, 1994), as indicated in Table 2.1. First, we conducted a desk search to develop a long list of smallholder-based ICT platforms in Uganda. The Ugandan context provides the most dynamic ICT platform community in sub-Saharan Africa, with more than 38 ICT platforms (GSMA, 2020). As such, Uganda provides an excellent context for identifying organizations fitting the ICT platform archetypes addressed in our study. We consulted policy documents and reports from the Ugandan government and development organizations to identify platforms for the long list.

Second, we reduced the number of platforms on the list by restricting our search to platforms that had been in operation for at least two years, that covered at least 2,000 farmers and at least one full region of the country, that targeted more than one major crop grown in the region and that used mobile-based and/or web-based technology. Third, we assigned the remaining platforms to the four cells of Table 1 and ranked them in order of fit according to the two dimensions of the table. We then approached the four highest-ranked platforms in the lists to invite them to participate in this study. All four platforms agreed (see Table 2.2 for descriptions of the four platforms).

### Table 2.2

<table>
<thead>
<tr>
<th></th>
<th>Input-information provider</th>
<th>Output-information provider</th>
<th>Input-market coordinator</th>
<th>Output-market coordinator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of the platform</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology used</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Focus region

- Northern region
- All regions
- Central and Eastern region
- Eastern region

### Target crops

- Soybeans, maize, sunflowers, sorghum
- All major crops grown in the region
- Maize, beans, potatoes, groundnuts
- Maize, beans, soybeans, sesame, groundnuts, rice, sorghum, etc.

### Number of beneficiaries

- 2,000 subscriptions
- 80,000 farmers registered
- 3,000 farmers registered

### Starting year

- 2014
- 2007
- 2015
- 2017

### Core services

- Provides agronomic and weather information, extension advisory services and profiles of input suppliers
- Disseminates commodity prices on more than 23 agricultural commodities
- Provides farmers with access to production inputs and support services
- Provides agronomy and weather information
- Links produce sellers (farmers) to buyers

### Other services

- Agricultural insurance
- Input microloans
- Value chain analyses
- Farmer profiling

### Business model

- Village agent model
- Market scouts
- Village agent model

### Language used

- Local languages of choice
- English
- English
- English

### Frequency

- On-demand
- Weekly
- On-demand
- On-demand

### Fees

- Free access
- Annual subscription access requires internet
- Orders paid through mobile money wallet
- SMS costs for registration and posting of offers

### 2.3.2 Data Collection

- Data were collected through interviews, observations, and desk research. We conducted primary data collection in two steps. The first step involved four key informant interviews with managers from the four platforms, who were typically responsible for general management decisions, operations, organizational structures and strategizing. Their job titles included Director and Senior Market Specialist (Table 2.4). To guide the interviews, we prepared an interview guide based on case-study concepts derived from our theoretical background and Yin (2013)’s approach to interviewing (see Table 2.3). The interview guide addressed approaches that the ICT platforms adopted to enhance farmers’ uptake of agricultural input technologies and their strategies in terms of services provided, network structures, actor roles in co-creation of value and expected strategic changes. We asked questions about the initial situation when the platform was first established and the current situation, including the reasons for any changes. Each interview lasted approximately one hour. The first round of interviews enabled us to map the larger actor networks of the platforms. We used this to approach people across...
different actors, including village agents, traders, NGO field officers and farmers (see Table 2.4 for the full list of informants).

In the second step, we purposively selected representatives from the actor-network of each case based on their experience with the platforms, gender diversity (to obtain insights from both genders) and knowledge about the platforms’ operations. We conducted 26 key informant interviews across the four cases, with six respondents from each of the first three cases and four respondents from the fourth case. The interview guide in this second round included questions on the respondents’ experiences with the ICT platforms, services they received, benefits and impact on their use of inputs (see Table 2.3 for example questions). Two categories of input technologies were explored to generate insights into input use. First, we looked at inputs for improved seed varieties, fertilizers and other agrochemicals (e.g. herbicides or pesticides). Given that such inputs often require different management practices, we also examined the use of better farm practices as a second category of input technologies.

When needed, people knowledgeable about the specific context of the cases and who could speak the local language were used as translators (e.g. Ingenbleek et al., 2013). Following Eisenhard (1989), all interviews were recorded after obtaining consent from the respondents. To triangulate the information obtained from the responses gathered from the primary source of information, we also collected information from field observations and materials derived through desk research from several secondary sources, including the websites and annual reports of the ICT platforms in the case studies. These sources were used to mitigate the risk of informant bias, control subjective and individual judgments, and enhance the findings’ validity (Gibbert et al., 2008).
Table 2.3

<table>
<thead>
<tr>
<th>Study concepts</th>
<th>Example Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Market system structure</strong></td>
<td>Wh at type of market actor or other stakeholders do you work with in the delivery of services you provide? Who are your reasons for working with them? How are the market actors aligned with each other? How do the services improve the alignment between market actors?</td>
</tr>
<tr>
<td><strong>Services provided by ICT platforms</strong></td>
<td>Wh at services do you offer to the various actors with whom you work? Why these services? How are they expected to contribute to farmers' uptake of agricultural input technologies?</td>
</tr>
<tr>
<td><strong>Value co-creation</strong></td>
<td>Wh at mutual benefits do actors realise from being connected to the platform? How does the platform facilitate problem-solving among the various actors? How does the platform involve users in the delivery of services?</td>
</tr>
<tr>
<td><strong>Uptake of agricultural input technologies</strong></td>
<td>Wh ich input s or practices accessed through the platform have you tried on your own farm, and why? Wh ich input s or practices are you currently using on your farm, and why?</td>
</tr>
<tr>
<td><strong>Expected strategic changes</strong></td>
<td>Wh at challenges do you currently face in providing services to different actors? In what ways would you solve those challenges? Ho w do you see your strategy changing about the solutions mentioned?</td>
</tr>
</tbody>
</table>

Table 2.4

<table>
<thead>
<tr>
<th>Cases</th>
<th>Study district(s) interviewed</th>
<th>Description of key informants interviewed</th>
<th>Location</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1: Input-information provider</td>
<td>Oumulimis Omaman and Lira</td>
<td>Director 1 - Kampala Male</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Case 2: Input-marketing coordinator</td>
<td>Ezey Agriapp Namutumba and Mukono</td>
<td>Director 2 - Ezey Agriapp Male</td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td>Case 3: Output-information provider</td>
<td>Soroti, Sereere, and Kampala</td>
<td>Senior Market Specialist 3 - Kampala Male</td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td>Case 4: Output-marketing facilitator</td>
<td>Kudu platform</td>
<td>Director 4 - Kampala Male</td>
<td>Female</td>
<td>Male</td>
</tr>
</tbody>
</table>

Chapter 2
2.3.3 Data Analysis

Data from all key informant interviews were transcribed verbatim, and personal identifiers (e.g. names) were removed from the transcriptions to protect the confidentiality of the participants. Several steps were taken to analyse the transcriptions. The first step involved thoroughly reading and rereading the transcriptions and other materials to familiarize with the dataset. We then analysed each case separately, following Eisenhardt’s within-case data analysis procedure, using the Atlas.ti software (Woods et al., 2016b).

To understand how ICT platforms led to improved uptake of agricultural input technologies by farmers, we first explored the strategies used by these ICT platforms based on the case-study concepts from the first round of coding: market-system positioning, services provided and value co-creation activities. This led to the following second-level codes, which were later developed into two sub-second-level codes: initial (at the start of the platform) and current. For each sub-second-order theme, codes were derived across the strategies used: market-system positioning, services provided and value co-creation services (see Figure 2.1 for the coding structure). To obtain insight into how the strategies in each case influenced the uptake of agricultural input technologies by farmers, we derived initial codes concerning uptake (e.g. ‘weed twice’, ‘now do row planting’, ‘use NPK’, ‘use foliar fertilisers’ and ‘use improved seed’), which were then grouped together to form broader categories (see the coding structure in Figure 2.1).

We then explored data on the future strategic outlook of ICT platforms and their expected strategic changes (see the coding structure for the codes derived). This generated insight into challenges faced by ICT platforms and suggested solutions leading to strategic changes.

Following Yin (2013), we then conducted a cross-case analysis to identify, compare and discuss cross-case patterns in the strategies used, the uptake of inputs by farmers and expected strategic changes.
2.4 Results

Figure 2.1

Chapter 2
2.4.1 Output Market Information Provider (Farmgain Africa)

Founded in 2007 by individual agricultural experts as a for-profit private business organization, Farmgain Africa offers agriculture-related services to various actors in agricultural value chains. Through a national market information platform, the organization explicitly positions itself between farmers and output market buyers (Figure 2.2). The national market information platform is intended to create transparency in output market prices and reduce transaction costs related to market search, thereby increasing farmers’ access to produce markets and incomes to support investment decisions. As such, Farmgain Africa’s philosophy revolves around creating transparency within output markets for farmers.

![Value chain diagram showing Farmgain's role in connecting input market companies, agro-input dealers, farmers, NGOs, government departments, radio stations, and market scouts to output market buyers.]

**Figure 2.2** Farmgain’s market positioning

To collect output-market information, the platform relies on produce dealers from the respective markets, referred to as ‘market scouts’.
The main service that Farmgain provides is the dissemination of commodity-price information for the major crops grown and sold to markets across the country. This information is shared with over 2,000 subscribing organizations in the form of reports, which the organizations then share with farmers. Thus, farmers depend solely on subscribing organizations for access to market information. In addition, the platform uses the market information it collects to offer agribusiness support services (e.g. value-chain analyses and business-plan development) for its subscribers and other non-subscribing organizations.

Results from the interviews with farmers and NGOs indicate that Farmgain co-creates value for its network of value chain actors through two ways. First, the use of produce dealers as data collectors ensures the collection of quality data that will be widely trusted by the subscribers while also providing an opportunity for produce dealers to earn additional income. As noted by Field Officer 3-

...we pay for the information because we trust the mechanism used by the platform to collect it.

Engaging produce dealers who also deal in some or all the commodities covered by the platform thus helps users to be confident about the quality of data delivered by the platform. As the Senior Market Specialist noted, ‘...the platform shares market trends that help us design interventions for farmers’.

Regarding input uptake, the interviews with farmers revealed that output-market information accessed through subscribing organizations increased their awareness about crops and varieties.

Second, using NGOs (e.g. Socadido) as intermediaries amplifies the platform’s coverage, helping many farmers make informed decisions concerning marketing and production. In addition, subscribing organizations use the information to support the agricultural interventions they extend to farmers based on crops for which there is high demand in the market. According to Field Officer 3-

...the platform shares market trends that help us design interventions for farmers.

Regarding input uptake, the interviews with farmers revealed that output-market information accessed through subscribing organizations increased their awareness about crops and varieties.
price information mainly increased the farmers’ use of other inputs (e.g., fertilisers), whereas

Farmer 3 indicated, ‘... Socadido provides us with extension advisory services to support our farming activities’.  

Farmer 2 noted, ‘... the problem is that we sometimes receive this information when the prices have already changed’.  

Therefore, as part of its future strategic changes, Farmgain plans to adjust its business model and directly offer more affordable output information to farmers, focusing on smaller profit margins but drawing on a larger pool of subscribers. In this regard, the platform’s Senior Market Specialist noted, ‘One of our plans is to make this information affordable and accessible for many farmers to benefit from our information in a timely manner’.  

In addition, the platform plans to add input information to its services, as noted by the Senior Market Specialist: ‘...we intend to add fertiliser prices to our portfolio to help address the problem of low fertiliser use amongst farmers’. It is interesting to note that providing information on input and output markets constitutes part of the company’s strategic objectives, as evidenced by its strategic documents. The platform is thus moving towards input markets to solve challenges associated with limited access to and low use of inputs by farmers.
2.4.2 Output Market Coordinator (AgriNet)

The Kudu platform was developed in 2017 by Makerere University as a research-design project, and it was operationalised in the field by AgriNet Uganda, a for-profit private company operating within agricultural value chains since 2012. The platform positions itself at the level of the output market, explicitly between produce buyers and farmers, using community-based village agents as intermediaries within the chain (Figure 2.3).

As explained by the director of AgriNet Uganda, the company aims to use its Kudu platform ‘...to help farmers access better markets beyond their social circles to help increase their incomes while enabling us to earn a commission on produce sold through the platform’. The platform also maintains relationships with various NGOs (e.g. CARD Uganda and Kilimo Trust) within its network to create awareness and mobilise farmers to use the Kudu platform. This mechanism registered more than 3,000 farmers in the first two years of its operation.

Figure 2.3

Emerging from the company’s experience in produce marketing at the time, many farmers were decriing a lack of markets for their produce, while the buyers were also decriing a lack of produce for their businesses. Director 4-1 recounted, ‘...you know, farmers were citing lack of...’
markets for their crops while buyers like me were saying they lack produce from the farmers, so we decided to bring these two together through Kudu. To bridge the gap and improve the access of farmers to produce markets, Agrinet deployed the Kudu platform—a virtual market that directly connects farmers to buyers through an automated matching mechanism that matches sales requests to offers based on crop, price, quantity and location, as submitted by farmers and buyers, respectively. Farmers and buyers post produce sales and offers to the platform in real-time using a simple-feature phone through the Unstructured Supplementary Service Data (USSD) code.

With its market positioning and the direct virtual matching of farmers to output buyers, Kudu co-creates value for its network actors in three ways. First, the platform offers farmers and produce buyers an avenue to sell and buy farm produce without incurring high transactional costs related to market search and transportation. Reduced costs improve market efficiency, enhancing gains for farmers and buyers. This was illustrated by Trader 4-1: ‘...and through the platform, we get linked to farmers who have the produce we want, without travelling long distances in villages looking for produce’.

Second, directly matching farmers to buyers eliminates intermediaries from the marketing chain, resulting in increased incomes for farmers. As explained by Farmers 4-1 and 4-3, ‘...with Kudu, we are linked to buyers who have already agreed to the prices posted with our offers, so in this way, we gain more, as the prices are better than before with intermediaries’.

Finally, using village agents as local intermediaries to oversee the physical transactions between farmers and buyers guarantees the transparency of transactions while providing an opportunity for village agents to earn income through commission. For instance, Farmer 4-1 noted that ‘...agents help to ensure that the physical exchange of produce and money between the farmer and buyer takes place according to the offers made through the platform without any problems’.

Observations made through the platform interface revealed that, since Agrinet operationalized ICT Platforms as agricultural value-chain coordinators...
Ku du u, more than 700 successful transactions have been completed among the 3,000 registered farmers. Village agents have complained of low levels of facilitation: ‘The commission we get is too low, and sometimes the work we carry is not paid for, and we end up spending our own money for the good of farmers’, Village Agent 2-1.

Results from key informant interviews indicate that the direct matching of farmers to output buyers through the platform has created certainty for farmers with regard to produce markets, which has subsequently influenced the use of inputs—especially the improved seed varieties—by most farmers. As Farmer 4-2 described, ‘Knowing what is marketable has helped us to use improved seeds to produce for the available market’. Similarly, Farmer 4-3 remarked, ‘...for example, we planted masavu beans [an improved bean variety] because that’s what the buyers are looking for on the platform’. As observed, farmers’ use of better farm practices was more strongly influenced by their interactions with other organisations than it was by the information on output markets, as noted by Farmer 4-3: ‘...we try to follow practices that are taught to us by the different extension officers from other CARD and local government’.

The company is beginning to rethink its strategies, as it realised that offering a virtual market alone is insufficient to improve production potential and incomes for farmers. Farmer 4-1 indicated: ‘We would like to produce more for the available markets, but we need credit to buy inputs that can improve our production’. In the same vein, Director 4-1 explained, ‘...constrained financially; maybe in the future, this is something we can add...’. Despite these challenges, AgriNet’s plans include moving towards input markets and potentially coordinating the entire value chain.
2.4.3 Input Market Coordinator (Ezy Agric app)

The Ezy Agric app was developed in 2015 by the Akoriion Company LTD, a for-profit agricultural company involved in the digitization of agricultural value chains. The company startup was supported by Chemonics, which implemented the Commodity Production and Marketing (CPM) activity of the Feed the Future Uganda programme. As Director 2-1 explained, ‘Chemonics helped us develop our idea into a product best fit for the Ugandan and African Market’.

The main goal of the Ezy Agric app was to provide farmers with various production and marketing solutions. Ezy Agric initially positioned itself between farmers and agro-dealers/input suppliers to improve farmers’ access to and use of production inputs to enhance farm productivity. To this end, the company incorporated the e-VAM (Electronic Village Agent Model), a service-delivery model in which young people are employed as village agents and equipped with smartphones to conduct last-mile delivery of inputs and to gather data from farmers (Akoriion 2016 report). Using Ezy Agric, village agents capture demographic, production, input and product-supply data on farmers, and they use GPS to map the cultivated land. With these digital farmer profiles, Akoriion aggregates input demands to negotiate good prices from vetted suppliers of genuine agro-input products, as observed from the company’s strategic document.

Through the app, individual farmers access a wide range of agro-inputs (e.g. improved seeds, fertilizers, chemicals and sprayer) previously inaccessible to most farmers in rural areas. As illustrated by Farmer 2-1, ‘...with Ezy Agric, we can now order inputs, and the village agent will deliver them without travelling to town’.

The platform manages and processes input orders placed by farmers for last-mile delivery to farmers’ doors through its e-VAM network. The company’s revenue consists of a commission on each sale.
Institutions and other stakeholders to its network (see boxes and arrows shaded orange in Figure 2.4). This was intended to close the knowledge gap concerning production and enable farmers to access other professional services relating to farm production that were currently lacking.

For instance, as indicated by Director 2-1, ‘From the experience, we realised that farmers lacked knowledge on how to use these inputs, so we added agronomic information and production-related services’.

After expanding its network to include more actors, including a research organisation and agricultural service providers (some trained by the company), Ezy Agri now offers additional services, including production information (e.g., real-time weather information) and professional production-support services (e.g., land measurement, soil-type testing, and spray services) that support overall farm production.

Figure 2.4  

With its market positioning and the services it offers, Ezy Agri co-creates value for its actors in four ways. First, it allows agro-input suppliers to sell a variety of inputs while enhancing farmers’ access to the needed inputs. Second, the platform...
Institutions as outlets through which to communicate their research-based knowledge to a wider farming community, with more than 80,000 farmers profiled (at the time of this study) as receiving extension services from the app, supported by village agents. Third, the use of a two-way communication channel involving a smartphone-based app allows farmers to access inputs and production information, as well as photograph their farms in order to receive timely advice on diseased or affected plants. Such a mechanism enhances interactions and problem-solving for farmers.

Finally, using village agents as intermediaries between the platform and farmers provides a human face in offering registration support, on-the-spot advisory services and last-mile delivery of input and production-related services to farmers. As Director 2 noted, ‘...we earn on a commission basis; the more orders farmers make, the more commission we get from the agro input suppliers, which we also share with the agents’ services that enhance farmers’ access to and use of inputs. As we observed, however, the commission system for remunerating village-based agents was inadequate to maintain them in their roles. More than four of the village agents we contacted had abandoned their roles, citing low levels of facilitation.

As indicated by our results, additional services resulting from the change in the platform’s positioning improved the awareness of farmers concerning the benefits of inputs and how to use them. Information gathered from field interviews suggests that farmers’ use of inputs improved when they received production information and other related services provided by the app. For instance, Farmer 2 noted, ‘We knew we could get inputs from the app, but using them was a challenge. With information on the app, we can now use the inputs correctly in the garden’. In addition, Farmer 2 indicated that ‘...some of these inputs require one to know how to measure land and apply them, which was a problem, and now we have land mapping services...’.
which we can use to know how much of the inputs to use. As stressed by Farmer 2-1, ‘I planted the improved seed I bought from the app after knowing how much to plant in my land acre without wasting the seed’.

As illustrated by the quotations from the farmers presented above, additional services enhanced the use of inputs by farmers due to the improved knowledge on inputs and related services they had accessed from the app. These findings are consistent with observations made in farmers’ fields, which revealed gardens planted with improved maize and bean varieties. While access to production knowledge improved farmers’ use of better farm practices, such improvements were also influenced by the low capital required for farm practices. As indicated by Farmer 2-4, ‘We now know how to use these practices, and it is easy for us because they don’t require much money’.

As shown by observations made in farmers’ fields, farmers usually planted in rows to ease weeding and clear garden boundaries in order to control weeds. While the coordination of various services by the platform increased the use of inputs by some farmers, uptake decisions were still constrained by limited access to microcredit, the unaffordability of smartphones and the high cost of internet data required to access and use the app. In addition, it was observed that using a smartphone made farmers dependent on the village agents to order inputs and other services. This is because many farmers did not own a smartphone, and those who did, could not navigate the interface or could not afford internet access. The company recognises these challenges and plans to revise its strategy accordingly.

As noted by Director 2-1, ‘...we are in discussion with bigger banks on providing microcredit to farmers, we also know that produce markets are key for farmers to gain from their farm production and invest in inputs, so we are now looking into how to bring output buyers onto the app.’ In doing so, the platform is moving towards incorporating output markets and coordinating the entire value chain.
2.4.4 Input Information Provider (M-Omulimisa)

Founded as an agricultural company by two individuals in 2014 to provide agriculture-related services, M-Omulimisa initially positioned itself between research organisations and farmers to address the production knowledge gap among farmers. Learning from the experiences of farmers, especially with regard to changing weather patterns, M-Omulimisa added the Agriculture Insurance Consortium (AIC) in 2016 through a broker partnership to help farmers manage agricultural risks related to weather shocks while earning commissions from the sale of agricultural insurance. At the time of the study, the platform had just expanded its network to include a microcredit institution (Microfinance Support Centre) and various input companies to complement its production-related knowledge in order to stimulate farmers’ access to and use of inputs. As recounted by Director 1–1, ‘...we partnered with Microfinance Support Centre to help farmers access inputs on credit and remove the problem of limited cash flow for farmers’.

The platform thus started by focusing on one point of the uptake barriers and moved to address a variety of uptake barriers, as shown by the orange-shaded boxes and arrows in Figure 2.5.

**Figure 2.5** Market positioning of M-Omulimisa

![Diagram showing market positioning of M-Omulimisa](image)
M-Omu offers customized agronomic information to farmers using simple mobile phones through the Unstructured Supplementary Service Data (USSD) code to bridge farmers’ gaps in knowledge and information concerning inputs. In addition, the platform aggregates the input demands of farmers to help input suppliers plan and stock the inputs required by farmers.

Consistent with the changes in its market positioning, the platform now provides additional services, including highly subsidized weather-index-based crop insurance to individual farmers, accessed and paid through a mobile money wallet. Furthermore, the platform now manages a low-interest micro-loan scheme based on farmer groups.

By the time of the study, the platform had registered more than 20,000 farmers receiving various ICT-based agriculture services, including e-extension, weather-index-based crop insurance, agricultural-input loans and input delivery.

Results from key informant interviews revealed that the platform co-creates value for its actor network in five ways. First, it offers an outlet for research institutions to communicate their research-based knowledge to a wider farming community than would be possible using face-to-face services. One of the platform’s research partners confirmed this finding, highlighting the platform’s role in scaling agricultural technologies among farmers.

Second, the two-way communication channel using a user-friendly, simple-phone-based USSD code enables farmers to seek and receive on-the-spot extension advice cost-effectively and non-time-consuming.

For example, as Farmer 1-2 indicated, ‘...we can ask and get responses on our phones without travelling to access it’.

Third, by aggregating input demand and managing the micro-loan scheme, the platform provides farmers with access to inputs on low-risk credit. At the same time, it provides agricultural-input dealers...

---

face on the platform’s operations. These agents assist farmers (especially those who cannot use
their own phones) with registration, on-the-spot advisory services, microloan applications and
last-mile delivery of inputs. Their role is incentivised through commission. As indicated by
Village Agent 1-2, ‘When input loans are approved and inputs delivered, we are able to earn
a commission from each group that has received input loans, although it’s not enough for the
work we do’.

The provision of customised production information by SMS increased the farmers’ use of
better farm practices (e.g. timely planting and row planting) in response to the
recommendations provided by the platform. As Farmer 1-3 explained, ‘because of the
information we get, we conduct our farm operations in time and use improved farm practices’.

Interestingly, the improved use of better farm practices could also have been influenced by
the low cost of capital required to use them. In addition to using better farm practices, farmers
became more aware of improved seed varieties and fertilisers due to the platform’s input
information and extension advisory services. For instance, Farmer 1-1 noted, ‘Because of the
information we get from M-Omulimisa, we now know what inputs to use to increase our yields’.

Similar findings were observed in M-Omulimisa’s project progress report for 2018, indicating
that farmers’ knowledge of inputs had increased because of production information shared
through mobile phones.2

2 www.m-omulimisa.com
Further more, while production information increased awareness of input technologies, integrating input microloans as a complementary service boosted the use of inputs. As Farmer 1-4 indicated, ‘Most of us have started using the improved seed because of the input loans we get through M-Omulimisa’.

This sentiment was shared by Village Agent 1-1: ‘We see that the use of improved seed by farmers is increasing due to input loans accessed through M-Omulimisa’.

Whereas introducing a group-based micro-loan scheme improved the farmers’ use of inputs, its coverage remains low. In addition, the long application processes limit access to only a few farmers. M-Omulimisa plans to change its credit access strategy to address the bureaucratic application processes. Director 1-1 explained, ‘...but discussions are underway for digitalising the whole process to quicken access to these loans’.

Similarly, the platform plans to develop an app that will facilitate direct access to inputs and outputs by farmers, thereby improving input and output linkages. As noted by Director 1-1, ‘We also plan to develop an app that can allow individual farmers to order and pay for their own inputs directly, and to access various produce buyers on the app’.

The platform is thus moving towards output markets and the coordination of the entire value chain.

2.4.5 Case comparison

In this section, we compare the cases based on the platforms’ overall strategies to improve farmers’ uptake of agricultural input technologies. We do this by exploring similarities and differences in market positioning, services provided, and co-created value, and how these variations drive small holders’ uptake of agricultural input technologies (see Table 2.5). We also explore the platforms’ expected strategic changes in order to investigate their outlook on the coordination of diverse actors, service linkages and value co-creation in the further improvement of the uptake of input technologies by farmers.
Market system positioning

All of the ICT platforms included in this study sought to solve barriers that affected farmers’ uptake of input technologies by positioning themselves at different intersections within the market system: between buyers and farmers (Farmgain Africa and Kudu); and between research organisations and farmers (Mishin and Omulimi). Learning from their own experiences and realising that farmers’ input use could not be solved by focusing exclusively on one point of the barriers, some platforms started to co-evolve by moving from their initial positioning towards positions where they could solve the various barriers to uptake. The input market-based platforms changed their market positioning from information access to input linkage and vice versa.

Although we did not observe a similar change in positioning for the output-market platforms, they are still planning to move in the future based on their expected strategic changes. The changes in market positioning for the ICT platforms support the increasing notion that farmers’ uptake of input technologies cannot be solved by focusing exclusively on the coordination of inputs or the provision of information relating to inputs. Solving the uptake barriers thus requires an integrated value-chain approach in which both input and output markets and related services (including financing) are addressed simultaneously.

Services provided by the platforms

The services provided by the ICT platforms are consistent with their market-system positioning, including the changes that some of the ICT platforms had made. For instance, the input information provider added the management of the group-based input microloans to its range of services, while the input market coordinator added custom production information. The addition of such services demonstrates that, as service ecosystems, ICT platforms are adaptive in nature, changing with the constraints, needs and opportunities existing...
within the market system. Such changes largely eliminated barriers that hindered farmers from adopting production-increasing technologies.
<table>
<thead>
<tr>
<th>Concepts</th>
<th>Output-market coordinator (Kudu platform)</th>
<th>Output-information provider (Farmgain Africa)</th>
<th>Input-market coordinator (Ezy Agric app)</th>
<th>Input-information provider (M-Omulimisa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market-system positioning</td>
<td>• Limited improvement in farmers’ use of input supplies to address farmers’ knowledge and stimulate farmers’ access to and use of information.</td>
<td>• Limited improvement in farmers’ use of inputs and better farm practices.</td>
<td>• Initial positioning led to limited improvement in farmers’ use of inputs.</td>
<td>• Change in positioning increased farmers’ use of inputs and better farm practices.</td>
</tr>
<tr>
<td>Services provided</td>
<td>• Limited improvement in farmers’ use of input suppliers to address farmers’ knowledge and stimulate farmers’ access to and use of information.</td>
<td>• Started with services that enhance farmers’ access to and use of information.</td>
<td>• Started with services that enhance farmers’ access to and use of information.</td>
<td>• Started with services that enhance farmers’ access to and use of information.</td>
</tr>
<tr>
<td>Value co-creation activities</td>
<td>• Limited improvement in farmers’ use of input suppliers to address farmers’ knowledge and stimulate farmers’ access to and use of information.</td>
<td>• Started with services that enhance farmers’ access to and use of information.</td>
<td>• Started with services that enhance farmers’ access to and use of information.</td>
<td>• Started with services that enhance farmers’ access to and use of information.</td>
</tr>
<tr>
<td>Uptake of input technologies</td>
<td>• Limited improvement in farmers’ use of input suppliers to address farmers’ knowledge and stimulate farmers’ access to and use of information.</td>
<td>• Started with services that enhance farmers’ access to and use of information.</td>
<td>• Started with services that enhance farmers’ access to and use of information.</td>
<td>• Started with services that enhance farmers’ access to and use of information.</td>
</tr>
<tr>
<td>Expected strategic changes</td>
<td>• Limited improvement in farmers’ use of input suppliers to address farmers’ knowledge and stimulate farmers’ access to and use of information.</td>
<td>• Started with services that enhance farmers’ access to and use of information.</td>
<td>• Started with services that enhance farmers’ access to and use of information.</td>
<td>• Started with services that enhance farmers’ access to and use of information.</td>
</tr>
</tbody>
</table>
Value co-creation activities

Integrating resources from several actors is one of the value co-creation activities in which all platforms were engaged. For example, NGOs played a role in exchanging market information, creating awareness and providing extension advisory services to farmers. Similarly, the use of intermediaries (e.g., village agents and market scouts) allowed the platforms to have an on-site presence and a human face to increase interaction with farmers and other actors while providing insight into the needs and challenges within their networks. Such insight enhanced the efficiency with which the provision of services was aligned with these challenges and needs while providing earning opportunities for intermediaries (either through commission or wages), thereby contributing to youth employment in the country.

The use of a two-way communication channel by the input-information provider and input-market coordinator allowed farmers to interact directly with the platforms and seek on-the-spot advice concerning urgent challenges (e.g., pests and diseases). Such interactions enhanced joint problem-solving and reduced the risk of downtime to solve problems in the market, thus enabling farmers to make informed production decisions. Such a mechanism suggests that these platforms obtained new insights that allowed them to add value for farmers, as evidenced by their changes in market positioning.

The provision of on-demand access to information and other services by the output-market coordinator, input-market coordinator and input-information provider enhanced timely production decisions by farmers, compared to the case of the output-information producer, which involved access to information on a weekly basis. In addition, the use of preferred local languages by the input-information provider enhanced the farmers’ interaction with and understanding and use of information, compared to cases in which English was the only medium of exchange. Similarly, the use of simple phones by the output-market coordinator and input-information provider improved the platforms’ usability for farmers, compared to the
ICT Platforms as agricultural value-chain coordinators

Uptake of agricultural input technologies

Our findings demonstrate that agronomic information provided by the input-market cases (M-Omu limisa and Ezy Agric) enhanced the uptake of improved practices that do not require a financial investment. In contrast, improvements in the uptake of inputs that do require capital (e.g., seeds and fertilizer) did not occur until the input-information provider added low-risk input microloans. On the other hand, the output-market cases (FarmGain and Kudu) improved farmers’ use of improved varieties of seeds that were in high demand in the market, but had no effect on the use of other inputs (e.g., fertilizer) or on the use of improved farm practices. The latter improvements did not occur until other organizations complemented the platform with information on such practices. In addition, in the input cases (M-Omu limisa and Ezy Agric), the change in the market positioning of platforms to address various challenges faced by farmers also enhanced their uptake of agricultural inputs over time, as compared to the platforms that remained at their initial positions (FarmGain and Kudu).

Expected strategic changes

While improvements in the use of inputs and farm practices could be observed across several cases, uptake barriers remained in both input and output markets. This made it necessary for ICT platforms to adapt their strategies to solve these barriers. Albeit at varying speeds and points of integration, all of the ICT platforms in this study were moving towards the same model of value-chain coordination to bring on board both input/output actors and supporting services. Moreover, our findings indicated that incentivizing intermediaries (e.g., village agents), who play a crucial role in actor networks, remains a challenge requiring attention from the platforms.
Chapter 2

The four cases in this study illustrate different strategies that ICT platforms use to improve the uptake of agricultural inputs by farmers. Based on this analysis, we outlined the pathways that ICT platforms take to do this (Figure 2.6). As evidenced by their expected strategic changes, all of the ICT platforms had begun departing from their initial positioning in the market to converge towards becoming future coordinators of the value-chain ecosystem. These ICT platforms are expected to adopt an integrated value-chain approach to providing related services.

Figure 2.6 Pathways for ICT platforms in improving the use of agricultural-input technologies by farmers

2.5 Discussion And Implications

...
restricted to their original strategies, as evidenced by their dynamic positioning within the market system, their services and the value they co-create in order to improve the use of input technologies by farmers.

These results suggest that, although there are different points of departure for the development of ICT platforms in smallholder agriculture, the endpoints are likely to be the same if they are to address the challenges faced by smallholders. The strategic changes that the ICT platforms made as they departed from their initial positioning to converge towards becoming value-chain coordinators indicate that ICT platforms recognise that farmers face a wide variety of uptake barriers that should be addressed simultaneously.

Our findings logically connect to several lines of literature. As indicated by previous research on value chains, improving the use of inputs by farmers requires linking to both input and output markets simultaneously to resolve the barriers to uptake (Mishra and Dey, 2018). To this knowledge, our findings add that this insight apparently implies that, sooner or later, ICT platforms stand to gain by changing their roles, positioning and activities. As such, they go through a learning process— as emphasised by the literature on organisational learning—thus suggesting that new insights lead to changes in organisational forms, strategies and practices (Santa and Nurcan, 2016). Through such processes, ICT platforms evolve into new roles, as discussed in the literature on human evolution (Seabright, 2010; Wilson, 2020).

2.5.2 Practical implications

The current study has three primary implications for ICT platform managers, policymakers, development partners and other organisations seeking to improve access to and use of ICT Platforms as agricultural value-chain coordinators.
First, ICT platforms can stimulate learning and induce dynamic responses regardless of how they began. They should learn from each other and adapt their strategies to create greater impacts on farmers’ uptake of input technologies, thereby benefiting the entire agricultural sector. A platform that avoids change or learns too slowly risks becoming redundant within the network. This study envisions the creation of business ecosystems that focus on the co-creation of value through co-production service offerings that provide the competitive advantage that ICT platforms need in order to stay in business. Those in need of such an advantage should broaden the range of services they offer, acquire new skills and knowledge, and reduce costs by engaging in cost-sharing collaborative arrangements with other actors within the market system.

As a second implication of our study is related to the network perspective on which it is based, which encompasses interventions relating to information provision and coordination. This perspective is broader than those adopted in many educational programmes for agricultural business managers. Our study thus warns that an overly narrow disciplinary perspective can lead ICT platforms to overlook important market developments and avoid taking on coordination roles that could potentially increase their impact. In other words, learning to coordinate requires a disciplinary basis that should be taught effectively in educational programmes for managers of ICT platforms, as well as throughout the value chain.

Third, to accelerate development towards platforms that encompass the entire value chain, platforms could join forces through mergers and acquisitions and/or form an industry organization that facilitates learning and harmonization. This implication is particularly applicable to countries with relatively dense networks of ICT platforms, like Uganda. An industry organization could help manage the learning processes across the various ICT platforms in order to create new innovations (Cerchione et al., 2016; Gorry, 2016) and work towards leveraging resources and knowledge exchange (Hernández-...
2.5.3 Limitations and Direction for Future Research

First, while our results are fairly consistent across the different cases, the pattern that we find in our study is based on one case for each archetype. As such, these findings may be interpreted as theoretically, but not empirically generalizable (Yin, 2009). Second, our data were gathered in Uganda, a country with one of the highest numbers of ICT platforms in Africa. Replications in other countries with fewer platforms are likely to find less interaction between platforms and lower learning processes. As such, the patterns revealed in our study may take longer to become identifiable in other contexts, if they appear at all.

Future research may also generate more formal evidence of relationships between ICT platforms and smallholder adoption of production technologies. In our study, we addressed such effects only in a qualitative manner. More formal studies assessing different pathways could further test these effects while incorporating important insights from the current study. Finally, future studies could examine the perceptions of smallholders of the ICT services provided to them. Our study showed that learning on the part of ICT platforms regarding orientation towards users (farmers) is essential to stimulating uptake of inputs. As such, there may be many micro-level barriers (e.g. interface design and service marketing) that impede ICT platforms from helping to stimulate uptake, but that may be overlooked by managers who consider only strategic aspects, as discussed in the current study.

2.6 Conclusion

ICT Platforms as agricultural value-chain coordinators
adapted their original positioning claimed more success in improving farmers’ uptake of inputs
Chapter 3

Actor needs in ICT platforms for smallholder agricultural value chains - A case in Uganda

This chapter is submitted as: Connetie Ayesiga, Esther Ronner, Peter Ebanyat, and Paul T.M. Ingenbleek. Actor needs in ICT platforms for smallholder agricultural value chains - A case in Uganda.
Abstract

Information and communication technology (ICT) platforms are often seen as an effective way to organise and coordinate small holder-based agricultural value chains. According to empirical evidence, however, most current ICT platforms are technically oriented, and they tend to neglect users’ needs in the design of ICT services. When platforms do consider the needs of users in their design, they tend to focus solely on the needs of smallholder farmers while largely neglecting those of other actors within the value chain. Based on focus group discussions and interviews, this study explores ICT service needs and preferences for interface design features for small holder-based value chain actors to derive potential synergies, trade-offs, and solutions based on the case of the M-Omu lìmi is a ICT platform in Uganda. While findings show that many value chain actors have similar needs for ICT services, some needs and preferences for interface design features differ between actors and, in some cases, they even contradict each other. In light of these contradictions, ICT platform managers must first prioritise needs that cut across all value chain actors and make trade-offs concerning whose needs they consider most important. This study provides practical implications for ICT platforms to keep all value chain actors on board and contribute to the development of small holder-based agricultural value chains.

Keywords: ICT4D, small holder-centred design, digital innovations, ICT services, synergies, trade-offs, agriculture, Africa
3.1 Introduction

In the past decade, large-scale investments in the Information and Communication Technology (ICT) infrastructure in Sub-Saharan Africa have profoundly enhanced access to and use of mobile phones and internet among smallholder farmers (World Bank, 2018). This has led to the development of ICT platforms in smallholder agriculture (Wyche and Olson, 2018). In the smallholder agriculture context, ICT platforms refer to mobile and web-based digital bases that integrate multiple interfaces and applications such as Short Messaging Service (SMS), video, and audio for different users, including farmers and input suppliers (Kiété et al., 2021). By offering different applications, ICT platforms provide opportunities for improving the efficiency of smallholder-based agricultural value chains (Joekyna, 2022a).

As part of these efforts, increasing emphasis is being placed on the roles that ICT platforms could play in improving access to and the use of agricultural inputs among smallholder farmers, thereby contributing to solutions for increasing farm productivity and food production for the growing population in Africa (World Bank, 2017; McGuire & Sperling, 2016).

The existing literature has identified potential benefits of ICT platforms with regard to strengthening the use of agricultural inputs by smallholders. As argued by (2017), ICT platforms enhance farmers' access to low-cost and real-time information on agricultural inputs and farm practices, thereby increasing awareness about and the use of agricultural inputs. Several authors indicate that ICT platforms enhance farmers' access to value chain services, including micro-loans, extension services, insurance, and output markets, thereby increasing opportunities for access and use of agricultural inputs (Cole and Fernando, 2016). Other studies, such as conclude that ICT platforms could help overcome spatial barriers and reduce transaction costs, which subsequently increases actors' needs for ICT services.

Chapter 3

Actors’ needs for ICT services

60
farmer profits that smallholders could invest in agricultural input technologies (Graham, 2018).

Despite these potential benefits, the uptake of ICT platforms among smallholders remains low. According to existing evidence, even many farmers sign up for ICT services, no more than 30% actively use them (Goedegebuure et al., 2021; Krell et al., 2021; Tsan et al., 2019; Tinnwele et al., 2020; McCamell et al., 2021a; Munthal). Limited innovation capabilities, due to a limited focus on the market; a lack of awareness about the services offered by the platforms; and/ or the inability to afford (smart)phones or internet access (Matto, 2018) are among the barriers that smallholders face. Various studies have addressed the design challenges of ICT platforms. For instance, Chiputwa et al. (2022) conducted workshops to collect agricultural information and forecast indicators from farmers and codevelop a digital interface that meets the needs and expectations of the users. Agyekum et al. (2020) used multistakeholder and focus group discussions to identify the challenges and needs of smallholders to design a smartphone-based farm monitoring app that overcomes literacy and language barriers. In addition, Ortiz-Crespo et al. (2020) elicited feedback from farmers and extension agents in Tanzania to create a logo (McCamell et al., 2021a; Smidt and Jokonya, 2022b; Steinke et al., 2021).
in smallholder agriculture and the platforms’ economy at large typically requires more complex design in a single set of services intended for multiple independent clients in the network.

For the smallholder context, these clients include value chain members (e.g., input providers, output buyers, and perhaps microfinance and insurance providers). These actors can all make use of and add to the platform’s information base. They may also extend the function of the platform from information provision to allow farmers to make input purchases and offer their produce for sale. The design of such typical platform services has yet to be addressed in the literature. Such knowledge is nevertheless important and relevant, as neglecting the needs of value chain actors may lead them to withdraw from platforms, thus creating gaps in other services that ICT platforms can provide, and ultimately undermining the very existence of the platforms.

In this study, we explore the needs of farmers and other key actors in smallholder-based value chains with regard to ICT services. To this end, we adopt a user orientation, as derived from the New Service Development (NSD) process (Lindh and Norrman, 2018). Given that access to and the use of ICT services depend in part on interface design features (Agyekum et al., 2020; Coggins et al., 2022; Krell et al., 2021), we also explore preferences for various features of ICT interface design. More specifically, we investigate potential synergies and trade-offs between the needs and preferences of various actors and propose solutions for these trade-offs.

Our study was guided by the following research questions: (I) What are the needs and challenges faced by various value chain actors with regard to ICT services? (II) Which preferences do value chain actors have with regard to ICT interface design features? (III) Which actors’ needs for ICT services
Chapter 3

3.2 Background

3.2.1 Challenges in smallholder-based agricultural value chains in sub-Saharan Africa

This study contributes to the literature on the use of ICTs amongst smallholders in three ways. First, previous studies have focused largely on integrating the needs of smallholder farmers into the design of ICT services (e.g. Gbango et al., 2020). Our study extends this literature by showing how ICT service design can deliberately integrate the needs of other actors within the value chain as well. Second, this study identifies synergies and trade-offs in the needs of various actors within the smallholder value chain with regard to ICT services, as well as in their preferences for ICT interface design features. This generates insight into important aspects of services and interface design features that developers of ICT platforms should consider when redesigning their platforms to address challenges faced by a variety of actors within the value chain. Third, the study explains how the design of ICT services can entail trade-offs between the needs and preferences of value-chain actors. The insights generated by this study could help managers design their platforms in order to increase the use of ICT services amongst smallholder farmers and other value-chain actors in Uganda and elsewhere.

The remainder of the paper is organised as follows. In the next section, we present the relevant background of the study. We then provide an overview of the methods and results, followed by the implications of the results and our conclusions.
buyers, wholesalers/traders, extension agents and service providers, such as microloan banks and, in some cases, insurance companies (Agyekumhene et al., 2020). Several authors have highlighted the many challenges within smallholder-based value chains in Sub-Saharan Africa that could explain the persistent low rates of productivity at farm level. These challenges include drastic variations in weather conditions, which affect farm production and the produce supplied (provided by both public and private extension systems, which fail to cover all farmers, and technologies).

Furthermore, there are often few input suppliers and output buyers (e.g., Ingenbleek et al., 2013). Even when they are present, they are likely to have difficulty reaching farmers, due to high operating costs resulting from poor road infrastructure.

Moreover, poor infrastructure (including digital infrastructure) tends to limit the access of farmers to information and markets for inputs, outputs, credit and other production-related services and resources (Brown et al., 2018). This significantly increases the cost of production and makes farming unprofitable (Gerreff and Fernandez-Messina, 1999), reducing investments in input technologies by farmers.

Furthermore, the activities of actors within the value chain (e.g. production, marketing, addition of value) are often uncoordinated, with information gaps and lack of transparency in market uncertainties for both buyers and sellers, resulting in a lack of produce markets and low income for smallholder farmers. Given their upstream position, these farmers are more vulnerable to exploitation by better-informed value chain actors, such as intermediaries and agro-dealers (Orr, 2018).
As argued by several studies, ICT platforms within the agriculture sector could address some of these challenges in an efficient way. For instance, Deichmann et al. (2016) argue that ICT platforms can eliminate asymmetries in agricultural information and increase production knowledge through new ways of providing extension services (e.g., delivering production messages through mobile telephony). As demonstrated in studies by Foster and Graham (2017) and Kron and Dannenberg (2018), ICT platforms can eliminate existing market barriers by linking farmers to buyers and input suppliers in a cost-effective and time-effective manner.

Furthermore, studies by Campion (2018) and Abdullahi et al. (2021) highlight how ICT platforms can empower smallholder farmers to access better financial services and take better farm decisions. Other studies have concluded that ICT platforms can provide customized financial products that meet the distinct needs, preferences, and capabilities of farmers (GSMA, 2020; Joiner and Okeleke, 2019; Steinke et al., 2021).

3.2.2 Identification of needs and preferences for ICT services

One example of a user-driven approach is ‘user-centric design’, which guides the design of services that match the needs and context of users. Within the context of smallholder-based value chains, smallholder-centered design could be regarded as a specific case of the user-centric design approach that places the perspectives of smallholders and the actors with whom they interact (Edman et al., 2014, p. 109). Service design involves understanding the experiences of users and using this information to systematically improve the attributes and features of the services offered, thus resulting in successful new services. Such design thinking has led to the use of user-driven and participatory approaches to innovation in service development (Wetter-Edman et al., 2018).
3.2.3 The role of interface design features

Despite the critical necessity of addressing the ICT service needs of actors within the value chain, the ICT4D literature discusses the importance of considering interface design features to enabling users to access service innovations (Agyekumhene et al., 2020; Coggins et al., 2022; Krell et al., 2021). Interface design features refer to hardware and software (e.g. voice, icons, text support, phone type, operating system, language) that enable users to access and use the services provided (Ahmed et al., 2019). It has been argued that the involvement of users in
interface design can improve the fit between interface design features and the service needs of users (Ojasalo et al., 2015). This is because, even if ICT services are well-designed, their optimal use depends on the user-friendliness and usefulness of the interface design (Costopoulou et al., 2016).

The design of widely accepted ICT services, similarities or differences across actors with regard to the desired services and interface design features could potentially lead to synergies and trade-offs (Edward Freeman, 2010; Freeman, 1984). Within the context of this study, synergies refer to derived similarities in needs that may benefit all actors and enhance the use of ICT services. In contrast, trade-offs involving the exchange of one thing in return for another (Cord et al., 2017). In the case of ICT (Turkelboom et al., 2015). For instance, one actor may need data to fulfil specific goals, whilst another may be reluctant to share such information, due either to a lack of understanding with regard to the purpose of the ICT services and the interconnectedness of actors along the value chain or genuine privacy concerns. If they are not addressed in the design, such decisions may result in changes in attitudes towards or perceptions of the use of ICT services by actors (Deng et al., 2016), thereby affecting usability and, ultimately, the potential ICT platform to the development of smallholder ICT platform.

3.3 Methods
3.3.1 Study approach and context
We conducted a qualitative study to explore the needs and preferences of actors within the context of their
Actors’ needs for ICT services

3.3.2 Data collection

We conducted focus group discussions (FGDs) with farmers and key informant interviews (KIIs) with other value-chain actors to derive in-depth insights into the challenges, needs, and preferences of actors within the value chain.

referred to as ‘experience-led evolution’. To this end, the platform offers a context that
preferences of these actors with regard to ICT services and interface features. Our objective was to investigate synergies and trade-offs. The FGs yielded insights into the experiences and contextual information of small holders and helped to identify their needs and preferences (Yin, 2013). The KII with buyers, input suppliers, village agents and non-governmental organizations helped us to derive individual insights specific to the roles and services they provide, in addition to learning the unique perspectives emerging from their environments with regard to the design of ICT services (Krueger, 2014). Collecting data from various types of actors helped to validate responses from the various categories of respondents. In all, we conducted 12 FGs with farmers and eight KIIs interviews with other value-chain actors.

To guide the FGs and KII s, an interview guide was developed (following Yin, 2013), based on the study concepts derived from our conceptual background, and covering major questions specific to the category of respondents (Table 3.1). The questions were designed (1) to investigate the challenges that participants perceive within the value chain and (2) to elicit the needs and preferences of participants with regard to ICT services and interface features. These insights helped to identify potential synergies, trade-offs and solutions. The questioning sequence started with an introductory question intended to facilitate free, open dialogue amongst participants, as recommended by Krueger (2014). Once the respondents were comfortable with the topic and had settled into the discussion, several transitional, key and closing questions were asked. During the initial and subsequent interviews, we applied the guide with flexibility, incorporating unanticipated questions that needed further probing as we went along.
### Table 3.1: Study concepts with example questions used with key informants and smallholder farmers

<table>
<thead>
<tr>
<th>Concepts</th>
<th>Example questions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>What challenges do you currently face in your farming or business activities?</td>
</tr>
<tr>
<td></td>
<td>How do these challenges affect your production/business?</td>
</tr>
<tr>
<td></td>
<td>Which options are available for resolving some of the challenges?</td>
</tr>
<tr>
<td></td>
<td>Is there a way in which ICT platforms could resolve your challenges?</td>
</tr>
<tr>
<td></td>
<td>If yes, in what ways?</td>
</tr>
<tr>
<td>Service needs</td>
<td>Have you ever registered for M-Omulimisa?</td>
</tr>
<tr>
<td></td>
<td>If yes, what type of services do you receive from the platform?</td>
</tr>
<tr>
<td></td>
<td>Do you face any challenges in accessing the platform?</td>
</tr>
<tr>
<td></td>
<td>What types of services do you require from the platform to resolve your challenges and improve your production/service delivery/business across the value chain?</td>
</tr>
<tr>
<td>Preferences</td>
<td>How would you like to access such services from the platform?</td>
</tr>
<tr>
<td></td>
<td>How often would you want to access the services?</td>
</tr>
<tr>
<td></td>
<td>In which languages do you prefer to interact with the platform?</td>
</tr>
<tr>
<td></td>
<td>Which other features would you like to have that are not mentioned above?</td>
</tr>
</tbody>
</table>

To select participants for the FGDs, we focused on rural and peri-urban areas whose farming communities had access to value-chain services provided by the M-Omulimisa platform. While farmers may be reached through ICT services, it remains a challenge to reach them with inputs and collect outputs from more remote areas. For this reason, we excluded communities in remote areas where transport and distribution systems were absent, and we included only farmers whose communities could be reached by supply chains. To determine the farmers to be included in the study (i.e., rural and peri-urban), expert opinions were sought from the M-Omulimisa platform and its partner—World Vision, a non-governmental organization that has worked in Northern Uganda for more than three decades. It was decided to designate farmer groups located beyond 35 km of the main markets/roads or administrative towns as rural and to designate those within a radius of 35 km as peri-urban. In each of the selected rural and peri-urban areas, we purposely selected farmer groups (Pattan, 2015) within which to recruit respondents with experience in ICT services.
To identify challenges, needs and preferences, as influenced by the contexts of farmers (e.g. proximity to markets, main roads, shops for inputs), we selected farmer groups from the selected rural and peri-urban geographic locations. This resulted in six mixed groups of all farmers (three from rural and three from peri-urban). To identify challenges and needs specific to the vulnerable groups, which may not arise when they are part of the larger groups, we selected some groups consisting of young adults, women and older people (Table 3.2). This resulted in three additional groups for young adults, two additional groups for women and one additional group for older people, all of which were distributed across the rural and peri-urban locations. The use of similar categories of farmers across the different geographic locations and group types enhanced the reliability and validity of the insights obtained (Yin, 2013). Each focus group included 8–12 participants.

Table 3.2

<table>
<thead>
<tr>
<th>Type of Focus Group</th>
<th>Location Type</th>
<th>Age Group</th>
<th>Number</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women FGD 1</td>
<td>Peri-urban</td>
<td>22–52</td>
<td>8</td>
<td>Barr sub county, Lira</td>
</tr>
<tr>
<td>Women FGD 2</td>
<td>Rural</td>
<td>27–61</td>
<td>9</td>
<td>Aromo sub county, Lira</td>
</tr>
<tr>
<td>Mixed FGD 1</td>
<td>Peri-urban</td>
<td>24–64</td>
<td>10</td>
<td>Agali sub county, Lira</td>
</tr>
<tr>
<td>Mixed FGD 2</td>
<td>Peri-urban</td>
<td>20–58</td>
<td>8</td>
<td>Barr sub county, Lira</td>
</tr>
<tr>
<td>Mixed FGD 3</td>
<td>Peri-urban</td>
<td>22–62</td>
<td>10</td>
<td>Agali sub county, Lira</td>
</tr>
<tr>
<td>Mixed FGD 4</td>
<td>Rural</td>
<td>26–69</td>
<td>9</td>
<td>Aromo sub county, Lira</td>
</tr>
<tr>
<td>Mixed FGD 5</td>
<td>Rural</td>
<td>19–58</td>
<td>10</td>
<td>Aromo sub county, Lira</td>
</tr>
<tr>
<td>Mixed FGD 6</td>
<td>Rural</td>
<td>25–60</td>
<td>9</td>
<td>Aromo sub county, Lira</td>
</tr>
<tr>
<td>Young adults FGD 1</td>
<td>Peri-urban</td>
<td>19–31</td>
<td>9</td>
<td>Agali sub county, Lira</td>
</tr>
<tr>
<td>Young adults FGD 2</td>
<td>Peri-urban</td>
<td>23–34</td>
<td>9</td>
<td>Barr sub county, Lira</td>
</tr>
<tr>
<td>Young adults FGD 3</td>
<td>Rural</td>
<td>17–35</td>
<td>10</td>
<td>Agwe nge sub county, Lira</td>
</tr>
<tr>
<td>Older people FGD 1</td>
<td>Rural</td>
<td>48–68</td>
<td>10</td>
<td>Agwe nge sub county, Lira</td>
</tr>
</tbody>
</table>

To compare and obtain reliable insights from key informants, we selected two value-chain actors from the same category (i.e. input suppliers, produce buyers, village agents, NGOs) across the network of value-chain actors interacting with the ICT platform (Figure 3.1), resulting in a total of eight KII s (Table 3.3). The questions used with key informants were similar to the questions and study concepts presented in Table 1, adapted according to the context.
respondents’ roles within the value chain, with the objective of learning how ICT platforms

![Figure 3.1](image)

**Table 3.3**

<table>
<thead>
<tr>
<th>Category</th>
<th>Name of actor</th>
<th>Respondent Identification</th>
<th>Role</th>
<th>Years in role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>MK agro input dealer shop</td>
<td>Owner</td>
<td>5 years</td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>Agri Net cereal and grain legume buyer</td>
<td>Director</td>
<td>13 years</td>
<td></td>
</tr>
<tr>
<td>Village</td>
<td>Lincoln Obua</td>
<td>Village agent 1</td>
<td>3 years</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alex Okello</td>
<td>Village agent 2</td>
<td>2 years</td>
<td></td>
</tr>
<tr>
<td>NGOs</td>
<td>GOAL Uganda</td>
<td>Dynamic programme manager</td>
<td>7 years</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sasaoka Africa 2000</td>
<td>Livelihood, ICT manager</td>
<td>6 years</td>
<td></td>
</tr>
</tbody>
</table>
3.3.3 Data analysis

Data from the FGDs and KII s were transcribed verbatim using a computer and coded qualitatively using ATLAS.ti data-analysis software (Woods et al., 2016a). To explore challenges, needs and preferences of ICT-based actors with regard to ICT services and interface design features, we analysed the transcripts in a series of steps. The first step involved a thorough reading and re-reading of the transcripts to become familiar with the data set (Ezzy, 2013). To identify the needs and preferences of the various actors with regard to ICT services, we first explored the value-chain challenges faced by the actors using the key study concepts in the first round of coding. This helped us to identify the contextual and holistic challenges, thus leading to first-order codes for ‘value chain challenges’ (see Figure 3.2 for coding structure).

In the second step, we identified needs for ICT services, as emerging from the challenges, given the tendency of needs to arise from the ways in which value-chain actors understand the challenges they encounter within the value chain. This generated insight into the actors’ needs that could be solved by ICT platforms, along with their preferences for ICT interface design features, thereby fulfilling the ICT service needs identified for each category of value-chain actors. These insights were grouped together into the second-order themes of ‘ICT service needs’ and ‘preferences for ICT interface design features’ (Figure 3.2).

This yielded insight into ‘synergies and trade-offs regarding ICT service needs, and synergies and trade-offs regarding preferences for ICT interface design features’ (Figure 3.2).
Figure 3.2: Actors' needs for ICT services
3.4 Results

Our empirical analysis focused on exploring value-chain challenges faced by various actors within the value chain and on identifying their needs and preferences for ICT services and interface features, with the objective of gaining insight into synergies, trade-offs, and solutions.

In the following sections, we describe the findings (supported by illustrative quotations) and present the identified challenges and needs for ICT services, followed by the preferences for interface design features for each value-chain actor.

3.4.1 Farmers’ challenges, ICT service needs and preferred interface design features

Based on the results from the FGDs, the main challenge for smallholder farmers is a lack of key value-chain services to complement the extension services they receive, which are crucial to make the value chain work. These complementary services fall into four broad categories: (1) access to output markets, (2) access to a broad range of inputs, (3) access to microloans for all farmers, and (4) access to additional information (e.g., on output markets, weather, and extension services) (See quotations in Table 3.4). For instance, farmers either sold their produce at low prices due to uncertainties with regard to larger buyers (Women FGD 1 and FGD 2) or lost money through market search due to the high transportation costs (Young adult FGD 1). Because of these challenges, farmers indicated the need for ICT platforms to connect them to produce buyers, in order to increase their farm income, thereby enabling them to invest in better inputs.

Farmers lacked access to a range of inputs, including seeds, fertilizers, pesticides, post-harvest equipment, storage facilities, and related services (e.g., spraying) (Mixed FGD 1, Mixed FGD 3). The lack of access to post-harvest equipment and storage facilities affected produce quality, thereby attracting low prices (Mixed FGD 3). Moreover, many farmers considered the quality of inputs to be poor, with poor seed germination rates (Mixed FGD 5). Uncertainty concerning the quality of agricultural inputs discouraged farmers from investing in improved...
1. Quality assurance for inputs would enhance the farmers’ trust in the ICT services, as well as...
Table 3.4 Illustrative quotations from farmers’ challenges, needs for ICT services and preferred interface features

<table>
<thead>
<tr>
<th>Needs and preferences</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complementary services</td>
<td>Outputs:</td>
</tr>
<tr>
<td></td>
<td>‘Right now, we don’t have dependable buyers, and we rely on local traders who cheat us and give us low prices’. (Young adults FGD 1) We need connections to buyers within our localities. This would help us not waste money and time looking somewhere else to be able to sell our produce’. (Young adults FGD 1)</td>
</tr>
<tr>
<td></td>
<td>‘...This is something we need help with, because we try to produce, but who would we sell to if we used improved seeds? Most local traders just take advantage of us, because we have no other options’. (Female FGD 2)</td>
</tr>
<tr>
<td></td>
<td>Inputs:</td>
</tr>
<tr>
<td></td>
<td>‘We would also like to get all inputs from the platform, such as seeds, pesticides and fertilisers. They could be bundled together with post-harvest handling equipment as loans for easy access’. (Mixed FGD 3)</td>
</tr>
<tr>
<td></td>
<td>‘We get poor germination, particularly for soybean seeds in some farmers’ gardens, to either batch problems or something else’. (Mixed FGD 5)</td>
</tr>
<tr>
<td></td>
<td>‘Some agro-dealers sell fake inputs. The platform should link us to dealers who are verified to sell good-quality inputs; otherwise, it’s the farmers who are losing’. (Young adults FGD 1)</td>
</tr>
<tr>
<td></td>
<td>Microloans:</td>
</tr>
<tr>
<td></td>
<td>‘For instance, in this village, only one group was able to get the input loans, and only for seeds, leaving most farmers. Even then, the input loans should have come with all inputs needed by the farmers. For now, we may get seeds, but the seeds need fertilisers’. (Mixed FGD 4)</td>
</tr>
<tr>
<td></td>
<td>Information:</td>
</tr>
<tr>
<td></td>
<td>‘We incur losses due to long dry spells or the late onset of rains’. (Older people FGD 1)</td>
</tr>
<tr>
<td></td>
<td>‘We also grow other crops, like beans, sunflowers and tomatoes, and we need information on them. Sometimes, one crop fails and another works better and, this way, we balance the income from our farms’. (Mixed FGD 2)</td>
</tr>
<tr>
<td></td>
<td>‘Information on buyers within our surroundings, along with prices and linkages to markets to able to sell our produce”. (Young adults FGD 1)</td>
</tr>
<tr>
<td></td>
<td>Buyer loyalty</td>
</tr>
<tr>
<td></td>
<td>‘If you look at last season, some soybean buyers came around to buy and promised to come and we had no choice’. (Female Women FGD 1)</td>
</tr>
<tr>
<td></td>
<td>‘These buyers just set the prices without listening to our woes and, if we don’t agree to their prices, they don’t buy our produce, leaving us with no one to buy our produce’. (Mixed Group 3)</td>
</tr>
<tr>
<td></td>
<td>‘If the platform can could help us interact more with these buyers and agro input agro-dealers, it would help improve our relationships and trust with them’. (Mixed FGD 4)</td>
</tr>
<tr>
<td></td>
<td>Digital literacy</td>
</tr>
<tr>
<td></td>
<td>‘...but we would need to be trained to use the phones; sometimes we see text messages coming from M-Omu lisi, but, because we don’t know to proceed in order to get more information, we end up ignoring the messages’. (Mixed Group 3)</td>
</tr>
<tr>
<td></td>
<td>Simple interface tools</td>
</tr>
<tr>
<td></td>
<td>‘I think that what works for us farmers is the simple phone that we have through SMS, because you can store it on your phone and refer to it later’. (Young adults FGD 1)</td>
</tr>
<tr>
<td></td>
<td>‘Even audio could work for those farmers are too busy to read’. (Mixed FGD 3)</td>
</tr>
<tr>
<td></td>
<td>‘...using the radio could also work, because it could be shared, especially in the evening, when farmers are back at home’. (Young adults FGD 1)</td>
</tr>
<tr>
<td></td>
<td>‘Our local language (Luo) is preferred, and the good thing is that we all speak same language, make it easy to use the platform’. (Older people FGD 1)</td>
</tr>
</tbody>
</table>
Reported rarely interacting with produce buyers and being unaware of prevailing market prices, which forced them to sell their produce to random local traders at low prices. This suggests the presence of underdeveloped buyer-farmer relationships, which undermined any chance of buyer loyalty. According to the participants, this was manifested during the marketing season when buyers offered low prices (Female FGD 1, Young adults F GD 3), simply walked away or dismissed the concerns of farmers (Mixed Group 2). To overcome these problems, farmers suggested using ICT platforms to enhance interactions between them and other actors (e.g., buyers and input suppliers) in order to create trust and build loyalty (Mixed F GD 4). This would help build stronger relationships and prevent similar issues in the future (see Table 3.4 for supporting quotations).

A third challenge related to digital literacy. Most of the farmers in the FGDs indicated they were reluctant to use ICT services due to illiteracy and limited training in the use of mobile phones (Mixed F GD 3). Consequently, the farmers—most of whom owned simple-feature phones—did not use their phones to access agriculture-related services, as they perceived difficulties in navigating the interface (Women F GD 1). For this reason, they expressed a need for ICT platforms to train them in using mobile phones to access and use the ICT services provided.

Finally, to fulfill the ICT service needs mentioned above, farmers preferred ICT platforms to focus on easy-to-use mobile phone interface tools, like USSD codes, audio messages, and a toll-free line available to assist with additional inquiries concerning interactions with value-chain actors (Mixed F GD 3). In addition, farmers favored radio programmes for crucial activities, such as announcing the start of the buying season, stating the location of buying centres, and providing weather forecasts for wider coverage (Young adults F GD 2). The farmers also expressed a preference for local languages as a means of communication, thereby enabling those with lower levels of education to utilize the ICT services.
3.4.2 Agro-input suppliers’ challenges, ICT service needs and preferred interface design features

The KII demonstrated that agro-input suppliers lacked physical connections to farmers, which limited their potential customer base (agro-input dealer, seed supplier) not withstanding low input sales (see Table 3.5 for illustrative quotations). As a result, agro-input dealers were unable to provide services that were not related to products, such as advising farmers on the proper use and application of agrochemicals (a role currently played by the platform’s village agent). To address these challenges, agro-input suppliers expressed a need for ICT platforms to connect them directly to farmers and expand their customer base. Such connections would result in increased input sales and benefits for agro-input suppliers, in addition to improving their participation in the value chain and utilization of ICT services.

Table 3.5 Illustrative quotations on input suppliers’ challenges, needs for ICT services and preferred interface design features

<table>
<thead>
<tr>
<th>Needs and preferences</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical connections to farmers</td>
<td>‘There have not been arrangements to widen our business reach, between us and farmers’. (Seed supplier)</td>
</tr>
<tr>
<td></td>
<td>‘If we can’t get farmers to buy our inputs, then there is no benefit’. (Agro-input dealer)</td>
</tr>
<tr>
<td>Payment services</td>
<td>‘In this way, the platforms could also process payments to us (the input provider) through mobile money, without farmers coming to us’. (Agro-input dealer)</td>
</tr>
<tr>
<td></td>
<td>‘In fact, through such an app, we could also have deposits and bookings for seeds made, because…for example, for seeds, demand is high, and we do not want to keep it for long, because it could go bad, and we would incur losses’. (Seed supplier)</td>
</tr>
<tr>
<td>Advanced interface tools</td>
<td>‘For us, a smartphone is easy: orders can come through an app, and we deliver, because such a technology would provide for efficient order processing’. (Agro-input dealer)</td>
</tr>
<tr>
<td></td>
<td>‘I prefer English, because it is easily used to navigate; maybe farmers could have it translated, I don’t know, but pictures of inputs could help farmers make a choice’. (Agro-input dealer)</td>
</tr>
<tr>
<td></td>
<td>‘English becomes easy to manage but, with technology the smartphone and simple phones work together’. (Seed supplier)</td>
</tr>
</tbody>
</table>

Agro-input suppliers also recommended that ICT platforms should incorporate input orders and payment/pre-payment services, which could entail the management of seed pre-payments during the marketing season, when farmers have cash, rather than during the planting season, when they are cash constrained. Furthermore, integrating a mobile-money payment system could provide a simpler way of processing and tracking payments, in addition to reducing delays.
Transport expenses for farmers. These services could enhance the overall usability of the ICT services amongst both agricultural input suppliers and farmers.

To fulfill the needs mentioned above, agricultural input suppliers expressed a preference for using advanced interface tools (e.g., smartphone apps) that could enable farmers to buy inputs directly while enabling agricultural input suppliers to reach more farmers efficiently (Table 3.5). The use of a smartphone app could also allow for the integration of payments and order tracking, as well as real-time communication and feedback between farmers and agricultural input suppliers, thereby increasing the efficiency of the supply chain. Furthermore, agricultural input suppliers expressed a preference for the English language as the medium of communication (Agricultural input dealer). Nevertheless, they acknowledged the need for the platform to incorporate farmer-friendly features and local languages in order to cater to the diverse capabilities of farmers and improve their access to ICT services, as stated by both the agricultural input dealer and the seed supplier.

3.4.3 Output buyers’ challenges, ICT service needs and preferred interface design features

As with the input suppliers, results of the KII indicated that output buyers also lacked physical connections to farmers (Cereal and grain legume buyer, Oilseed processor), which hindered interaction and service exchange between them (Table 3.6). While output buyers do have the potential to finance some value-chain activities, our findings indicate that coordination is still a challenge. More specifically, buyers indicated that, although they have limited connections to farmers, they are expected to buy produce from them as part of their involvement in the platform (Oilseed processor, Cereal and grain legume buyer). Individualized operations with widely dispersed farmers increase transaction costs for output buyers, which discourages their participation and cooperation in value-chain activities. To derive more benefits from ICT services, output buyers expressed a need for direct connections to farmers, as well as the need...
Chapter 3

To incorporate produce bulk ing and crop-yield prediction in order to reduce transaction costs

(Cereal and grain legume buyer, Oilseed processor).

Table 3.6 Illustrative quotes from buyers’ challenges, needs for ICT services and preferred interface design features

<table>
<thead>
<tr>
<th>Needs and preferences</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical connections to farmers</td>
<td>‘The main challenge with ICT platforms is connecting with farmers for produce marketing’. (Cereal and grain legume buyer)</td>
</tr>
<tr>
<td></td>
<td>‘If [the platform] could connect us directly and not simply provide prices but actual connections to farmers’. (Oilseed processor)</td>
</tr>
<tr>
<td></td>
<td>‘The platform can monitor the volumes and location of this produce’. (Cereal and grain legumes buyer)</td>
</tr>
<tr>
<td>Farmer loyalty</td>
<td>‘We provide extension support services as well as seeds, but when it comes to buying the produce, farmers don’t remember how much we have invested in supporting their production, rement, like SHS20’. (Cereal, grain and legumes buyer)</td>
</tr>
<tr>
<td></td>
<td>‘…but in the end, we never get the produce. How can you come back? Tell me how you can keep coming when you are not sure the farmers will have produce for you’. (Cereal, grain and legumes buyer)</td>
</tr>
<tr>
<td></td>
<td>‘If we could get a scheme to explore rewards that could keep farmers loyal, it would help’. (Oilseed processor)</td>
</tr>
<tr>
<td></td>
<td>‘Farmers need to know why they are doing business with us, what is required, and basic minimum information on how to keep time, records, bulk and negotiate prices’. (Cereal and grain legumes buyer)</td>
</tr>
<tr>
<td>Advanced interface tools</td>
<td>‘For us to be helped in terms of efficiency, an app is better; farmers can upload their bulk produce, and we will pick it’. (Oilseed processor)</td>
</tr>
<tr>
<td></td>
<td>‘The use of an app is fine. Like this, we can update our price information frequently and also get alerts about the farmers’ bulked produce’. (Cereal, grain and legumes buyer)</td>
</tr>
<tr>
<td></td>
<td>‘But for us, we prefer smartphones, and English is best for such operations. The local language can be used by farmers with the platform, but we prefer English’. (Oilseed processor)</td>
</tr>
</tbody>
</table>

Output buyers also experienced a lack of loyalty from farmers, which hindered their ability to establish beneficial connections with them. In the past, output buyers provided support services to farmers (e.g. pre-finance inputs and extension advisory services). According to our results, however, farmers often breached their agreements with buyers and sold their produce to other buyers — a practice commonly referred to as ‘side-selling’ (Cereal and grain legumes buyer, Oilseed processor). Side-selling by farmers left output buyers frustrated, and it discouraged them from fulfilling their roles in the value chain. To build trust and loyalty between farmers and output buyers, the output buyers suggested that ICT platforms could facilitate continued interactions between them through relevant ICT interfaces, as well as physical meetings.
Further more, output buyers expressed a need for ICT platforms to provide farmers with training in digital literacy and business skills, including bulk marketing, to enhance their capacity to use their phones to access ICT services and manage their business relationships (Cereal and grain legume buyer).

To fulfill the needs mentioned above, output buyers preferred advanced interface tools (e.g., smart phone apps) to improve the expected produce-market connections between the platform, buyers, and farmers (Cereal and grain legume buyer, Oilseed processor). Unlike simple-feature phones, an interface based on a smart phone app could track expected production and bulking processes, thereby enabling produce buyers to plan their field operations. Furthermore, buyers preferred using English as a medium of communication to streamline business operations into ICT services without the need for translation (Cereal and grain legume buyer, Oilseed processor).

3.4.4 Village-based agents’ challenges, ICT service needs, and preferred interface design features

According to the KII s, village-based agents (VBAs) receive inadequate remuneration for their work, due to a lack of connections to input suppliers and produce buyers (Table 3.7). Despite the expectation that VBAs would earn commissions from the sale of inputs and produce supplies to buyers, such value-chain connections were absent (Village agent 1). The lack of connections to input and output markets made VBAs reliant on facilitation from the platform, which was perceived as inadequate. To address this challenge, ICT platforms should fully integrate VBAs into their ICT services, in order to enable linkages to commission markets for inputs and outputs. Furthermore, to ensure successful connections between VBAs and input and output markets, ICT platforms should train farmers on how to use their phones to access ICT services (Village agent 1). Digital literacy would improve the farmers’ use of ICT services and benefit all actors within the chain.
Table 3.7 Illustrative quotations on Village agents’ challenges, needs for ICT services and preferred interface design features

<table>
<thead>
<tr>
<th>Needs and preferences</th>
<th>Quotations</th>
</tr>
</thead>
</table>
| **Connection to input and output markets** | ‘...for us (as village agents), the platform needs to think of how it can connect us to buyers and input suppliers, so that we can earn more commission’. (Village agent 2)  
‘Our earnings are not clear, because the services from which we are to earn are not integrated into our activities. Right now, our facilitation is based only on loans received by farmers’ groups, which are not enough’. (Village agent 1) |
| **Digital literacy for farmers** | ‘Many farmers do not know how to use the platform, and they are therefore not able to use the services provided through the platform, which places pressure on us to move from one farmer to another to help them’. (Village agent 2)  
‘For farmers to benefit from ICT services, they need more training in the use of mobile phones’. (Village agent 1) |
| **Advanced interface tools** | ‘For the work we do, a smartphone is better, as we can use it advise farmers, as well as to connect input dealers to farmers for ordering and delivery’. (Village agent 1) |

To fulfil the needs mentioned above, the results indicate that VBAs prefer using advanced interfaces (e.g. smartphones) to establish direct connections with farmers, input suppliers and produce buyers, as well as to track farmers’ input orders and plan for input delivery (Village agent 1). In addition, smartphone tools could enable farmers to post their produce offers for timely pickup by village agents or buyers (see quotations in Table 3.7), whilst also reducing transaction costs related to transporting farm produce by either farmers or buyers (Village agent 2).  

3.4.5 Non-governmental organisations’ challenges, ICT service needs and preferred interface design features
farmers’ access to production information and to provide connections to input and output markets in a timely and cost-effective manner.

Findings from the interviews indicate that the current lack of coordination among value-chain actors limits farmers’ access to value-chain services, and especially to input and output markets, which in turn affects the expected farmer-level impacts of NGOs. To overcome these challenges, NGOs suggested that ICT platforms should coordinate the entire value chain and enable farmers’ access to all actors and services within the value chain, including extension information, physical linkages to input and output markets, and other related services (NGO 1 and 2). This could help overcome barriers faced by farmers and enable NGOs to reach more farmers and create more impact efficiently.

Furthermore, to enable farmers to make full use of ICT services, ICT platforms should provide digital literacy trainings (NGO 1, NGO 2). While farmers may use mobile phones for social communication, navigating codes and keywords to access ICT services requires additional skills (NGO 2), without which access to and use of ICT services may be limited.

To meet the needs mentioned above, NGOs preferred advanced interface tools that are compatible with both simple-feature phones and smartphones, to cater to all categories of farmers and value-chain actors using the platform to provide services to farmers (Table 3.8). For instance, a smartphone interface could enable audio-video tools to support field diagnostics, cater to illiterate farmers, and help identify pests and diseases (NGO 2), thus addressing off-farm challenges. Furthermore, NGOs preferred offline engagement for extension advisory services, especially in areas where internet connectivity is weak and costly (NGO 2).
### Table 3.8 Illustrative quotations on NGO’s challenges, needs for ICT services and preferred interface features

<table>
<thead>
<tr>
<th>Needs and preferences</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coordination of the value chain</strong></td>
<td>‘We would like them to add more strength on markets, post-harvest handling and other services. We would like to have a value-chain-based ICT platform where everything along the chain can be found’. (NGO 2)</td>
</tr>
<tr>
<td></td>
<td>‘Coordination between input suppliers and ICT firm remains a challenge. This needs to be streamlined so that all partners are fulfilling their roles in enhancing access to inputs amongst farmers’. (NGO 1)</td>
</tr>
<tr>
<td><strong>Digital literacy</strong></td>
<td>‘We know that using USSD code is easy, but we can’t assume that for farmers who did not go to school. In fact, training farmers in business skills could be part of this training as well, so that they will be able to negotiate with other value-chain actors and have a say with regard to their produce’. (NGO 2)</td>
</tr>
<tr>
<td></td>
<td>‘...train farmers in the use of phones. I think we assume that, once we send information in a text, farmers will know what to do’. (NGO 1)</td>
</tr>
</tbody>
</table>

### 3.5 Synergies and trade-offs in the needs and preferences of actors

[The text continues with further discussion and analysis of the table's data.]
chains: (1) building loyalty between farmers and business actors (e.g. buyers); (2) conducting digital literacy trainings for farmers; and (3) designing multi-faceted platforms. Fostering loyalty between farmers and business actors (e.g. buyers) is crucial for correcting market uncertainties to ensure smooth and efficient value chain interactions and service delivery (La joie-O’Malley et al., 2020; Liverpool-Tasie et al., 2020). In addition, the use of contractual agreements between buyers and farmers can remove uncertainties related to the timely supply of inputs, the timely purchase of farmers’ outputs and farmers’ commitment to and capacity for managing business relationships effectively. 

et al., 2021a). To address this challenge, we agree training farmers in using mobile phones is crucial (Abdullahi et al., 2021; McCampbell et al., 2021b), as are awareness campaigns led by ICT platforms and other Kelil, 2021).
available, whilst offering solutions that connect farmers to resources, including markets. Such efforts have been based on the use of simple-feature mobile phones that use USSD codes (Abdulai et al., 2023). In light of the increasing availability of mobile phones, the results of our study emphasise that investments in ICT services should be concentrated on multi-faceted platforms for both simple-feature and smart phones, thus catering to all actors.

Whereas all actors participating in our study agree that the ICT-service needs discussed above are important for ICT platforms to consider, our results also identify trade-offs that ICT platforms must balance. One challenging trade-off for ICT-platform developers has to do with the choice between efficiency and reach, given the differences in preferences for ICT interface design features. On one hand, farmers prefer simple phone tools (e.g. SMS, USSD) which are easy to use and overcome illiteracy, in addition to increasing participation and the impact of ICT services. On the other hand, other value-chain actors prioritise capability and computational power to support efficient operations across different actors, which leads them to prefer internet-enabled smart phones and the use of English as a medium of communication.

These divergent preferences thus pose a choice for ICT developers: either they can reach many farmers and create more impact by using simple-feature phones, or they can prioritise efficiency within the value chain and reach a more limited number of farmers, but abide by the needs of the other actors within the value chain.

Another trade-off relates to the choice between inclusion and exclusion. The preference of farmers for local languages is driven by a sense of identity and belonging, which can stimulate inclusion and participation in ICT-based value chains. While the preference for English by other actors could facilitate collaboration amongst various value-chain actors and stakeholders, without disrupting their reporting structures, the use of English may impede farmers’ access to ICT services and exclude their participation in ICT-based value chains.
### Design implications

#### Value chain

- **Multifaceted**

#### Chapter 3

Table 3.9: Key insights and design implications for synergies and trade-offs

<table>
<thead>
<tr>
<th>Synergies and trade-offs</th>
<th>Key insights</th>
<th>Description</th>
<th>Design implications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Synergies</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Trade-offs</strong></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.5.1 Theoretical implications

This study contributes to the smallholder literature on use of ICTs by demonstrating the importance of involving users in the design process, in order to create ICT services that correspond to their needs, preferences and capabilities (Kitsios and Kamariotou, 2020; Magesa, 2019; Crespo et al., 2020; Steinke et al., 2021). As also emphasised by other authors (LaFond and Davis, 2016) user involvement in the design (Van der Burg et al., 2019). This is important to create value for all. The benefits of market orientation for businesses have long been discussed (Narver & Slater, 1990; Kohli & Jaworski, 1990): firms commit to actions that benefit all actors (Mukhtar and Azhar, 2020). By understanding the needs of actors within the value chain from production to marketing and by aligning value
3.5.2 Practical implications

The results of this study have practical implications for the managers, owners and funders of ICT platforms, as well as for input and output market companies, NGOs and policy-makers. To encourage actor participation in ICT-based value chains and to enhance the use of ICT services among all actors, this study has three important implications for the design of ICT services.

First, managers, owners and funders of ICT platforms should prioritise solutions that resolve challenges that cut across the various actors to enhance mutual benefits. Solutions that are related to the creation of efficiency in the business processes of actors and that support their decision-making. Examples include production, marketing processes (e.g. produce bulk and pickup alerts; price information), inputs and credit connections.

demand, online and offline) and the capabilities of different actors. Such interfaces could also audio and video). Multi-...ing (Kilelu et al., 2011). To play these as the capacity of those on whom they rely to provide this range of services (e.g. village agents).
3.6 Conclusion and direction for future research

models that take into account logistical arrangements for the delivery of inputs and outputs with a quality-assurance mechanism. Developing the capacity of ICT platforms and their agents could ensure that the information that is disseminated is of good quality and relevance, and that it is thus reliable.

In collaboration with NGOs and input and output companies, ICT platforms should design loyalty-building interventions that could enhance buyer-seller relationships, increase transparency and build trust, thereby enhancing the use of ICT services amongst both categories of actors. Such interventions should enhance transparency and the exchange of credible information (e.g. bulk alert and price information) in order to enable timely produce delivery and pick-ups, in addition to mitigating conflicts. To address loyalty constraints and low prices for farmers, our study highlights the crucial role that ICT platforms can play in creating value for all actors. For instance, ICT platforms could develop business models that enhance access to input and output markets, with loyalty incentives for some volume thresholds. Such incentives could increase market certainty for farmers while reducing the costs of operation costs for buyers, who could ultimately offer a premium price for farmers’ produce. This could

3.6 Conclusion and direction for future research

models that take into account logistical arrangements for the delivery of inputs and outputs with a quality-assurance mechanism. Developing the capacity of ICT platforms and their agents could ensure that the information that is disseminated is of good quality and relevance, and that it is thus reliable.

In collaboration with NGOs and input and output companies, ICT platforms should design loyalty-building interventions that could enhance buyer-seller relationships, increase transparency and build trust, thereby enhancing the use of ICT services amongst both categories of actors. Such interventions should enhance transparency and the exchange of credible information (e.g. bulk alert and price information) in order to enable timely produce delivery and pick-ups, in addition to mitigating conflicts. To address loyalty constraints and low prices for farmers, our study highlights the crucial role that ICT platforms can play in creating value for all actors. For instance, ICT platforms could develop business models that enhance access to input and output markets, with loyalty incentives for some volume thresholds. Such incentives could increase market certainty for farmers while reducing the costs of operation costs for buyers, who could ultimately offer a premium price for farmers’ produce. This could

3.6 Conclusion and direction for future research

models that take into account logistical arrangements for the delivery of inputs and outputs with a quality-assurance mechanism. Developing the capacity of ICT platforms and their agents could ensure that the information that is disseminated is of good quality and relevance, and that it is thus reliable.

In collaboration with NGOs and input and output companies, ICT platforms should design loyalty-building interventions that could enhance buyer-seller relationships, increase transparency and build trust, thereby enhancing the use of ICT services amongst both categories of actors. Such interventions should enhance transparency and the exchange of credible information (e.g. bulk alert and price information) in order to enable timely produce delivery and pick-ups, in addition to mitigating conflicts. To address loyalty constraints and low prices for farmers, our study highlights the crucial role that ICT platforms can play in creating value for all actors. For instance, ICT platforms could develop business models that enhance access to input and output markets, with loyalty incentives for some volume thresholds. Such incentives could increase market certainty for farmers while reducing the costs of operation costs for buyers, who could ultimately offer a premium price for farmers’ produce. This could

3.6 Conclusion and direction for future research

models that take into account logistical arrangements for the delivery of inputs and outputs with a quality-assurance mechanism. Developing the capacity of ICT platforms and their agents could ensure that the information that is disseminated is of good quality and relevance, and that it is thus reliable.

In collaboration with NGOs and input and output companies, ICT platforms should design loyalty-building interventions that could enhance buyer-seller relationships, increase transparency and build trust, thereby enhancing the use of ICT services amongst both categories of actors. Such interventions should enhance transparency and the exchange of credible information (e.g. bulk alert and price information) in order to enable timely produce delivery and pick-ups, in addition to mitigating conflicts. To address loyalty constraints and low prices for farmers, our study highlights the crucial role that ICT platforms can play in creating value for all actors. For instance, ICT platforms could develop business models that enhance access to input and output markets, with loyalty incentives for some volume thresholds. Such incentives could increase market certainty for farmers while reducing the costs of operation costs for buyers, who could ultimately offer a premium price for farmers’ produce. This could
Our study, the realization of ICT-based value-chain development hinges on the equitable fulfillment of the needs of all actors within the value chain, and not only those of smallholder farmers. Given that our results are based on a single case study, we invite future research on this subject, which could contribute insights into the relevance of eliciting the needs and preferences of all actors within the value chain in the process of designing and re-designing ICT services. Our results also indicate that multi-faceted interfaces that integrate the design interface preferences of various actors with loyalty interventions are crucial to enhancing access to and the use of ICT services across all value-chain actors. Future research is needed in order to collect empirical evidence on the impact of our recommendations.

Acknowledgements

We are grateful to the Plant Production Systems Group at Wageningen University for funding this research as a follow-up to the project ‘N2Africa: Putting nitrogen fixation to work for smallholder farmers in Africa’ (www.N2Africa.org). We would also like to thank the farmers, village agents, produce buyers, input suppliers, NGOs and the M-OmuliMi ICT platform in Northern Uganda for their collaboration and cooperation in data collection.

Disclosure statement

No potential conflicts of interest were reported by the authors.
Chapter 4

Effect of Information and Communication technology-based loyalty incentives on farmers’ use of agricultural inputs and productivity: Evidence from a field experiment in Uganda
Abstract

To address low yields and contribute to food security in sub-Saharan Africa, policy-makers encourage smallholders to use productivity-enhancing agricultural inputs. Yet rates of use of such inputs remain disappointing, among others, because farmers are uncertain whether buyers will be willing to pay for the improved outputs to make a purchase. Loyalty incentives that encourage farmers to use the inputs and promise commitment from buyers may help overcome such uncertainty. This study, therefore, examines the effects of loyalty incentives shared by an Information and Communication Technology (ICT) platform on farmers' use of agricultural inputs and soybean yields using survey data from 234 farmers in Northern Uganda.

The results indicate a significant ($P < 0.001$) influence of financial and non-financial loyalty incentives on farmers’ use of improved seed and fertilizer compared with no incentives. Average soybean yields significantly increased above the control (619 kg ha$^{-1}$) by 525, 747, and 854 kg ha$^{-1}$ for non-financial, financial, and a combination of financial and non-financial incentives, respectively. Our results suggest that loyalty incentives are effective in increasing the adoption of productivity-enhancing inputs to increase yields in smallholder farming, thereby advancing the knowledge on loyalty interventions for sustainable intensification of agricultural production and technology adoption through ICTs.

Keywords: ICT platforms, ICT4D, output market access, technology adoption, producer-buyer relationship, sub-Saharan Africa.
4.1 Introduction

The demand for food is growing globally due to population growth, growing incomes, and rapid urbanization (FAO, 2017; Van Itterbeek et al., 2016), yet production remains low due to dependence on rain-fed smallholder agriculture, declining soil fertility, and decreasing farm sizes (Lower et al., 2021). The central tenet of improving food production is using sustainable agricultural practices such as improved seed cultivars, organic and mineral fertilizers, crop rotations with legumes, and other related technologies. Yet, the uptake of these technologies remains low among smallholders in sub-Saharan Africa.

One factor contributing to farmers’ low uptake is limited access to output markets and, more generally, the uncertainty that smallholders face trying to sell their harvested produce. Such output market uncertainty discourages farmers from investing in productivity-enhancing inputs (Aker and Ksoll, 2016; Simtowe et al., 2019b; Suri and Udry, 2022).

Output market uncertainty often stems from the lack of trust and loyalty between farmers and produce buyers (Agyekumhene et al., 2020; Barnes et al., 2017; Bold et al., 2017; Chavas and Nauges, 2020; Dubbert, 2019). As a consequence, output market uncertainty leads to lower investment in inputs and associated farm practices, and consequently to lower farm productivity and a less-than-optimal contribution to overcoming output market uncertainties, and increasing uptake of inputs and practices as well as crop yields (Bellemare, 2020; Sebhatu et al., 2020).

Reducing food security. Vice versa, enhancing loyalty between farmers and output buyers will
The relationship marketing literature suggests loyalty interventions as instruments to strengthen market relationships. Loyalty intervention is a system of integrated, structured and personalized marketing actions that offer loyal customers a wide range of financial and/or non-financial incentives (Bombaj and Palmatier, 2016). While the impacts of loyalty incentives in hospitality and other businesses (Liu and Ansari, 2020; Viswanathan et al., 2017) have been examined, such loyalty incentives have not been widely applied in smallholder agricultural systems.

Within the existing literature, some studies have looked at incentives within contract farming and examined their effects on the quality of outputs (Hoffmann et al., 2023; Saenger et al., 2013; Treurniet, 2021), input choices in shared output arrangements (Burchardi et al., 2019), yields, incomes and welfare (Arouna et al., 2021; Bellemare, 2018; Otsuka et al., 2016). These studies, however, are to the best of our knowledge absent. This absence is logically explained by the fact that sharing the information on loyalty incentives among many small and dispersed farmers, is still a burdensome and costly effort. The Information and Communication Technology (ICT) reach farmers efficiently through SMS (c.f., Larochelle et al., 2019; Mohammed and Abdulai, 2022; Van Campenhout et al., 2021) communicating loyalty incentives.

This study aims to test whether an ICT-coordinated loyalty intervention with an assured produce market creates a change in farmers’ use of agricultural inputs, and consequently improves crop
ICT-based loyalty incentives for improved use of inputs and yields

4.2. Background

4.2.1 The role of loyalty incentives in agricultural value chains

A growing body of research has examined the impact of improved agricultural inputs such as seed and fertilizers on productivity of smallholder farmers. For example, Tufa et al. (2016; van Heerwaarden et al., 2018; van Vugt et al., 2018; Vanlauwe et al., 2019) showed how the use of improved seed varieties significantly increased soybean yields in smallholder farms in Malawi. Likewise, Ronner et al. (2016) showed that P-fertilizer and rhizobium inoculants increased smallholders’ soybean yields in northern Nigeria. Similar increases in soybean yields were reported in farmers’ fields in northern Uganda due to P-fertilizer and rhizobium inoculants use (Miriam et al., 2022), with positive effects of fertilizer use in combination with no-tillage reported in Ghana (Bua et al., 2017). Despite the benefits of these productivity-enhancing technologies, smallholders’ adoption remains low (among others) due to limited access to information and linkages to input and output markets.
In general, farmers have limited access to quality inputs (Khonje et al., 2018; Mukhtar and...)

Even if they can obtain quality inputs, access to buyers that are willing to pay for the improved farm output remains a challenge. As such buyers are sourcing from many small and dispersed small holders they face high transaction costs due to poor infrastructure and limited institutional support.

Buyers also cope with uncertainty about the produce quality and quantity that farmers can offer, because they can’t be certain that farmers have access to the necessary inputs (Dubbert, 2019; Dubbert et al.,...). Thus, the lack constrains farmers’ use of agricultural inputs and productivity (Aggarwal et al., 2018; Aker et al., 2016; Krone and Dannenberg, 2018). Therefore, the need for proper coordination of the value chain such that farmers can access and be informed about inputs as well as buyers (Chavas and Nauges, 2020).

In a value chain coordination process, input providers coordinate deliveries to small holders to ensure that a target group of farmers can access all important inputs (Kilelu,...). It further ensures that when farmers use the inputs to improve their produce, buyers are actually present to make them an offer for the improved quality and/or quantity (Reinker and Gralla, 2018). Value chain coordination thus removes market uncertainty for the farmers’ market situation has changed and to persuade them to participate by purchasing and using the inputs... So called loyalty incentives may help to achieve this.

Chapter 4

108
4.2.2 Loyalty incentives

Loyalty incentives are any kind of compensation that is given to an individual before or during a transaction with the goal of changing their attitude and behavior towards the company or business giving the incentive (Keh and Lee, 2006). In the context of smallholders, attitudes and behavior are changed to use the inputs and practices that are preferred by the output buying company. To date, loyalty incentives for smallholders have only been offered as part of contract farming arrangements (Arouna et al., 2021; Bellemare, 2018). Implementing loyalty incentives through contracts comes, however, with high transaction costs to reach individual farmers or farmer groups through extension or buyer agents. With the rapid development of ICT platforms in agricultural value chains, implementation of loyalty incentives is becoming more feasible (Purohit and Thakar, 2019). ICT platforms are digital tools on which multiple interfaces and applications are integrated for users (Baryamureeba, 2004; Zahedi and Zahedi, 2012), including farmers and other value chain actors. ICT platforms can play an important role as they can easily communicate the loyalty incentives and stimulate a change of behavior among farmers (Purohit and Thakar, 2019).

The literature distinguishes two types of loyalty incentives: financial and non-financial. Financial incentives are defined as rewards in a transaction that includes cash such as discounts, bonuses, or upgrades. For example, Alshurideh et al. (2020) found that financial incentives attracted individuals to a company and raised their commitment. Financial incentives are rewards in a transaction that do not include cash such as recognition, gifts, privileges, and special treatment (Brashear et al., 2015; Lilien, 2016). Non-financial incentives may also be combined, because individuals may be attracted by different types of incentives.
In this study we used both financial and non-financial loyalty incentives, together with interactions and relationship building between farmers and the buyer, to create a certain market outlet for farmers. Moreover, the loyalty incentives could only be obtained above a certain sales threshold to the buyer, which we expected to translate into increased use of agricultural inputs among farmers, to increase their produce volume to sell to this buyer. We hypothesized as follows:

H1: Financial (price bonus) and non-financial (tarpaulins) incentives will have a positive effect on farmers’ use of agricultural inputs compared with the control.

The two types of incentives aimed to cater to different types of farmers. On the one hand, in the context of smallholder farmers, non-financial incentives such as gifts for recognition might be fitting in an informal, non-fortified economy in which people generally exchange favours. For instance, Melnyk and Bijmol (2015) found that adapting non-financial incentives to individuals’ needs confers pride of being recognized, which increases their commitment and loyalty (Brashier-Alejandro et al., 2016). Tarpaulins as non-financial incentives were therefore expected to attract farmers to the loyalty programme to ease threshing and winning of their soybean grain to increase quality and earn better prices. Financial incentives, on the other hand, would appeal to farmers who have a certain level of access to output markets but are long for better value (prices) from produce buyers. Price bonuses as financial incentives were therefore expected to attract farmers’ enrolment in the LP to earn more from their production.

As a result, both non-financial and financial incentives may appeal to different types of farmers, but are expected to have the same effect on input use. Hence, we hypothesized as follows:

H2: There is no significant difference in use of agricultural inputs among farmers receiving financial incentives (price bonus), compared to farmers receiving non-financial incentives (tarpaulins).
The loyalty incentives were expected to enhance farmers’ use of inputs, to increase farmers’ crop yields to meet the expected volume to supply to the buyer. Several studies indicate significantly improved crop yields due to the uptake of improved seed varieties and/or fertilizers for crops such as maize, legumes, and other cereals. For soybean specifically, improved seed varieties, fertilizers and the use of rhizobium inoculants (rhizobia bacteria responsible for fixing nitrogen from the atmosphere) are expected to increase crop soybean yields. Hence, we hypothesized:

H3: Financial (price bonus) and non-financial incentives will have a positive effect on farmers’ soybean yields compared with the control.

Figure 1 shows the loyalty incentives and their expected outcomes based on theoretical and conceptual frameworks described above. Although loyalty incentives are expected to enhance adoption of agricultural technologies among smallholder farmers in Africa include; age of the household head’s characteristics, education; household characteristics such as farm size, land tenure security; farm (urban etc.); farm characteristics such as farm size, land tenure security; farm output markets). These factors are included in the analysis as control variables to
explore to what extent these variables affect the relationship between loyalty incentives and outcome variables.

From the conceptual framework described above, the loyalty intervention offers price bonus and tarpaulins as financial and non-financial incentives to farmers, that can be earned during the future during the marketing season. We expected these incentives to result in increased investments in inputs, to increase produce volumes to supply to the output buyer, influenced by household and farm (environment) characteristics (Figure 4.1). In turn, the loyalty intervention would improve the relationship between farmers and buyers, reducing market uncertainties on both sides, and serving as an incentive for both parties to continue their relationship in future.

**Figure 4.1** Conceptual model

**Loyalty incentives**

- Financial incentives (Price bonus)
- Non-financial incentives (Tarpaulins)

**Use of inputs**

- Improved seed
- Fertilizers
- Rhizobia

**Improved yields**

- (Kgs per ha)

**Control variables**

- Farmer characteristics (age, education, gender, location)
- Household characteristics (household size, location (rural or peri-urban), credit access)
- Farm characteristics (land size, land tenure security)
- Farm environment and conditions (distance to all-weather road, distance to agro-input shops, and distance to output markets)
4.3. Methods

4.3.1 Study context

We test our hypotheses in the context of a loyalty intervention offered through an ICT company called M-Omulima (www.m-omulima.com), implemented with soybean farmers in Lango sub-region, Northern Uganda. Soybean production provides opportunities for farmers in this region to improve their incomes and nutrition, as soybean is a relatively cheap protein source. Soybean contributes to enhanced soil fertility for other crops through its ability to fix nitrogen from the atmosphere. In addition, soybean farmers in Lango sub-region were part of previous interventions, including the N2 Africa project in which soybean production increasing technologies were disseminated to farmers through the M-Omulima ICT platform. These technologies included improved soybean varieties, phosphorus fertilizers such as triple super phosphate (TSP) and single super phosphate (SSP), and rhizobium inoculants.

At the time of study, the M-Omulima platform facilitated farmers with soybean production information, linkage to input suppliers and access to input loans in collaboration with a government microfinance institution, particularly for improved seed. The existing ICT platform provided a suitable context to test the impact of financial and non-financial loyalty incentives on farmers’ use of agricultural inputs.

4.3.2 Experimental design

We implemented a cluster randomized controlled trial in which 45 farmer groups (clusters) selected from the M-Omulima ICT platform database were randomly assigned to treatment groups. The selected farmers’ groups were those who had access to production information on soybean technologies and linkage to input providers and access to credit through the microloan scheme. The use of independent and geographically dispersed farmer groups (clusters) helped to avoid contamination across treatment groups. All the farmer groups were ICT-based loyalty incentives for improved use of inputs and yields
located in the Lango sub-region, with similar geographical features, production conditions, income levels, culture and language.

The 45 clusters were randomized to four treatments namely (i) Financial incentives (cash bonuses only). (ii) Non-financial incentives (tarpaulins only) (iii) Both financial + non-financial incentives (both cash bonuses and tarpaulins) (iv) Control (no incentives). All information on the loyalty intervention was communicated through the ICT platform. Farmers in the treatment groups interacted with the buyer through physical meetings and through buyer agents to enhance trust and market certainty. Farmers in the control group only received general information on the buyer’s presence in the area via SMS (Appendix 1). All groups received production information on soybean (when to plant, weed, etc., synchronized with the farming calendar) and contacts of input suppliers (Appendix 4.1). In total, we had n = 11 groups for each of the control, financial and non-financial treatment groups while the both financial + non-financial treatment group had n = 12 groups. The unequal number of groups resulted from some groups being located in the Eastern region but being entered wrongly in the M-Omuli miis ICT database as located in the Lango sub-region. All information shared to all treatment groups was translated in the Langi local language and sent to the different treatment groups through mobile phones during the second season of 2021 (August to December 2021). All farmers could ask for clarifications about the information shared through the platform or the village agents working with the ICT platform. In addition, the village agents were expected to aggregate farmers’ produce for the buyer and earn a commission while reducing the transaction costs for both the farmers and the buyer.

We applied the loyalty incentives to the case of soybean production in Northern Uganda (more detail in section 3.1). The financial incentive comprised a price bonus: farmers would receive a premium price of 0.03 USD for every kilo, if they sold more than 800 kg of soybean to the buyer. Non-financial incentives offered were tarpaulins (used by farmers to dry their harvest).
4.3.3 Sampling and data collection

Although the unit of randomisation was a farmer group (cluster), the unit of analysis was the household. To select survey respondents from each of the 45 farmer groups recruited into the LP intervention, we used the probability-proportional-to-size sampling because of unequal group sizes, and used simple random sampling to select actual household participants for the survey. This resulted in a randomly selected sample of 234 farmers who had grown soybean in the second season to complete the questionnaire.

Data about farmers’ use of inputs (improved seed, fertiliser and rhizobia), social demographics, and other variables such as distance to input and output markets, was collected using a cross-sectional survey questionnaire, programmed on a computer tablet using Open Data Kit (ODK). A 5-point Likert scale was used to measure farmers’ use of inputs scoring from 1-very little extent, 2-little extent, 3-neutral, 4-large extent, 5-very large extent. In addition, an additional score of “Not at all” was added to reflect non-use of inputs by farmers. The use of a Likert scale served to assess farmers’ intensity of using inputs from their own behaviour perspective.

Soybean yields were based on farmers’ estimates, collected in kilograms per acre and translated to kg ha⁻¹ during analysis.

Prior to data collection, enumerators were trained covering all aspects contained in the survey questionnaire to ensure understanding of all variables and terms used. The questionnaire was pre-tested among farmers in one of the communities outside the villages covered by this study (Ingelbeck et al., 2013). To collect the data from respondents, consent was requested before we proceeded with the interviews. M-Omulimisa’s village agents were used to mobilise the randomly selected farmers. In cases where these farmers were not available during the day of data collection.
4.3.4 Data analysis

Data analysis involved the use of two techniques. First, a multivariate analysis of variance (MANOVA) was used in R version 4.2.3 to test the study hypotheses of the effects of loyalty programme incentives on farmers’ use of improved seed, fertilisers and rhizobia combined. “Not at all” scores with the “Very little extent” score to fit in with the 5-point Likert scale.

To account for violations of normality assumptions expected from Likert-scale data, bootstrapping was conducted to generate a bootstrapped distribution of F-statistics for the MANOVA model. The bootstrapped test yielded the same results as the MANOVA statistic, indicating that our test statistic was dependable. We used a 95% confidence interval for the MANOVA test.

To determine significant differences in medians of the control and treatment groups (H2), the Kruskal–Wallis test for non-parametric data was used, followed by a pairwise comparison to show how the use of inputs (improved seed, fertilisers and rhizobia) was affected by the different treatment groups.

To determine effects of other factors on the relationship between loyalty incentives and outcome variables, we included control variables using the multivariate analysis of covariates (MANCOVA) test at 90% confidence interval, which we assumed to have enough precision about the effect of the control variables on the effect of the loyalty intervention. Second, we conducted an ANOVA to test the effects of loyalty incentives on soybean yields obtained by farmers (H3). We used Tukey’s HSD test to compare differences.
4.4. Results

4.4.1 Effects of financial and non-financial loyalty incentives on farmers’ use of inputs

Compared with the control, all treatments had a positive effect on the combined use of improved seed, fertiliser and rhizobial inoculants. $F(9, 690) = 8.4782, p < 0.001$; Pillai’s Trace = 0.2987, partial $\eta^2 = 0.10$, a large effect size (Cohen 1988, p.368). The true population mean of 8.4782 falls within the confidence interval of 15.042 and 16.517 at 95% (Table 4.1a), and therefore confirms the Pillai’s Trace results. Thus, hypothesis 1 which predicted a positive and significant effect on farmers’ input use by financial and non-financial incentives compared to control is supported.

Table 4.1a & b

<table>
<thead>
<tr>
<th>Summary MANOVA</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>1</td>
</tr>
<tr>
<td>Treatment</td>
<td>3</td>
</tr>
<tr>
<td>Residuals</td>
<td>230</td>
</tr>
</tbody>
</table>

Significance codes: 0 ‘****’ 0.001 ‘***’ 0.01 ‘**’ 0.05 ‘.’ 0.1

a)

<table>
<thead>
<tr>
<th>Boot statistics</th>
<th>Boot Confidence Intervals (95%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R original bootBias bootSE bootMed Lower Upper</td>
<td>1 1000 8.4782 -7.4798 0.39453 0.93849 15.042, 16.517</td>
</tr>
</tbody>
</table>

If we consider the use of improved seed, fertilisers and rhizobial inoculants individually, all treatments had a positive effect on the use of improved seed and fertiliser. About one third of the farmers who received a combination of both financial and non-financial incentives used improved seeds to a ‘large extent’, and 12% to a ‘very large extent’, compared with 41% to a ‘very little extent’ in the control group (Figure 4.2). For fertilisers, 6% of farmers who received a combination of both financial and non-financial incentives were ‘neutral’ in their use of fertiliser, and 11% used...
fertilisers to a ‘little extent’, compared with 98% who scored ‘very little extent’ in the control

significant differences across treatment groups on farmers’ use of improved seed, fertilizer and

Figure 4.2 Percentage of respondents using improved seed, fertilizer and Rhizobia across control (n = 65), non-financial (n = 50), financial (n = 52), both financial and non-financial (n = 67).
The post-hoc test results confirmed that for the use of improved seed and fertilizer, the control group was significantly different from all treatment groups (Table 4.2). Although the combination of both financial and non-financial treatments was significantly different from the non-financial treatment, it was not significantly different from the financial treatment. This means that the financial incentives could have attracted farmers to use improved seed more than the non-financial incentives in the treatment with both financial and non-financial incentives. For fertilizer use, similar significant differences were only found between the control and financial treatment, and between the control and the combination of both financial and non-financial treatments (Table 4.2). For rhizobia, the post-hoc test results showed that the differences between the control and treatment groups were not significant with \( p > 0.05 \) (data not presented).

Our results from the pairwise comparison showed that use of improved seed was statistically different between farmers who received non-financial incentives alone and those who received a combination of both financial and non-financial incentives, and between farmers in the control and those who received financial incentives alone. In the use of fertilizers, statistical differences were observed between farmers in the control and those who received financial incentives and between farmers in the control and those who received a combination of both financial and non-financial incentives. There were no significant differences observed between farmers who received financial incentives alone and those who received non-financial incentives alone in the use of both improved seed and fertilizers. Therefore, hypothesis 2 predicting no significant differences in use of agricultural inputs among farmers receiving financial incentives compared to farmers receiving non-financial incentives is supported.
Table 4. Pairwise comparison MANOVA

<table>
<thead>
<tr>
<th>Response variables</th>
<th>Group1</th>
<th>Group2</th>
<th>P.adj</th>
<th>P.adj.signif</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved seed</td>
<td>Control</td>
<td>Financial</td>
<td>0.00</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>Non-financial</td>
<td>0.00</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>Both</td>
<td>0.00</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>Financial</td>
<td>Non-financial</td>
<td>0.83</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>Financial</td>
<td>Both</td>
<td>0.06</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>Non-financial</td>
<td>Both</td>
<td>0.00</td>
<td>*</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>Control</td>
<td>Financial</td>
<td>0.04</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>Non-financial</td>
<td>0.10</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>Both</td>
<td>0.01</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Financial</td>
<td>Non-financial</td>
<td>0.99</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>Financial</td>
<td>Both</td>
<td>1.00</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>Non-financial</td>
<td>Both</td>
<td>0.93</td>
<td>ns</td>
</tr>
</tbody>
</table>

Significance codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

With the control variable added in our MANCOVA, we found that phone ownership of the household head (p < 0.1) and area planted with soybean (p < 0.05) had a significant effect on farmers’ use of improved seed, etc. However, the effects sizes were very small with Partial Eta Squared; $\eta^2$ at 0.03 and 0.004 for phone ownership of the household head and land located to soybean production, respectively.

Table 4.3 MANCOVA summary results

<table>
<thead>
<tr>
<th>Df</th>
<th>Pillai</th>
<th>Approx F</th>
<th>num df</th>
<th>den df</th>
<th>P values</th>
</tr>
</thead>
</table>

Chapter 4
### 4.4.2 Effects of financial and non-financial loyalty incentives on farmers’ yields.

The average yields per treatment were; 619 kg/ha for the control, 1146 kg/ha for the non-financial incentives, 1465 kg/ha for the financial incentives, and 1475 kg/ha for a combination of both financial and non-financial treatment groups. Results from an ANOVA revealed that there was a statistically significant difference in soybean yields between the treatment groups \( F(3, 230) = 45.71, p < 0.001 \). Our results indicated that farmers who used ICT-based loyalty incentives for improved use of inputs and yields had on average higher yields due to the loyalty incentives. Thus, hypothesis 3, predicting a positive and significant effect on farmers’ yields by financial and non-financial incentives compared to control is supported.

**Table 4.4** Anova model results showing wing effects of treatments on soybean yield.

<table>
<thead>
<tr>
<th></th>
<th>Df</th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>F value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>3</td>
<td>30512650</td>
<td>10170883</td>
<td>45.71</td>
<td>0.000***</td>
</tr>
<tr>
<td>Residuals</td>
<td>230</td>
<td>51175441</td>
<td>222502</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tukey’s HSD Test for multiple comparisons showed that the mean value of soybean yields was significantly different between at least two treatment groups (\( p < 0.05 \)). These differences were significant between all treatment pairs, except between the financial and both financial and non-financial (\( p < 0.99, 95\% \text{C.I.} = [216.34, 234.87] \)) treatment groups.
Figure 4.3 Effects of treatments on soybean yield

Table 4.5 Tukey’s HSD test showing multiple comparisons between treatment groups

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Difference</th>
<th>Lower</th>
<th>Upper</th>
<th>P adj</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-financial-Control</td>
<td>526.79261</td>
<td>297.16528</td>
<td>756.42</td>
<td>0.00</td>
</tr>
<tr>
<td>Financial-Control</td>
<td>846.39229</td>
<td>619.27463</td>
<td>1073.51</td>
<td>0.00</td>
</tr>
<tr>
<td>Both-Control</td>
<td>855.65666</td>
<td>643.13206</td>
<td>1068.18</td>
<td>0.00</td>
</tr>
<tr>
<td>Financial-Non-financial</td>
<td>319.59968</td>
<td>77.81446</td>
<td>561.385</td>
<td>0.00</td>
</tr>
<tr>
<td>Both-Non-financial</td>
<td>328.86406</td>
<td>100.73171</td>
<td>556.996</td>
<td>0.00</td>
</tr>
<tr>
<td>Both-Financial</td>
<td>9.264375</td>
<td>-216.34167</td>
<td>234.87</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Table 4.6

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Estimate</th>
<th>Std Error</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>462.86</td>
<td>94.1</td>
<td>4.919</td>
<td>0.000***</td>
</tr>
<tr>
<td>Improved seed</td>
<td>260.45</td>
<td>26.79</td>
<td>9.722</td>
<td>0.000***</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>35.12</td>
<td>76.67</td>
<td>0.458</td>
<td>0.647</td>
</tr>
</tbody>
</table>

Significance level codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Adding fertilizer together with improved seed led to increased yields in the financial and combination of both financial and non-financial but not in the non-financial treatments (Figure 4.4 A). Furthermore, as the extent of use of inputs increased, soybean yield increased in the financial and in the combination of financial and non-financial treatments (Figure 4.4 B).

Figure 4.4:

A) Box plots of input use on soybean yield across the control and treatments. B) Likert scale effects of extent of use of each input type on soybean yield.
4.5. Discussion

The purpose of this study was to assess the effects of financial and non-financial loyalty incentives on smallholders’ use of agricultural inputs and resulting crop yields. Our results show that financial and non-financial incentives communicated through mobile phones significantly influenced farmers’ use of agricultural inputs (improved seed and fertilizer) and consequently increased farmers’ yields.

While our findings show large effects of the treatments on the use of improved seed compared with the control, there were only small differences between the financial and non-financial treatment groups, and the financial and a combination of financial and non-financial treatment groups. As hypothesized, the evidence indicates that farmers are more likely to use agricultural inputs if they expect loyalty incentives from an assured buyer. These findings are consistent with findings by studies on marketing incentives in contract schemes. For instance, Hoffmann et al. (2023) investigated the effect of a modest food safety premium on semi-subistence farmer’s investment in a food safety technology in Eastern Kenya. The authors found that a 5% market premium for produce that met the associated regulatory standard increased maize farmer’s investment in the food safety technology. Treurniet (2021) found that an individual price bonus focusing on compositional quality improved the quality of milk among Indonesian dairy farmers. Saenger et al. (2013) showed positive effects of both a higher penalty for low quality milk and a bonus for high quality milk on dairy farmers’ use of inputs in Vietnam.

Our study extends relational marketing strategies to crop farming, particularly for smallholder farmers, and demonstrates how loyalty interventions can help buyers differentiate themselves through competitive offers to enhance farmers’ loyalty (Brahe-Alejandro et al., 2016) and stimulate smallholder uptake of agricultural inputs. Our results show that market uncertainty resulting from lack of access to market information (available buyers and...
prices affect farmers’ use of agricultural inputs, as seen from the control groups. Furthermore, our results suggest that interactions and relationships building with the buyer in addition to loyalty incentives communicated through the ICT platform could have increased farmers’ market certainty (Ola and Menapa, 2020), stimulating their investments in productivity enhancing agricultural inputs.

Although our findings indicate effects of loyalty incentives on fertilizer use, large differences were only observed between the control and financial treatments, and between the control and the combination of both financial and non-financial treatments. These results suggest that financial incentives appeared to be more attractive than the non-financial. Despite the widespread demonstration of productivity enhancing incentives of phosphorus fertilizers (e.g. TSP) among farmers in the region, the lack of access to such types of fertilizers, the high investment costs, the risk of weather shocks, and the variability in response and profitability could have limited farmer’s use.

We were unable to test hypothesis 1 for rhizobia, as few farmers used rhizobial inoculants. Despite efforts in previous projects to enhance awareness on rhizobial inoculants and their benefits in soybean cultivation (Van Heerwaarden, 2017), the supply chain has not been developed and inoculants are not available in local shops in rural Uganda (Vanlauwe et al., 2019). Rhizobial inoculants are produced at a small scale by Makerere University and not widely distributed, hindered by the lack of effective distribution networks (Ronne et al., 2016, Vanlauwe et al., 2019).

This finding was also echoed by (Brown et al., 2017) who find that uptake of maize-legume agricultural inputs among farmers in Africa was hindered by unreliable input market infrastructure, failing to meet the input needs of farmers.

Although the effects were small, phone ownership and area planted with soybean increased farmers’ use of agricultural inputs.
particular crop, including soybean, enhanced farmers’ use of agricultural inputs (Añgeles et al., 2018). These results indicate that farmers with large areas planted with a crop give more priority to that crop, and are inclined to invest more resources in that particular crop. Hence, as soybean production is regarded a profitable venture in the study area, farmers who allocate more land to soybean are expected to intensify their investments in agricultural inputs to enhance their yield gains. The effects of phone ownership by the household head indicate that phone access and ICT platforms can enhance farmers’ access to information and capacity to use it to invest in agricultural inputs (Akter and Ksoll, 2016). The increases in yield as an effect of the increased use of inputs were influenced by the use of improved seed rather than fertiliser, due to the limited use of the latter. Although few farmers used fertiliser, our results showed that adding phosphorus fertiliser to improved seed positively influenced yields, in line with Van Heerwaarden et al. (2023), Ronner et al. (2016) and Ulzen et al. (2018). Furthermore, our study showed that soybean yield increased with larger self-beneficial effects of improved seed and phosphorus fertiliser on soybean yield, (physical) access to such agricultural inputs remains a challenge in many countries in sub-Saharan Africa (Sheahan and Barrett, 2017; Bold et al., 2017). There are reported extent of use of inputs. Despite the 

126
ICT-based loyalty incentives for improved use of inputs and yields

Chapter 4

ICT-based loyalty incentives for improved use of inputs and yields

127
4.6. Conclusion

This study assessed the effects of financial (price bonus) and non-financial (tarps) incentives, delivered through an ICT platform, on the use of productivity-enhancing inputs and yields among soybean farmers in Uganda. The results indicate that loyalty incentives enhanced farmers’ use of agricultural inputs (improved seed and fertilizers) and soybean yields, as farmers were incentivized to increase their produce volumes for the buyer. Furthermore, our study shows that ICT platforms have the potential to mitigate uncertainties related to output markets (produce buyers and prices) by enabling access to timely and accurate market information, which enhances farmers’ investments in agricultural inputs.

Although information on inputs, output market, and expected loyalty incentives enhanced farmers’ use of inputs, availability of required inputs remains a barrier to more widespread use of inputs among smallholder farmers.

Acknowledgements

We thank the Plant Production Systems Group, Wageningen University for funding this research as a follow-up to the N2 Africa: Putting Nitrogen Fixation to Work for Smallholder Farmers in Africa project (www.N2Africa.org). We also thank the farmers, village agents, Agrinet Uganda Ltd, and M-Omuliimi ICT platform in Northern Uganda for their collaboration in the experiment and data collection.

Disclosure statement

We have no competing interests to declare.
Appendix 4.1 Loyalty intervention information sent to individual farmers across the treatment and Control groups

<table>
<thead>
<tr>
<th></th>
<th>Financial</th>
<th>Non-Financial</th>
<th>Financial + Non-financial</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st set</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd set</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd set</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>Education</td>
<td>Household size</td>
<td>Gender</td>
<td>Control</td>
</tr>
<tr>
<td>------------</td>
<td>-----------</td>
<td>----------------</td>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>65</td>
<td>30.7</td>
<td>5</td>
<td>Male</td>
<td>55</td>
</tr>
<tr>
<td>52</td>
<td>31.8</td>
<td>5</td>
<td>Female</td>
<td>45</td>
</tr>
<tr>
<td>50</td>
<td>31.2</td>
<td>5</td>
<td>Male</td>
<td>39</td>
</tr>
<tr>
<td>67</td>
<td>39</td>
<td>5</td>
<td>Female</td>
<td>59</td>
</tr>
</tbody>
</table>
Chapter 5

Marketing Innovations in Rural Markets in Emerging Economies: Strengthening Loyalty through an ICT Platform in Uganda

This chapter is to be submitted as: Connetie Ayesiga, Esther Ronner, and Paul T.M. Ingenbleek. Marketing innovations in rural markets in emerging economies: Strengthening loyalty through an ICT platform in Uganda
Abstract

The growing presence of mobile phones in remote rural areas of emerging economies opens new opportunities for marketing innovations in agricultural, rural markets. The development of smallholder-based agricultural value chains is, in that respect, particularly important to enhance the production of sufficient food for rapidly growing populations. Historically, integrating widely scattered small-farming communities in value chains has always been difficult because remoteness comes with many barriers that hinder the development of market relationships. We present results from a field experiment on an ICT platform providing loyalty incentives as a relationship-building mechanism between farmers and a buying company in Uganda. Both financial and nonfinancial loyalty incentives appear to positively affect farmers’ loyalty intentions. Affective and calculative commitment mediate these relationships. The effects appear to be stronger for farmers that have greater trust in the ICT platforms. Pressure from other buyers negatively influences farmers’ loyalty intentions, but the effect is weaker than that of loyalty incentives. These findings suggest that loyalty incentives are effective innovations for value chain development in rural markets of emerging economies.

Keywords: Marketing innovations, Value chains, Rural markets, Emerging economies, ICT4D, Buyer competition, Sub-Saharan Africa.
5.1 Introduction

In his seminal work on the fortune at the bottom of the pyramid, Prahalad (2001) already foresaw that Information and Communication Technology (ICT) would have a disruptive impact on rural markets in emerging economies, opening a new technological basis for innovations that could potentially solve persistent problems in these markets. In the past, it has always been difficult to develop rural markets because reaching a sufficient number of farmers without exceeding transaction costs was sheer impossible. The rapid dissemination of mobile phones has created new opportunities, including the possibility to reach farmers efficiently through SMS messages or through web-based platforms and applications that provide information and other services.

Prominent examples of platforms that have contributed to market development include e-Choupal, which provides up-to-date marketing and agricultural information to millions of farmers in India (Mukerji, 2020), and M-Pesa, a mobile money system in Kenya that allows farmers to make and receive payments.

Innovation in rural markets of emerging economies is not only essential to reduce poverty among small-scale farmers but also to ensure that food production keeps pace with the growing and urbanizing population (cf. FAO et al., 2016; van Berkum, 2021). The often dispersed agricultural communities are largely integrated with markets through small-scale traders that visit the communities to collect small quantities of agricultural output and resell it to larger traders in more central markets who aggregate it to higher volumes that can be transported to the urban populations.

This market system has always been vulnerable to disruptions, like bad road conditions preventing traders to travel, shortages of critical inputs like improved seeds and fertilizers, and a scarcity of reliable price information, thus leading to few incentives for farmers to increase the quality and quantity of their production (Fafchamps, 2003; Ingenbleek, 2020). Developing value chains of input providers,

Innovations for Strengthening loyalty through ICT platforms

Chapter 5

135
Chapter 5

The growing food demand and increasing food prices, however, bring many new traders in such value chains that can continue to innovate and invest in food production in an upward cycle. To deal with this problem by extending their services to farmers with interventions in relationship development. The marketing literature offers many insights into loyalty that can foster relational exchange in this context indeed strengthen farmers' loyalty to output market buyers, whether the effects occur with both financial and non-financial incentives, whether and which type of commitment explains the relationships, and whether the effects are moderated by farmers’ trust in the ICT platform and the pressure from other buyers. Uganda is a particularly suitable context for this study. In this article, we examine the impact of loyalty incentives in the rural context of soybean farming in Northern Uganda. Specifically, we address the questions of whether loyalty incentives in rural contexts in emerging economies. With ICT platforms now providing opportunities to reach farmers with incentives that encourage them to make long-term investments in commitment.
Innovations for Strengthening loyalty through ICT platforms

Because while the rural area fits all the typical characteristics of rural areas in emerging economies, it also has one of the highest number of ICT platforms in Sub-Saharan Africa (GSMA, 2020) and high penetration of mobile phones (UCC, 2018).

In doing so, our article adds to the emerging literature on innovation in rural markets of emerging economies. The existing literature on innovation at the bottom of the pyramid has mostly focused on urban markets, with limited attention for co-creation between companies and people living at the bottom of the pyramid (BOP) (Kolke et al., 2014). The relatively few studies in marketing that look at rural sectors of emerging economies tend to focus on hindrances to market integration, like market orientation (Ingenbleek et al., 2013; Kwaramba et al., 2022) and market place literacy (Teklehaimanot et al., 2017; Viswanathan et al., 2021).

More precisely, our study makes the following contributions to this literature. First, it shows that loyalty incentives offered through an ICT platform have a positive effect on farmers’ loyalty intentions, thereby contributing to the development of stable value chains. In that respect, we also show that the effect of loyalty incentives is stronger than that of perceived pressure coming from other traders entering the region. Because the innovation requires active contributions from farmers, value chain partners, and the ICT platform, it is also a process of co-creation at the BOP.

Second, our study shows that the effect is generalizable across financial and non-financial incentives, though, as we show, both types of incentives stimulate different types of commitment (calculative and affective, respectively), which helps to explain why the loyalty instrument eventually influences loyalty intentions. Third, our study shows that the effects of loyalty incentives are contingent on a trusted ICT platform environment, suggesting that relationships in the value chain are strengthened more effectively when the new ICT institutions are also trustworthy. The remainder of this article is structured as follows: the next section presents the background on innovations in rural markets and loyalty incentives, followed by a review of the literature on loyalty incentives through ICT platforms.
5.2 Background

5.2.1 Innovation in rural markets of emerging economies

While large cities in emerging economies are increasingly becoming centres of innovation, innovation is often less self-evident in rural areas. Most important innovations in food production in emerging markets occur in so-called peri-urban areas surrounding the cities, where more intensive forms of agricultural production are adopted (cf., Cohen, 2006; Duranton, 2015). Agricultural economists have, however, pointed out that such innovations in peri-urban areas are unlikely to provide enough food to the rapidly growing cities (Barrett, 2021; O'Hara and Toussaint, 2021). Other have therefore pointed out that integrating smallholder producers from remote rural areas into the food system is also essential for food provision to urban areas, pro-poor development, women empowerment, and other humanitarian reasons reflected in the Sustainable Development Goals (Fan and Rue, 2020).

Dissemination of innovation to smallholder farmers in remote rural areas (Mishra and Dey, 2018) is often few inputs (e.g., Ingenbleek et al., 2013) among smallholder farmers in remote areas (Adekambi et al., 2015; Adekambi et al., 2018).
Research on subsistence marketplaces has shown that people living in resource-deprived contexts develop coping strategies relying on social relationships with others (Viswanathan et al., 2012). In rural areas, the social fabric of communities helps to achieve a larger scale and efficiency and to share practices between actors, leading to a more uniform quality and joint marketing (Viswanathan et al., 2014). Within such joint marketing arrangements and reliance on social networks, innovation is not absent. Work on jugaad innovation (improved or make-shift solutions using scarce resources) has highlighted the typical characteristics of innovation processes that are driven by a shortage of productive resources compensated for by inventive ideas (Prabhu, 2017; Prabhu and Jain, 2015; Radjou et al., 2012). Authors working on frugal innovation specifically highlight the need to focus on essential attributes of products so that products can become more affordable and be repaired more easily (Knorringa et al., 2016). That way, they also fit the typical conditions of rural areas. The rapid dissemination of mobile phones in some emerging economies can, in that way also be seen as a frugal innovation that had a transforming impact on the rural areas (Adomako et al., 2023; Levänen et al., 2022). Building on the spread of mobile phones, the rapid development of mobile-based ICT platforms is a potential game changer in rural agricultural markets. Mobile-based ICT platforms offer new ways to reach small holders with SMS-based services such as information on markets, prices, weather forecasts and tailor-made extension advisory services in a timely and cost-effective way. This is especially important given that small holder farmers are often dispersed with relatively low purchasing power, and relatively few companies present to provide inputs to farmers and to purchase their outputs. The two-way interactive communication mechanism enabled by ICT platforms provide opportunities for previously unconnected buyers to reach small holder farmers and potentially contribute to strengthening relationships (Tong et al., 2020).
al., 2020; Vieira et al., 2019) Strengthening relationships through ICT platforms, however, requires that both farmers and buyers benefit from their interactions in a way that farmers access produce markets at fitting prices and buyers get the needed produce volumes. To achieve this, relationship building interventions such as loyalty incentives may help. Hence, advancing the potential to expand loyalty interventions among the base of the pyramid actors in rural areas

In short, while mobile-based ICT platforms clearly have the potential to overcome structural disadvantages associated with rural areas in emerging markets, concrete marketing interventions are needed to bring their potential to real impact. With absence of stable market relationships being an important barrier hindering progress, ICT platforms can be used to implement loyalty incentives among farmers with the aim to relationships with output buyers.

5.2.2 Conceptual framework

The dependent variable in our study is farmers’ loyalty to a buying company. Loyalty is a field of knowledge that is well developed within marketing. It was in particular popular in the late 1990s and early 2000s (e.g., Dick and Basu, 1994; Oliver, 1999) but also more recently it is a topic of investigation (Wolter et al., 2017; Ziliani, 2019). We draw on ideas from this line of literature to study how relationships between farmers and farm output buyers in rural markets of emerging economies can be strengthened. Loyalty refers to the degree to which an individual exhibits intentions to and repatronise loyalty object and possesses a positive attitudinal disposition toward the loyalty object (Oliver, 1997).

The existing literature accordingly classifies loyalty into two components: attitudinal and behaviour (e.g., Dick and Basu, 1994). While attitudinal loyalty measures the degree to which an individual prefers and affectively likes a loyalty object over another (Zeithaml et al., 1996) behavioural loyalty reflects behavioural intention or actual action of repeated patronage (Bolton and Lemon, 1999; Mittal and Kamakura, 2001). In our research context, where the challenge is to strengthen value chain relations through farmers’ planned sales decisions to a particular
To strengthen farmers’ loyalty, this study develops specific loyalty incentives to create value to a transaction between farmers and a specific output buyer to drive farmers’ commitment, and lead to loyalty (see the conceptual framework in Figure 5.1). Studies in the loyalty literature taking a trust-commitment perspective argue that loyalty emerges through commitment, satisfaction, and trust (Garbarino and Johnson, 1999; Morgan and Hunt, 1994; Palmatier et al., 2007). Satisfaction and trust are derived from an individuals’ past experiences with the loyalty object (Morgan and Hunt, 1994; Oliver, 1999). Loyalty incentives are any kind of compensation given to an individual before or during a transaction with the goal of changing their attitude and behavior towards the company or business giving the incentives (Keihan and Lee, 2006).

Innovations for Strengthening loyalty through ICT platforms
we include both monetary and non-monetary incentives in our framework as drivers of commitment.

Figure 5.1

Commitment is defined as “an enduring desire to maintain a valued relationship” (Morrison et al., 1992, p. 316). The commitment literature distinguishes three forms of commitment arising from different motivations. First, calculative commitment which best describes the attachment status based on cost-benefit evaluations created to maintain relationships. Second, affective commitment which best describes the emotional attachment created to maintain a relationship derived from feelings of identification and affiliation (Bansal et al., 2004b; Petzer and Roberts/Lombard, 2021). Third, normative commitment which results from a force or social antecedent that makes an individual feel that they ought to be committed to a certain firm or brand (Meyer et al., 1993; Shukla et al., 2016). Literature suggests that normative commitment is highly correlated with affective commitment with weaker effects (Bansal et al., 2004b), so we follow previous authors by not considering it in this study and to focus on affective and calculative commitment.

Chapter 5
We add two moderating variables to the model, namely trust in the ICT platforms and pressure from other buyers. We draw on trusted environment theory (Grayson et al., 2008) to include the variable trust in the ICT platform. In our context, we define trust in the ICT platform as the trust farmers have in the ICT platform and its agents. In our study context where visits are too costly to reach the widely dispersed farmers, communication of incentives through ICT platforms is virtually the only option. Farmers’ trust in the ICT platform can affect the impact of loyalty incentives.

We further include a variable on the pressure of other buyers that may moderate the relationship between commitment and loyalty. We define pressure from other buyers as the existence of other output buyers trying to achieve produce volumes and market share through attractive offers to farmers. In our study context, fierce competition for agricultural produce results in many traders active in the market that approach farmers with attractive offers but on short-term basis. As such, they put pressure on farmers to be disloyal to the focal buying company.

5.2.3 Hypotheses development

Loyalty incentives and commitment

According to the existing literature, loyalty incentives help induce perceived value beyond the actual exchange value, which makes individuals become more committed and loyal to the loyalty object (Burke et al., 2019; Dillon and Dambro, 2016). This relationship between perceived value and commitment, resulting in loyalty behaviour. In this way, loyalty incentives shift customers’ perspectives to not only enrol in a transaction but endure a relationship with the firm, and reinforce their loyalty behaviour (Steinhoff and...
In the farming context, this means that farmers not only enrol to purchase inputs like seeds and fertilizers to produce the quality and quantity of crops that output buyers prefer, but that they also intend to sell the outputs to these buyers at the end of the farming season. Different forms of loyalty incentives in that respect, result in different types of commitment (Johnson et al., 2006; Verhoef, 2003). When the benefits of financial incentives are evaluated to exceed costs, farmers will develop calculative commitment by purchasing and using inputs to produce and sell outputs to the buyer, otherwise, they will not commit. On the other hand, when the benefits of non-financial incentives foster a sense of belonging and emotional connection, farmers will develop affective commitment (Bombrï and Dekimpe, 2020; Dlamini and Chinje, 2019). Thus, we hypothesize:

H1: (a) Financial/ (b) non-financial incentives have a positive influence on farmers’ calculative/affective commitment.

Commitment and loyalty

Commitment and its customers; thus, loyalty is formed (Agarwal and Mehrotra, 2018; Melnyk and Bijnol, 2015) (Agarwal and Mehrotra, 2018; Melnyk and Bijnol, 2015) (Burnham et al., 2003; Lam et al., 2004) (Chiou and Droge, 2006).

Commitment and loyalty
be too high or because alternatives are not reliable. Similarly, Raïes et al. (2015) found positive effects of calculative commitment on high brand loyalty.

On the other hand, farmers with affective commitment develop an emotional bond and feel a strong connection to the focal buyer, which motivates them to maintain the relationship to preserve the emotional benefits, even when faced with economic uncertainties. De Ruytter et al. (2001) found that positive effects of affective commitment on influence the intention to continue the relationship because it is perceived as noncoercive resulting in a positive and agreeable exchange atmosphere which builds trust and mutual support.

Verhoef et al. (2002) found positive effects of consumers’ affective commitment on customer referrals and the number of services purchased, while Chiu and Droge (2006) found a strong effect of consumers’ affective commitment on behavioural loyalty intentions.

Following the above arguments, high levels of calculative and affective commitment will therefore make farmers less likely to switch to other competing produce buyers. Thus, we hypothesize as follows.

H2: Farmers’ (a) calculative commitment and (b) affective commitment positively influence their loyalty.

The moderating role of farmers’ trust in the ICT platform

According to Grayson et al. (2008), a trusted environment in which a set of companies and individuals operate, can have an effect on business relationships. In our study context where communication of incentives occurs through an ICT platform, the ICT platform is an important aspect of the business environment that farmers may put their trust in. We therefore define trust in the ICT platform as the trust farmers have in the ICT platform and its agents. It cannot be taken for granted that farmers indeed fully trust the platforms because ICT platforms are relatively new, and have not had much time to build trust among small holders. In the study by...
between the loyalty incentives and farmers’ commitment because the loyalty incentives are communicated through the ICT platform. In our study context, when farmers perceive the ICT platform to be fair and transparent, it enhances their trust and commitment to the focal buyer. Hence, trust in the ICT platform moderates the relationship between loyalty incentives (financial and non-financial) and farmers’ commitment (affective and calculative). Therefore:

H3: Farmers’ trust in the ICT platform positively moderates the relationship between (a) financial incentives and farmers’ calculative commitment, and (b) non-financial loyalty incentives and affective commitment.

The moderating effect of pressure from other buyers

While loyalty incentives may enhance commitment and, consequently, loyalty, the presence of competitors in the business environment can increase or reduce an individual’s loyalty (Ganesh et al., 2000; Pratt et al., 2022). Indeed, the business environment can increase or reduce an individual’s loyalty to a focal buyer. Pressure from other buyers is defined as the existence of other output buyers trying to achieve produce volume and market share through attractive offers to farmers. If there is more pressure from other buyers, the other buyers will make offers that are also calculatively or emotionally appealing. This makes the loyalty incentives offered to farmers by the focal buyer less unique or less appealing to farmers. As a result, farmers may switch to competitors because the value offered by the incumbent firm is perceived as lower than that offered by competitors. If there is more pressure from other buyers, the other buyers will make offers that are also calculatively or emotionally appealing. This makes the loyalty incentives offered to farmers by the focal buyer less unique or less appealing to farmers. As a result, farmers may switch to competitors because the value offered by the incumbent firm is perceived as lower than that offered by competitors.
5.3 Methodology

5.3.1 Study context

We test our hypotheses in the context of a loyalty intervention offered through an ICT platform, M-Omu l i mi s a (www.m-omulimas.com), implemented with soybean farmers in Lango subregion, Northern Uganda. Soybean production and marketing provide opportunities for farmers in this region to improve their incomes and nutrition, as soybean is a relatively cheap protein source for humans and livestock. However, the quantities that most farmers produce are relatively small. Hence, an important buying company of soybean produce was looking for ways to increase farmers’ production volumes of soybean at marketable quality levels. Due to a high demand for edible oils for human consumption and soybean cake for animal feed, the company is confronted with competition of new traders to bid on farmers’ soybean harvests. At the same time, farmers complain about the lack of reliable output buyers and low prices offered by output buyers, which affects their willingness to invest and use productive inputs. The lack of reliable output buyers indicates the lack of producer-buyer relationships which affect both buyers and farmers in terms of produce volumes and predictability of sales and prices, respectively.

In addition, Uganda offers the most dynamic agricultural ICT platform community in sub-Saharan Africa, with over 38 ICT platforms targeting farmers (GSMA, 2020). Most ICT platforms in Uganda facilitate exchange of agricultural information and input and output market prices to farmers. The M-Omu l i mi s a platform facilitates linkages to input suppliers and access ways to increase farmers’ production volumes of soybean at marketable quality levels.
seller relationships and is looking for ways to strengthen farmers’ access to output markets.

As such, the platform provides an excellent context for the focal buyer to test loyalty incentives that address the weak buyer-seller relationships.

Notably, the study was influenced by unanticipated contextual changes. Low production due to the long drought spell tripled the price for soybean in the country. Farmers could not match the required quantity threshold due to low production affected by the prolonged dry spell, while the focal buyer was driven out of the market due to high prices offered by its competitors. This had several consequences for the study. First, given that the buying company stepped out, we could not measure loyalty in terms of actual selling behavior and therefore relied on intentions to measure loyalty. Second, to assess whether farmers had experienced negative consequences from the loyalty incentives that were offered to them in the planting season and a buying company that was unable to keep these promises, representatives from the ICT company and the focal buyer joined the principal researcher of this study at debrief meetings with all participating farmer groups to ask about their experiences. Farmers indicated that their harvests were affected by the long drought spell but that they had not experienced any negative consequences arising out of the experiment because the high prices paid by other buyers compensated for their lower production levels and the absence of the incentives that were promised to them. In fact, during the debrief meetings, farmers requested that the loyalty arrangements would be continued in the next season. During the meetings, plans were developed for the next season to improve the distribution of inputs and credit access with the ICT platform to ensure that farmers can access the required inputs to increase their production in the next season.
5.3.2 Experimental Design

We tested our model and hypotheses with primary data obtained from a cluster randomized trial, implemented through the M-Omulimisa ICT platform. Our experiment consisted of five parts: (1) intervention design, (2) sample recruitment and random assignment of participants into treatments, (3) implementation of the loyalty incentives to manipulate our constructs, (4) sampling for post-treatment outcome measures, and (5) data collection. The timeline of our field experiment is presented in Appendix 5.1.

In the intervention design, the principal researcher designed loyalty incentives in consultation with experts from non-government organizations working with M-Omulimisa, farmer group representatives, and village agents. As a result, a price bonus equivalent to 0.03 USD for each kilo sold in addition to the prevailing market price used by the buyer, and tarpaulins (used by farmers for drying and winnowing their produce grain and improve their produce quality) were included as financial and non-financial incentives, respectively. Both financial and non-financial incentives were promised to farmers if they would supply at least 800 kg of soybean individually or 20,000 kg as a group to the focal buyer.

The experiment included three treatment groups (financial incentives (cash bonuses only), no financial incentives (tarpaulins only), both financial + non-financial incentives (both cash bonuses and tarpaulins) and a control (no incentives) group. By including a group that received both incentives we could accommodate a scenario in which the effects of the loyalty incentives are contingent on one another and farmers would develop loyalty thus only in response to receiving both incentives.

To inform farmers in the treatment groups about the incentives, they received SMS messages in the Langua local language on their mobile phones during the second planting season of 2021 (August to December 2021). Farmers in the control group did not receive any information about the loyalty incentives. All farmers, including those in the control group, received general innovations for strengthening loyalty through ICT platforms.
5.3.3 Sampling, questionnaire development and data collection

45 farmer groups derived from the ICT platform’s database were selected for the experiment.
For the farmer group, we randomly selected 5 respondents as a reserve list for replacement in case the selected farmers were unavailable or refused to take part in the survey.

Table 5.1 Respondent demographics

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Age (years)</th>
<th>Education</th>
<th>Household size</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>65</td>
<td>30.7</td>
<td>8</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Financial</td>
<td>52</td>
<td>31.8</td>
<td>8</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Non-financial</td>
<td>50</td>
<td>31.2</td>
<td>8</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Both</td>
<td>67</td>
<td>39</td>
<td>8</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

A structured questionnaire was developed in consultation with a research expert who had field research experience in the study area, ensuring translational validity (Ingebliick et al., 2013).

To check for clarity of questions and reduce ambiguity, a pre-test with a preliminary questionnaire was conducted among 40 farmers selected from one of the communities outside the villages covered by this study (Ingebliick et al., 2013). This allowed to improve the questionnaire further.

Prior to data collection, the questionnaire was programmed onto a computer tablet using Open Data Kit (ODK), and enumerators were trained covering all aspects in the questionnaire to ensure understanding of the interview process, clarity of measurement variables, concepts and administration of the interview process (Ingebliick et al., 2013).

To identify the selected respondents for the survey, we used the ICT platform’s village agents after which research enumerators approached the respondents and requested their voluntary participation before the interviews. All respondents that were approached accepted to be interviewed. In cases where the respondents were not available during the day of data collection and a day that followed, other group members from the reserve list replaced them. The interviews lasted between 45 and 60 minutes on average and the use of a computer tablet helped achieve all responses in such a way that the enumerator would not proceed to the next question.
Chapter 5

The data collection was conducted during the marketing season, at the time when farmers make output sale decisions but before the focal company announced that it wouldn’t purchase soybean in the season. We used phone-based SMS to inform farmers that the focal buyer would not proceed with the buying arrangement due to low produce volumes and high prices. After data collection and at the end of the buying season, briefing meetings with farmers were conducted by the principal researcher together with representatives from the platform and the focal buyer to understand farmers’ experiences as already indicated in section 3.1.

5.3.4 Construct measurement

A total of five constructs were used in the study as illustrated in Table 1. Four of the constructs’ items (affective, calculative, trust and loyalty intention) were identified from previously validated scales and adapted to suit the context of this study. Loyalty intention was adapted from Johnson et al. (2006) and include the respondents’ selling intentions to and recommending the loyalty buyer to others. Trust items were adapted from measures of system trust by Grayson et al. (2008). Their system trust items focused on government regulators while ours focused on the ICT platform as a broader context in which farmers receive the information on the loyalty intervention. The items focused on whether the respondent believes that the ICT platform offers consideration to the respondents before taking actions in terms of the information shared is fair, sincere, honesty and the platform people behind the platform are fair and just. Responses to all construct items were made on 5-point

3


Chapter 5
Like scales (1 = strongly disagree, 5 = strongly agree). For one construct (pressure from other buyers), items were developed following suggestions in the literature (Rossiter, 2002). We first specified the domain of content that the construct was intended to capture based on a pre-test.

Then we developed indicators that capture those important aspects of pressure from other buyers from the perspective of the small holder farmers. The items focused on whether and how the respondents faced demands from other buyers to lure them to sell their produce. Responses to the construct items were made on a 5-point Likert scale (1 = very little extent, 5 = very large extent). To depict the Likert scale length to the respondents in our study context, we measured stick lengths corresponding to the Likert scale were used as a point of reference.

<table>
<thead>
<tr>
<th>Constructs</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculative commitment</td>
<td>234</td>
<td>1.00</td>
<td>4.57</td>
<td>2.7253</td>
<td>.88473</td>
<td>.783</td>
</tr>
<tr>
<td>Affective commitment</td>
<td>234</td>
<td>1.17</td>
<td>4.83</td>
<td>2.7692</td>
<td>.94744</td>
<td>.898</td>
</tr>
<tr>
<td>Trust in ICT platform</td>
<td>234</td>
<td>1.57</td>
<td>4.29</td>
<td>3.0971</td>
<td>.62606</td>
<td>.392</td>
</tr>
<tr>
<td>Loyalty</td>
<td>234</td>
<td>1.00</td>
<td>4.50</td>
<td>2.9430</td>
<td>.96818</td>
<td>.937</td>
</tr>
<tr>
<td>Pressure from other buyers</td>
<td>234</td>
<td>1.00</td>
<td>3.60</td>
<td>2.3718</td>
<td>.48644</td>
<td>.237</td>
</tr>
</tbody>
</table>

Table 5.2

Innovations for Strengthening loyalty through ICT platforms

Chapter 5

Table 5.2 presents the descriptive statistics of the constructs while Table 5.3 presents the construct items and sources.
<table>
<thead>
<tr>
<th>Construct</th>
<th>Items</th>
<th>Descriptions</th>
<th>Loadings</th>
<th>$a$</th>
<th>CR (rho_a)</th>
<th>CR (rho_c)</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Loyalty intentions</strong></td>
<td>LI 1</td>
<td>I consider the focal buyer to be my first choice to sell my produce.</td>
<td>.827</td>
<td>.916</td>
<td>.919</td>
<td>.935</td>
<td>.704</td>
</tr>
<tr>
<td></td>
<td>LI 2</td>
<td>It is very likely that I would sell my produce to the focal buyer next season</td>
<td>.873</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LI 3</td>
<td>I would recommend the focal buyer to other farmers.</td>
<td>.824</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LI 4</td>
<td>I would only consider selling my produce to the focal buyer if they offered higher prices than other buyers.</td>
<td>.836</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LI 5</td>
<td>I would sell my produce to the focal buyer again even if other farmers would not.</td>
<td>.837</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LI 6</td>
<td>Other buyers are not able to convince me to sell to them.</td>
<td>.838</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Affective commitment</strong></td>
<td>Af 1</td>
<td>I feel emotionally connected to the focal buyer.</td>
<td>.645</td>
<td>.882</td>
<td>.892</td>
<td>.911</td>
<td>.632</td>
</tr>
<tr>
<td></td>
<td>Af 2</td>
<td>I am proud to belong to the focal buyer’s network.</td>
<td>.840</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Af 3</td>
<td>I feel a sense of belonging to the focal buyer’s network.</td>
<td>.829</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Af 4</td>
<td>The relationship that I have with the focal buyer is something that I really care about.</td>
<td>.793</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Af 5</td>
<td>I would feel lost if my relationship with the focal buyer no longer exists.</td>
<td>.804</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Af 6</td>
<td>The relationship that I have with the focal buyer is very much like being with family.</td>
<td>.842</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Calculative commitment</strong></td>
<td>Ca 1</td>
<td>It would be very hard for me to leave the focal buyer right now, even if I wanted to.</td>
<td>.672</td>
<td>.868</td>
<td>.874</td>
<td>.899</td>
<td>.561</td>
</tr>
<tr>
<td></td>
<td>Ca 2</td>
<td>My farming would be disrupted if I didn’t sell to the focal buyer.</td>
<td>.811</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ca 3</td>
<td>I feel that I have too few options to consider not selling to the focal buyer.</td>
<td>.822</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ca 4</td>
<td>The relationship that I have with the focal buyer deserves my maximum attention to maintain.</td>
<td>.728</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ca 5</td>
<td>The relationship that I have with the focal buyer is something I intend to maintain.</td>
<td>.804</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ca 6</td>
<td>The relationship that I have with the focal buyer is of less value to me.</td>
<td>.695</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ca 7</td>
<td>Right now, staying with the focal buyer is a matter of necessity as much as desire.</td>
<td>.695</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Trust in the ICT platform</strong></td>
<td>Tr 1</td>
<td>I can trust the information received on my phone completely.</td>
<td>.663</td>
<td>.907</td>
<td>.824</td>
<td>0.863</td>
<td>.514</td>
</tr>
<tr>
<td></td>
<td>Tr 2</td>
<td>I can count on my phone network (dropped)</td>
<td>.781</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tr 3</td>
<td>The information received on my phone is truly sincere and honest.</td>
<td>.852</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tr 4</td>
<td>The connectivity in my area cannot be counted on.</td>
<td>.694</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The items in the questionnaire consisted of the actual name of the buyer but has been replaced with “focal buyer” for purpose of keeping the object anonymous.
5.3.5 Data analysis

Data were analysed using partial least squares structural equation modeling (PLS-SEM), a causal predictive approach designed to provide causal explanations (Hair et al., 2019). PLS-SEM was used for data analysis due to its unique advantages. First, PLS-SEM is a good technique for studies aiming to test complex relationships between constructs, which was also the case in this study (Sarsst et al., 2019). Thus, it is a preferred technique for theory testing which fits smaller sample sizes as is the case in our study (Hair et al., 2019). We used four dummy variables for the categories of loyalty incentives financial, non-financial and a combination of both financial and non-financial. The fourth dummy variable (control group) served as our reference category.

5.4 Results

5.4.1. Measurement model

Following Hair et al. (2019), we check the quality of the measurement model on: reliability, convergent validity, and discriminant validity. According to Table 2, Cronbach’s alpha and composite reliability values were all greater than the recommended value of .7 (Hair et al., 2019), indicating reliability was achieved. Next, convergent validity was examined by assessing the factor loadings and average variance extracted (AVE). We first inspected the loadings of individual items on their corresponding construct (Fornell and Larcker, 1981). Loadings above .70 are recommended, as they indicate that the construct explains more than 50 percent of the indicator’s variance (Hair et al., 2019), thus providing acceptable item reliability. Items with low loadings were eliminated (Trust 2 for trust in the ICT platform construct and Pressure 5 for pressure from other buyers construct). Then PLS algorithm was rerun, and the results were satisfactory. While some indicator loadings were less than .7, they were preserved since the constructs’ composite reliabilities exceeded the acceptable requirement of .7 (Hair et al., 2019). All AVEs were greater than .5 (Table 5.3), ranging from .514 to .704 which indicates that the constructs' reliability is acceptable.
Construct explains at least 50 percent of its items (Hair et al., 2019). The above results indicate that convergent validity was attained in this study.

The Heterotrait-Monotrait ratio (HTMT) criteria was used to evaluate discriminant validity, the extent to which a construct is empirically distinct from other constructs in the structural model (Henseler et al., 2015). According to Table 5.4, all HTMT values were less than the .85 conservative threshold (Henseler et al., 2015). Thus, supporting the conclusion that discriminant validity was established.

Table 5.4

<table>
<thead>
<tr>
<th></th>
<th>Affective</th>
<th>Calculative</th>
<th>Loyalty Intention</th>
<th>Pressure from buyers</th>
<th>Trust in ICT platform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affective</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calculative</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loyalty Intention</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure from buyers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trust in ICT platform</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.4.1.1 Model fit

Multicollinearity was checked using the variance inflation factor (VIF) for all items. Results showed all VIFs of individual items were below the threshold of 3.3. Common method bias was...
5.4.2 Structural model and hypotheses testing

After the measurement of the model’s validity and reliability and the overall model fit were adequately confirmed, the SmartPLS 4 bootstrap approach was applied with a 5,000 samples (Hair et al., 2019). Table 5.5 demonstrates the SEM analysis results below.

<table>
<thead>
<tr>
<th>Paths</th>
<th>Coefficients</th>
<th>t-statistics</th>
<th>p-values</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct effects path analysis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial</td>
<td>Calculative</td>
<td>1.329***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial</td>
<td>Affective</td>
<td>1.801***</td>
<td>16.471</td>
<td></td>
</tr>
<tr>
<td>Non-financial</td>
<td>L1</td>
<td>0.480***</td>
<td>9.791</td>
<td></td>
</tr>
<tr>
<td>Non-financial</td>
<td>Affective</td>
<td>0.352***</td>
<td>7.244</td>
<td></td>
</tr>
<tr>
<td>Calcuative</td>
<td>1.224***</td>
<td>8.072</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affective</td>
<td>1.663***</td>
<td>16.240</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mediation path analysis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial</td>
<td>L1</td>
<td>0.638***</td>
<td>4.701</td>
<td></td>
</tr>
<tr>
<td>Financial</td>
<td>Affective</td>
<td>0.634***</td>
<td>6.832</td>
<td></td>
</tr>
<tr>
<td>Non-financial</td>
<td>L1</td>
<td>0.588***</td>
<td>5.296</td>
<td></td>
</tr>
<tr>
<td>Affective</td>
<td>0.586***</td>
<td>5.900</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Moderation path analysis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial</td>
<td>Calculative</td>
<td>.120</td>
<td>.145</td>
<td>.885</td>
</tr>
<tr>
<td>Non-financial</td>
<td>Affective</td>
<td>.016</td>
<td>.154</td>
<td>.881</td>
</tr>
<tr>
<td>Loyalty</td>
<td>.095*</td>
<td>1.859</td>
<td>.063</td>
<td></td>
</tr>
<tr>
<td>Loyalty</td>
<td>.051</td>
<td>.958</td>
<td>.338</td>
<td></td>
</tr>
<tr>
<td>L1</td>
<td>.168</td>
<td>3.806</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L1</td>
<td>.221</td>
<td>2.021</td>
<td>.039</td>
<td></td>
</tr>
<tr>
<td>L1</td>
<td>.058</td>
<td>1.208</td>
<td>.261</td>
<td></td>
</tr>
</tbody>
</table>

Note: Significance level \( p < .01 \) (***) \( p < .05 \) (**) \( p < .10 \) (*)

2006; Hair et al., 2014).
The results shown in Table 5.5 indicate that Hypotheses 1a and 1b predicting positive effects of financial and non-financial incentives on farmers’ calculative and affective commitment, respectively, are supported. These positive effects are indicated by significant and positive coefficients: financial incentives ($\beta = 1.329; p < .01$); non-financial incentives ($\beta = 1.801; p < .001$).

In addition, positive effects of a combination of both financial and non-financial loyalty incentives on calculative ($\beta = 1.224; p < .01$) and affective commitment ($\beta = 1.663; p < .01$) were also observed. Moreover, Hypotheses 2a and 2b predicting positive effects of calculative and affective commitment on farmers’ loyalty intention, respectively, is supported as indicated by the positive and significant path coefficients: calculative commitment ($\beta = .480; p < .01$) and affective commitment ($\beta = .352; p < .01$).

5.4.2.1 Mediation analysis results

As our model suggests mediation paths from loyalty incentives via commitment to loyalty intention, we also conducted a mediation analysis (Preacher and Hayes, 2008). The study results show a positive mediation effect of calculative commitment from financial loyalty incentives to loyalty intentions ($\beta = .638; p < .01$). In addition, a positive mediation effect of affective commitment from non-financial loyalty incentives to loyalty intentions is observed ($\beta = .459; p < .01$). The results further show positive mediation effects of calculative commitment ($\beta = .588; p < .01$) and affective commitment ($\beta = .586; p < .01$), from a combination of both financial and non-financial loyalty incentives to loyalty intention.

5.4.2.2 Moderation analysis results

Regarding the moderation results shown in Table 5.5, Hypothesis 3a predicting a moderating effect of trust in the ICT platform on the relationship between financial incentives and calculative commitment is not supported ($\beta = - .120, p > .05$). In addition, Hypothesis 3b predicting a moderating effect of trust in the ICT platform on the relationship between non-financial incentives and affective commitment is not supported ($\beta = .016, p > .05$).
Chapter 5

Moderation effects of pressure from other buyers on the relationship between commitment (affective and calculative) and loyalty intention was also examined. Hypothesis 4a predicting a negative moderating effect of pressure from other buyers on the relationship between calculative commitment and loyalty intention is not supported (β = .095, p < .10). Furthermore, Hypothesis 4b predicting a negative and significant moderating effect of pressure from other buyers on the relationship between affective commitment and loyalty intention is not supported (β = -.051, p > .10). While we did not find moderation effects, our results show that pressure from other buyers has a negative and significant effect on loyalty intentions (β = -.168, p < .01). In addition, trust in the ICT platform has a positive and significant effect on calculative commitment (β = .221, p < .05, but with no significant direct effect on affective calculative commitment (β = .058, p > .05).

5.5 Discussion

This paper examined the influence of ICT-based loyalty incentives on farmers’ loyalty intentions, and the mediating and moderating effects of commitment and pressure, respectively, in an agricultural rural market context. We find significant positive relationship between loyalty incentives and farmers’ loyalty intentions to the focal buyer. While our theory is mostly supported, three results require further discussion.

First, in our moderation analysis we did not find significant effects of trust in the ICT platform on the relationship between loyalty incentives (financial and non-financial) and commitment (calculative and affective), while we expected to find positive effects. A possible explanation could be that the loyalty incentives themselves have strong effects, and are not hindered by the trust in the ICT platform especially in our context where the platform performs its job quite well and employs village agents who work as intermediaries between the platform and farmers. Thus, as argued by (Gray et al., 2008) trust in the environment (here the ICT platform) is...
Second, we predicted a negative and significant effect of pressure from other buyers on the relationship between commitment (calculative and affective) and loyalty intention. Our study found instead an indicative positive effect of pressure from other buyers on the relationship between calculative commitment and loyalty intention, while results on effective commitment were non-significant. For the indicative positive effects on the relationship between calculative commitment and loyalty intention, one explanation is that farmers have had previous negative experiences with other buyers which then lead to a positive effect on the relationship with the focal buyer. In addition, the positive effect on calculative commitment only and not with affective commitment could be due to farmers’ rational evaluation of trade-off of risks and benefits from the focal buyer. Hence the need to earn the loyalty incentive helps to turn the balance in favour of the focal buyer even when other traders show up in the market.

Overall, the stronger direct effects of pressure from other buyers on loyalty intention indicate that the change in the market structure due to many traders entering the market, leads to change in loyalty intention. Our findings are in that respect consistent with those of Kwaamba et al. (2022) who find that small holders’ market participation is positively associated with the market credibility and financial outcomes, driven by the need to make a profit from their farm production. Thus, business environments can increase or reduce an individual’s loyalty behaviour to the firm offering loyalty incentives (Liu and Ansari, 2020; Pratt et al., 2022).

5.6 Implications and conclusions

5.6.1 Theoretical implications

...
literature focuses mostly on the role of these platforms as information sharers, we show that information sharing can be used to achieve deeper objectives. By sharing information of loyalty incentives, ICT platforms can in fact contribute to the stability of relationships in increasingly turbulent rural markets.

With that, ICT platforms contribute to the development of stable value chains that can increase a stable food supply to meet the growing demand in urban environments.

Given the importance of loyalty incentives in relationship building and loyalty (Ramaswami and Arunachalam, 2016), our study shows that the loyalty literature can be broadened to the entire new context of rural markets in emerging economies with a high social relevance. This opens new doors for this body of knowledge: it can help to fix market failures in less affluent parts of the world.

Furthermore, the present research conceptualized and operationalized a new construct—pressure from other buyers, a market structure-focused variable which has not been explored in the literature and which is of particular relevance to relationship marketing research in the increasingly turbulent context of agricultural rural markets. Thus, the study helps to understand that, relationship building does not only depend on social factors within farming communities but also external factors have an impact and should be viewed as dynamic which may alter existing market structures and relationships. This finding aligns with prior findings, linking competitive offerings in the market to loyalty (Kwarabam, 2021).

In recent times, the surge in technological advancements in smallholder agricultural market systems have transformed the digital landscape offering opportunities for value chain actors to interact with each other. Our work also demonstrates how output market buyers can leverage digital innovations as a strategic resource to gain competitive advantage to implement loyalty instruments that yield loyalty and performance.

Our study findings suggest that even within more pervasive face-to-face interactions between...
buyers and sellers, ICT platforms are effective tools that can be used to build actor’ relationships

5.6.2 Practical implications

ICT platforms as potential partners that can stimulate smallholders’ food production to increase

Innovations for Strengthening loyalty through ICT platforms
5.6.3 Limitations and future research

Finally, we discuss the limitations and some directions for future research. First, our measure for loyalty focuses on intentions rather than actual behaviour. This is a limitation because while studies in the loyalty literature use intentions to predict actual loyalty behaviour, we cannot prove that such a gap is not present in our study. Second, loyalty incentives in our study are limited to price bonus and tarpaulins as financial and non-financial incentives, respectively, and experimented with one single crop, soybean. These results may vary with other types of incentives that use cash or other types of incentives and assessed with other staple crops such as maize or rice.

Third, the results of this study are based on an experiment with samples drawn from an existing ICT platform within an already established relationship with farmers. These results may be valid for this specific context and may vary in other settings where previous ICT use among farmers is absent. Moreover, while this setting is not unique, it has the unusual feature of long-term interaction between the farmers and the ICT platform. Future research could explore and compare different ICT contexts to allow generalization of the research outcomes, in a comparative study. Fourth, we conducted this study within one crop season. Future research should consider developing long-term loyalty interventions and measuring loyalty over time and determine the long-term effects.
5.7 Conclusion

This research set out to empirically test the effect of financial and non-financial loyalty incentives on farmers' loyalty intentions while testing for the mediating role of commitment (affective and calculative) and moderating roles of trust in the ICT platform and pressure from other buyers. The results of the study reveal that both loyalty incentives work in a rural context with effects strong enough on their own, and even stronger combined and that it doesn't even matter whether they are financial or non-financial, but they do influence farmers' marketing decisions. The results show that loyalty incentives can stand pressure from other buyers and trust in the ICT platform. While this study contextualized loyalty in existing literature, developing these types of loyalty incentives in small holder agricultural value chains in emerging economies is new, and shows potential to be developed into loyalty schemes for reciprocal, long term value chain gains.
Appendix 5.1: Timeline of our field experiment

<table>
<thead>
<tr>
<th>Experimental steps</th>
<th>when</th>
<th>Who</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention design</td>
<td>July 2021</td>
<td>Principal researcher in consultation with experts</td>
</tr>
<tr>
<td>Sample recruitment and random assignment of participants into treatments</td>
<td>July 2021</td>
<td>Principal researcher</td>
</tr>
<tr>
<td>Implementation of loyalty incentives to manipulate our constructs, August 2021 - December 2022</td>
<td></td>
<td>Principal researcher and ICT platform</td>
</tr>
<tr>
<td>Sampling for post-treatment outcome measures</td>
<td>January 2022</td>
<td>Principal researcher</td>
</tr>
<tr>
<td>Post-treatment measurement of outcomes</td>
<td>January - February 2022</td>
<td>Principal researcher and enumerators</td>
</tr>
<tr>
<td>Send announcement to withdraw from market</td>
<td>February</td>
<td>Principal researcher, ICT platform, and the focal buyer</td>
</tr>
<tr>
<td>Debriefer meetings</td>
<td>March 2022</td>
<td>Principal researcher, ICT platform, and the focal buyer</td>
</tr>
</tbody>
</table>
Appendix 5.2: Loyalty intervention information sent to individual farmers across the treatment and Control groups

<table>
<thead>
<tr>
<th>Financial</th>
<th>Non-Financial</th>
<th>Financial + Non-financial</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st set</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd set</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd set</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The buying season is here, as "focal buyer", we are ready to buy your soybean produce. Our bulk centres are located at . . . . . . . . . . . . . . . . . , . . . . . . . . . . . . . . Contact us on . . . . . . . . . . . . . . . . . . . . . . .

As you bring your produce to the bulk centre, make sure our buying agents record your name, produce supply and your group name, in order for your group to be awarded bonus points that will earn you the offered price bonuses of 100 shs per kilo if your group brings 20 tonnes and above of soybean produce. "focal buyer"

To earn your price bonuses, make sure you receive a supply card indicating your ID number, quantity of produce supplied and the name of your group. "focal buyer"

To earn your gift rewards of tarpaulins, make sure you receive a supply card indicating your ID number, quantity of produce supplied and the name of your group. "focal buyer"

To earn your price bonus and gift rewards of tarpaulins, make sure you receive a supply card indicating your ID number, quantity of produce supplied and the name of your group. "focal buyer"

As you can see, we will not be able to proceed with the buying arrangements due to low produce volumes and high prices. We regret the inconvenience and are open to having meetings with you to improve on our relationships. Our main buying centre in Lira town remains open to buy other produce. "focal buyer"
Chapter 6

General Discussion and Conclusions
6.1 Introduction

The rapid growth of ICT platforms continues to increase due to donor funding and commercial investments, which are predicted to continue (CTA, 2019). ICT platforms have been widely implemented in Sub-Saharan African agriculture to solve and enhance smallholders’ farm productivity by facilitating access to production information, inputs, output markets and other related services such as microfinance and index insurance. It is argued that such platforms can solve most of the challenges faced by smallholders as they have the potential to reach many scattered farmers with information and market linkage so that farmers can reach higher-value markets and increase their incomes. While ICT platforms are sometimes called digital-enabled technologies or digital tools, they all mean web and mobile-based digital tools that are used to share information and services to smallholder farmers.

This thesis focused on Uganda as a study case, a country with over 38 ICT platforms. These platforms include extension advisory tools, market information apps, and web-based information-sharing platforms, among others.

Most ICT platforms started from an information-sharing focus, with extension advisory services taking the biggest share to push agricultural technologies by building awareness about using inputs such as seeds, fertilizers, agro-chemicals, and other farm equipment. Over time, it has been realized that information provision alone cannot push adoption as farmers also require linkage to input dealers that supply these inputs, but also to output markets and other barriers, many platforms have evolved, while new ones are being set up, to provide linkage to inputs, output markets and other services simultaneously. This thesis reconciles these arguments in literature to understand the roles ICT platforms can play to enhance the uptake of smallholders to boost farm productivity and contribute to food security.

services (Chavas and Nauges, 2020; Ezeomah and Duncombe, 2019). To solve these additional
To achieve the overall aim, we started by focusing on ICT platforms as the object of investigation in Chapter 2. We explored the motivations and actions of ICT platforms in a qualitative case study of four ICT platforms, to understand the strategies used by the four ICT platforms in improving the uptake of agricultural inputs among smallholders and their future strategic directions. Comprehensive empirical insights from this chapter showed how ICT platforms have started converging towards becoming coordinators of value-chain ecosystems in order to solve many value-chain challenges faced by smallholder farmers. However, we also realised that most of the ICT platforms focused on smallholder farmers alone. Using the new service development literature that argues for value propositions for all actors in service design, we then zoomed into one of the ICT platforms in Chapter 3, to try to understand what core value chain actors need from ICT platforms.

The findings in Chapter 3 proposed loyalty interventions as one of the synergistic service needs among key actors of the value chain, for ICT platforms to build relationships and loyalty among the key actors, specifically between farmers and input providers and output buyers. The results from Chapter 3 resulted in loyalty interventions in Chapters 4 and 5, to assess the effects of such loyalty interventions on farmers’ use of inputs, yield increments and loyalty to a specific output buyer. Hence, the thesis evolved to address the following research questions: (1) What strategies do different types of ICT platforms use to improve the uptake of agricultural technologies among smallholder farmers? (2) What do actors need from ICT platforms in smallholder-based value chains? (3) What is the effect of an ICT-coordinated loyalty intervention with an assured produce market on farmers’ use of agricultural inputs and crop yields? (4) What is the effect of loyalty incentives on farmers’ loyalty behaviour?

Discussion and Conclusion
6.2 Overview of the main findings

Building on rich literature from economics, business ecosystem, marketing and qualitative data from four case studies of ICT platforms in Uganda, Chapter 2 explored the strategies used by ICT platforms to increase smallholders’ uptake of productive inputs and their future strategic directions. The study revealed that ICT platforms adapt their strategies with regard to market system positioning, services offered, and value co-created with other value chain actors to influence farmers’ use of inputs. Unlike the ICT platforms that did not adapt their strategies, those that adapted their strategies influenced farmers’ use of inputs more. As a result, the ICT platforms had started converging towards becoming coordinators of value-chain ecosystems in order to solve the many value-chain challenges faced by smallholder farmers.

The dynamic positioning of ICT platforms within the market system, their services, the value they co-create and their strategic direction indicate their recognition of the need to address challenges faced by smallholders simultaneously. With such evolution, this chapter proposes that the capacity of the people behind these ICT platforms is therefore built to develop sustainable business models that enhance value from ICT platforms without depending on external donor funds.

The focus of a single case ICT platform in Chapter 3 showed that various key value chain actors require similar ICT services. Synergistic needs among these actors were value chain coordination by the platform, loyalty building, digital literacy for farmers and multifaceted ICT interfaces. On the other hand, the identification of preferences for interface design features led to diverging preferences with respect to simple or advanced interface features. Specifically, farmers preferred a simple feature phone whereas the remainder of the value chain actors preferred a smart phone. The actor preferences for ICT interface design features resulted in trade-offs in interface preferences which included “reach versus efficiency”
The other trade-off is “inclusion versus exclusion” (use of English and impede farmers’ access to ICT services and exclude their participation in ICT-based value chains). The findings of this chapter emphasize the need for ICT platforms to first prioritize needs that cut across all value chain actors and make trade-offs about whose needs they consider most important, an idea that was developed further in Chapter 4.

Based on insights provided in Chapter 3 and particularly the synergistic need for loyalty building to correct output market uncertainties and improve farmers’ access to output markets identified as a factor that hinders the use of agricultural inputs—Chaprer 4 assessed the effects of an ICT-based loyalty programme on farmers’ use of inputs and yields. Using a cluster randomized controlled trial, this chapter provided evidence that the financial and non-financial benefits of an ICT-based loyalty programme with output market linkages positively influence farmers’ use of agricultural inputs and soybean yields. This chapter also provided evidence that loyalty incentives, already common with larger firms, are also effective in smallholder-based value chains, thereby advancing the knowledge on loyalty interventions for sustainable intensification of agricultural production and technology adoption through ICTs.

In Chapter 5, we further extended the evidence on the effects of loyalty incentives on smallholders’ loyalty to the specific output buyer. The findings in this chapter show that loyalty incentives offered through an ICT-platform have a positive effect on farmers’ loyalty towards the output buyer, thereby contributing to the development of stable value chains through relationship building. We also showed that the effect is generalizable across financial and non-financial incentives, and that both types of loyalty incentives stimulate different types of commitment (calculative and affective) respectively. The findings of this chapter help to explain why loyalty instruments eventually influence loyalty, suggesting that relationships in...
6.3 Boosting farmers’ use of inputs through ICT platforms

Smallholder-based agricultural value chains are composed of smallholder farmers and other independent actors, including input suppliers for seeds and fertilizers, small-scale aggregators (buyers), whole. sales/traders, extension agents and service providers, such as microloan banks and, in some cases, insurance companies (Aguyeke et al., 2020; and the inadequacy of both public and private extension systems to cover the often widely dispersed farmers (Munthali et al., 2018). Reaching Dey, 2018). Such challenges limit farmers’ access to information and markets for inputs, and other services within agricultural value chains and improve farmers’ use of agricultural
As indicated by previous research on value chains, our findings agree and argue that farmers’
use of inputs requires more than just providing agricultural information. Improving use of inputs
necessitates linking to both input and output markets simultaneously in order to resolve the
barriers to uptake (Lambrecht and Ragasa, 2018; Mishra and Dey, 2018), a role that ICT
platforms can fulfill as seen in this thesis. A case in example from this thesis is how one of the
ICT platforms has continued to disseminate soybean technologies even after a project
disseminating legume technologies in Uganda ended, with linkage to improved seed through
micro loans now available to rural farmers through the platform. If input and output markets
are coordinated simultaneously, increased use of inputs for food production is to be expected.

An important insight from Chapter 4 is that while development resources have gone into
developing low-cost agricultural innovations such as inoculants to boost smallholders’
productivity for soybean, their availability among farmers’ communities and knowledge of their
benefits is needed to increase their use and yields even more. Thus ICT platforms could further
their roles by predicting or forecasting input demands and coordinate with the suppliers to
arrange logistics in time for farmers.

6.4 ICT platforms as one stop centres for value chain services and linkages

Cost agricultural innovations such as inoculants to boost smallholders’
productivity for soybean, their availability among farmers’ communities and knowledge of their
benefits is needed to increase their use and yields even more. Thus ICT platforms could further
their roles by predicting or forecasting input demands and coordinate with the suppliers to
arrange logistics in time for farmers.

Discussion and Conclusion
In this study, we show that, despite availability of ICT platforms trying to reach the smallholders, none of the platforms under study provided all the services farmers needed. As such, farmers abandon the ICT platforms if the design and services do not meet their expectations (Kieti et al., 2022).

In Chapter 2, we showed that the developers behind ICT platforms go through a learning process— as emphasized by the literature on organizational learning leading to changes in strategies and practices (Santa and Nurcan, 2016) and evolving into new roles, as discussed in...

To improve ICT-based value chain coordination and enhance use of agricultural technologies among smallholders, ICT platforms need to orient themselves towards the needs of not only the smallholders, but also the different actors that provide services to smallholders to create value for all (cf. Kohli and...)

By coordinating and aligning value chain services to all actors’ needs, as revealed in Chapter 3, ICT platforms can stimulate the use of ICT services among their users and create mutual benefits for all value chain actors, hence increasing farmers’ access to value chain service that stimulate use of inputs. Thus, a one-stop centre ICT platform can reduce transactions costs across the value chain and ensure that farmers access all the required services to produce and market their produce without the need to register and navigate different platforms that cause digital fatigue.

6.5 Enhancing actor relationships through ICT platforms

Considering that there is a mismatch of needs and services provided by ICT platforms, in Chapter 3 we revealed the importance of involving users in the design process to create ICT services that meet their needs...

Magesa and Jonathan, 2022) using a smallholder-centred design as a specific case of user-oriented approach helped identify synergies and trade-offs in service needs and interface preferences among key value chain actors. The insights from Chapter 3 helped design a loyalty...
financial loyalty incentives on farmers’ use of inputs and yields relationships through interactions to share information and commit to actions (Mukhtar and Azhar, 2020) and marketing (Graham, 2019; Steinke et al., 2021). The positive effects of ICT-based financial and non-financial loyalty incentives on farmers’ use of inputs and yields indicate that enhancing gains from ICT platforms is important to enhance gains from ICT platforms and marketing without excessive transaction costs, but the rapid dissemination of mobile phones (Fabregas et al., 2019; Gupta et al., 2020). Chapters 4 and 5 show (Leliveld and Knorringa, 2018), are game changers in the context of our study to strengthen actor relationships and transform rural agricultural markets. The context of our study with a competitive market environment (CSA, 2015). The region has seen soybean production replace cotton growing, which Haas, 2021; Walusimbi, 2002). With the potential to increase farmers’ incomes nutrition for humans and livestock, as a way to rebuild the region, large investments have been to enhance soybean production. Such innovations have also come with interventions in value chain
Chapter 6

Historically, agricultural cooperatives were seen as vehicles that can enhance farmers’ access to market linkage through bulk marketing and price negotiation (Magnus and Schoonhoven-Speijer, 2020). With lack of institutional support, mismanagement of major cotton and coffee cooperative led to their collapse. Although, the national development plan vision 2030, focuses on rebuilding cooperatives (NPDA, 2013), past experiences remain a threat to their re-development. The advent of ICT platforms in smallholder agriculture, however, provides an opportunity to strengthen marketing relationships between the farmers and output buyers to benefit from their interactions in a way that farmers access produce markets at fitting prices, and buyers can obtain the needed produce volume.

6.6 Multifaceted interfaces for one stop centre-based ICT platforms

Historically, agricultural cooperatives were seen as vehicles that can enhance farmers’ access to market linkage through bulk marketing and price negotiation (Magnus and Schoonhoven-Speijer, 2020). With lack of institutional support, mismanagement of major cotton and coffee cooperative led to their collapse. Although, the national development plan vision 2030, focuses on rebuilding cooperatives (NPDA, 2013), past experiences remain a threat to their re-development. The advent of ICT platforms in smallholder agriculture, however, provides an opportunity to strengthen marketing relationships between the farmers and output buyers to benefit from their interactions in a way that farmers access produce markets at fitting prices, and buyers can obtain the needed produce volume.

6.6 Multifaceted interfaces for one stop centre-based ICT platforms

To design a one-stop ICT interface and enable access to the required value chain services, Chapter 3 demonstrated how ICT platforms can integrate different needs and challenges by paying particular attention to the social cultural disparities, capabilities and business goals of various value chain actors (i.e., language, literacy, and efficiency requirements). ICT-based services have largely made agricultural information and knowledge accessible to farmers through the use of simple mobile phones that use USSD code (Abdulai et al., 2023). With the increasing availability of mobile phones, the internet, and emerging technologies such as big data analytics (Wolfer et al., 2017), Chapter 3 emphasizes that investments for ICT services should be centered around designing multifaceted interfaces that integrate both simple feature phone and smartphone tools. Such tools need to be tailored to different languages, and type of...
Discussion and Conclusion

6.7 Digital literacy for farmers

To optimise interactions, linkages, service delivery, and improve the use of ICT services among smallholder-based value chains (McCampbell et al., 2021a). To tackle this challenge, we agree that digital literacy is crucial for farmers in using ICTs effectively. Training and retraining farmers in using mobile phones is critical for functional ICT-based value chains (Abdullahi et al., 2021; McCampbell et al., 2021b). Furthermore, awareness campaigns led by ICT platforms and other stakeholders, like government and communication companies, can improve digital literacy among farmers (Giampaolo et al., 2020; Steinke et al., 2021; Van der Burg et al., 2019).
6.8 Limitations and opportunities for future research

While my thesis contributes to the small holder literature on use of ICT platforms to enhance uptake of agricultural inputs and yields, it inevitably leaves unexplored avenues for future research. First, we addressed the relationship between ICT platforms and small holders’ uptake of production technologies based on one case for each archetype of ICT platforms, in a qualitative manner. Future research assessing different pathways could further test these effects quantitatively. This thesis showed that learning on the part of ICT platforms regarding orientation towards users (farmers and other key actors) is essential to stimulating uptake of inputs. As such, there may be many micro-level barriers (e.g. interface design and service marketing) that impede ICT platforms from stimulating uptake, that may be overlooked by managers who consider only strategic aspects, as discussed in this thesis. Further research could explore these micro-level barriers to understand how they could be solved.

Second, this thesis provides important insights into the relevance of eliciting all value chain actors’ needs and preferences in a (re)design process of ICT services for the development of small holder-based value chains. Namely, developing multifaceted interfaces that integrate different actors’ design interface preferences. I recognise that developing such an interface could enhance coordination of the entire value chain while enhancing mutual value for all actors. Therefore future research is needed to collect empirical evidence on the impacts of such recommendation.

Third, this thesis tested the effect of financial and non-financial loyalty benefits of an ICT-coordinated loyalty intervention on smallholders’ use of inputs in the context of soybean inputs (improved seed varieties, fertilisers and inoculants) and small holders in Northern Uganda. We were not able to assess effects on the use of inoculants because the absolute numbers of farmers using such an input being very small. We recognise that institutional gaps and logistic arrangements of such a loyalty intervention may be different for other parts of the country and...
the role of farmers’ experiences with the ICT platform and the inputs in farmers’ uptake of

Finally, while this thesis took steps to identify roles ICT platforms could play in reducing market uncertainties through relationship and loyalty building between farmers and buyers, the factors that disrupt value chain development such as influx of many buyers locally and regionally resulted in ways higher prices that could not be matched by the output buyer. Thus, we could not extend our research to investigate effectiveness of ICT-coordinated loyalty intervention on farmers’ actual selling behaviour.

In a nutshell, while ICT platforms are assumed to be silver bullets in facilitating and fostering agricultural value chain linkages cost-effectively, our study results show it is not so much in how fancy the digital platforms are, but how they address the user’s needs as well as how well they coordinate the ‘physical’ process.

6.9 Implications for practitioners and policy makers
### Table 6.1

<table>
<thead>
<tr>
<th>Practitioners</th>
<th>Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Policy</td>
<td>The need for policy interventions to create a conducive business environment such as improved physical infrastructure, better network connectivity and access to cheap internet for rural areas to support ICT-coordinated value chains.</td>
</tr>
<tr>
<td>• ICT developers</td>
<td>ICT services should prioritise solutions that cut across the needs of different actors, for mutual benefits. ICT platforms should learn from each other and acquire new skills and knowledge, and reduce costs by engaging in cost-sharing collaborative arrangements with other actors within the market system. ICT platforms could join forces through mergers and acquisitions or form an industry organisation that facilitates learning and harmonisation. ICT platforms should develop multifaceted interfaces that integrate tools for both simple-feature phones and smart phones, customised to different languages, different types of media, e.g. audio, video, SMS, etc., to cater to the preferences of different value chain actors. ICT platforms alone are not enough, the functioning of these platforms still relies on the physical presence of such as village agents. Hence, managers of ICT platforms need to develop their own capacity and the capacity of those they work with to ensure quality and reliable information exchange. They must develop their capacity in terms of human resources, as well as the capacity of those on whom they rely to provide this range of services (village agents) if they are to play multiple roles, including demand articulation, network building, knowledge brokering.</td>
</tr>
<tr>
<td>• Other value chain actors</td>
<td>Input suppliers and companies need to develop viable business models for the delivery of inputs such as fertiliser and rhizobial inoculants to ensure greater access by farmers in rural areas. Addressing the low use of inputs and low yields among smallholder farmers necessitates improving farmers’ physical linkage to inputs through input loans, quality inputs within their localities and knowledge about the benefits and use of the inputs. In collaboration with ICT platforms, other value chain actors need to build trust with each other through loyalty interventions and ensure delivery of timely and quality services such as inputs, output pick up, micro credit access, etc. Such arrangements will enhance buyer relationships, increase price transparency and exchange of credible marketing information to pull investment in input use by farmers.</td>
</tr>
</tbody>
</table>

### 6.10 Concluding remarks

For the last ten years of working in agricultural value chains in Uganda and specifically in central, eastern, southwestern and Lango sub-regions, I have had a chance to interact with different market-based interventions for various crops including pine apple, apple bananas, etc.
Discussion and Conclusion

...
References
Summary
Acknowledgements
About the Author
Completed training and supervision plan


References


Bohnen, H. (2018). The little we know: an exploratory literature review on the utility of mobile


Belley, A., Muoni, T., Öborn, I., Bergqvist, G., Nzihouba, G., Watson, C., Vanlaewen, B., and


Barnes, A. P., Muoni, T., Öborn, I., Bergqvist, G., Nzihouba, G., Watson, C., Vanlaewen, B., and


Bohnen, H. (2018). The little we know: an exploratory literature review on the utility of mobile


Belley, A., Muoni, T., Öborn, I., Bergqvist, G., Nzihouba, G., Watson, C., Vanlaewen, B., and


Barnes, A. P., Muoni, T., Öborn, I., Bergqvist, G., Nzihouba, G., Watson, C., Vanlaewen, B., and

References
References


Fornell, C., and Larcker, D. F. (1981). Structural equation models with unobservable variables and measurement error: Algebra and statistics. Sage Publications Sage CA: Los Angeles, CA.


Journal of Marketing 80, 36-68.


Journal of Business & Industrial Marketing.


JSI Research & Training Institute Inc., Arlington.


Journal of Marketing 74, 128-146.


Journal of the Academy of Marketing Science 32, 293-311.


References


new ICT platforms for agricultural extension in Ghana.

NJAS-Wageningen Journal of Life Sciences 86, 64-76.


References


Information Technology for Development 28, 558-584.


International Journal of Agricultural Sustainability 19, 549-565.


Global Food Security 20, 101-104.


Journal of Marketing Education 39, 47-60.


Wo l t e r ,  J .  S . ,  B o c k ,  D . ,  S m i t h ,  J .  S . ,  a n d  C r o n i n  J r ,  J .  J .  ( 2 0 1 7 ) .  C r e a t i n g  u l t i m a t e  c u s t o m e r  l o y a l t y  t h r o u g h  l o y a l t y  c o n v i c t i o n  a n d  c u s t o m e r-c o m p a n y  i d e n t i f i c a t i o n .  J o u r n a l  o f  R e t a i l i n g  9 3 ,  4 5 8 -4 7 6 .

W o o d s ,  M . ,  M a c k l i n ,  R . ,  P a u l u s ,  T . ,  a n d  A t k i n s ,  D .  P .  (2 0 1 6 a ) .  A d v a n c i n g  Q u a l i t a t i v e  R e s e a r c h  U s i n g  Q u a l i t a t i v e  D a t a  A n a l y s i s  S o f t w a r e  ( Q D A S ) :  R e v i e wi n g  P o t e n t i a l  V e r s u s  P r a c t i c e  i n  P u b l i s h e d  S t u d i e s  u s i n g  AT L A S .  t i  a n d  N V i v o ,  1 9 9 4-2 0 1 3 .  S o c i a l  S c i e n c e  C o m p u t e r  R e v i e w  3 4 ,  5 9 7 -6 1 7 .

W o o d s ,  M . ,  P a u l u s ,  T . ,  A t k i n s ,  D .  P . ,  a n d  M a c k l i n ,  R .  (2 0 1 6 b ) .  A d v a n c i n g  q u a l i t a t i v e  r e s e a r c h  u s i n g  q u a l i t a t i v e  d a t a  a n a l y s i s  s o f t w a r e  ( Q D A S ) :  R e v i e wi n g  p o t e n t i a l  v e r s u s  p r a c t i c e  i n  p u b l i s h e d  s t u d i e s  u s i n g  AT L A S .  t i  a n d  N V i v o ,  1 9 9 4–2 0 1 3 .  S o c i a l  S c i e n c e  C o m p u t e r  R e v i e w  3 4 ,  5 9 7 -6 1 7 .

W o r l d  B a n k ,  G .  (2 0 1 8 ) .  “ I n f o r m a t i o n  a n d  c o mmu n i c a t i o n s  f o r  d e v e l o p me n t :  D a t a - d r i v e n  d e v e l o p me n t , ”  R e p .  N o .  T e c h .  R e p .  N o .  1 2 8 3 0 1 .  W o r l d  B a n k .

W u ,  L.-Y . ,  C h e n ,  K.-Y . ,  C h e n ,  P .-Y . ,  a n d  C h e n ,  S .-L .  (2 0 1 4 ) .  P e r c e i v e d  v a l u e ,  t r a n s a c t i o n  c o s t ,  a n d  r e p u r c h a s e - i n t e n ti o n  i n  o n l i n e  s h o p p i n g :  A r e l a t i o n a l  e x c h a n g e  p e r s p e c t i v e .  J o u r n a l  o f  b u s i n e s s  r e s e a r c h  6 7 ,  2 7 6 8 -2 7 7 6 .

W u ,  X . ,  a n d  G e r e f f i ,  G .  (2 0 1 8 ) .  A m a z o n  a n d  A l i b a b a :  I n t e r n e t  g o v e r n a n c e ,  b u s i n e s s  m o d e l s ,  a n d  i n t e r n a t i o n a l i z a t i o n  s t r a t e g i e s .  I n  “ I n t e r n a t i o n a l  b u s i n e s s i n  t h e  i n f o r m a t i o n  a n d  d i g i t a l  a g e ” .  E m e r a l d  P u b l i s h i n g  L i m i t e d .

W y c h e ,  S . ,  a n d  O l s o n ,  J .  (2 0 1 8 ) .  G e n d e r ,  M o b i l e ,  a n d  M o b i l e  I n t e r n e t | K e n y a n  W o m e n ’ s  R u r a l  R e a l i t i e s ,  M o b i l e  I n t e r n e t  A c c e s s ,  a n d  “ A f r i c a  R i s i n g ” .  I n f o r m a t i o n  T e c h n o l o g i e s  &  I n t e r n a t i o n a l  D e v e l o p m e n t  1 4 ,  1 5 .

Y i ,  Y . ,  a n d  J e o n ,  H .  (2 0 0 3 ) .  E f f e c t s  o f  l o y a l t y  p r o g r a m s  o n  v a l u e  p e r c e p t i o n ,  p r o g r a m  l o y a l t y ,  a n d  b r a n d  l o y a l t y .  J o u r n a l  o f  t h e a c a d e m y  o f  m a r k e t i n g  s c i e n c e  3 1 ,  2 2 9 -2 4 0 .

Y i n ,  R .  K .  (2 0 0 9 ) .  “ C a s e  s t u d y  r e s e a r c h :  D e s i g n  a n d  m e t h o d s , ”  S a g e .
References


The demand for food is growing globally due to population growth, growing incomes and rapid urbanisation. In Africa alone, food demand is projected to double by 2050. Yet, food production depends on rain-fed subsistence agriculture, characterised by low levels of input use and low productivity due to decreasing soil fertility and shrinking farms. Various agricultural innovations have been deployed to enhance productivity and incomes for smallholders. However, smallholders’ use of such technologies has remained generally low, worsened by rising production risks and uncertainties driven by climate change. Agricultural technology adoption constraints are well documented; are largely information (weather, input, output and financial markets) and knowledge-related, besides infrastructure and human capital.

The recent proliferation of mobile-based Information Communication Technologies (ICT) in sub-Saharan Africa presents a great opportunity to reach many farmers with information on new varieties, weather forecasts, prices and market information in a timely manner. Various studies have explored how the application of ICT platforms could improve the uptake of agricultural input technologies in smallholder agriculture in sub-Saharan Africa. However, the evidence of the impacts of ICT platforms on smallholders’ uptake of agricultural technologies is mixed. There are concerns about whether ICT platforms should prioritise: input markets, output markets, or perhaps both, to create transparency on the incentives for farmers to “pull” and “push” investments in inputs. This thesis explores and analyses the roles of ICT platforms on farmers’ uptake of agricultural input technologies and find entry points for improved functioning of ICT platforms in smallholder-based value chains to boost farm productivity and contribute to food security, focusing on Uganda, as a case.

In Chapter 2, I explored the motivations and actions of ICT platforms in a qualitative case study of four ICT platforms, to understand the strategies used by the four ICT platforms in improving the uptake of agricultural inputs among smallholders and their future strategic directions. The
In this chapter, the insights from previous chapters have been combined to show how ICT platforms are starting to converge towards becoming coordinators of value-chain ecosystems to solve many value-chain challenges faced by smallholder farmers. Insights from Chapter 2 showed that most of the ICT platforms focused on smallholder farmers alone. Using the new service development literature that argues for value propositions for all service design actors, I then zoomed into one of the ICT platforms in Chapter 3 to try to understand what core value-chain actors need from ICT platforms. The findings showed that value-chain actors indeed require similar ICT services such as value-chain coordination, loyalty building, digital literacy for farmers, and multifaceted ICT interfaces. Results also showed a preference for simple and advanced interface features, specifically, a simple feature phone for farmers and a smartphone for the remainder of the value-chain actors. The findings of this chapter emphasize the need for ICT platforms to first prioritize needs that cut across all value-chain actors and make trade-offs about whose needs they consider most important. This idea was developed further in Chapter 4.

Based on insights provided in Chapter 3 and particularly the synergistic need for loyalty building to correct output market uncertainties, Chapter 4 examined the effects of loyalty incentives shared by an Information and Communication Technology (ICT) platform on farmers’ use of agricultural inputs and soybean yields using survey data from 234 farmers in Northern Uganda. The results indicated a significant ($P < 0.001$) influence of financial and non-financial loyalty incentives on farmers’ use of improved seed and fertilizer compared with no incentive. Average soybean yields significantly increased above the control (619 kg ha\(^{-1}\)) by 525, 747, and 854 kg ha\(^{-1}\) for non-financial, financial, and a combination of financial and non-financial loyalty incentives, respectively.
Financial incentives, respectively. The findings showed that the financial and non-financial benefits of an ICT-based loyalty programme with output market linkages positively influence farmers’ use of agricultural inputs and soybean yields. This chapter also provided evidence that loyalty incentives (common with larger firms) are also effective in smallholder-based value chains, thereby advancing the knowledge on loyalty interventions for sustainable intensification of agricultural production and technology adoption through ICTs.

In Chapter 5, the evidence in Chapter 4 was extended to assess the effects of loyalty incentives on smallholders’ loyalty behaviour to the specific output buyer. The findings showed that loyalty incentives offered through an ICT platform have a positive effect on farmers’ loyalty, thereby contributing to the development of stable value chains through relationship building. The results also show that the effect is generalisable across the financial and non-financial incentives, and both types of loyalty incentives stimulate different types of commitment (calculative and affective), respectively. The findings of this chapter help to explain why loyalty instruments eventually influence loyalty, suggesting that relationships in agricultural value chains are strengthened more effectively when the new ICT institutions are also trustworthy.

To increase access and use of ICT services among smallholder-based value chain actors, this study emphasizes that investments in ICT services should be centered around designing multifaceted interfaces that integrate both simple feature phone and smartphone tools. Such tools need to be tailored to different languages and types of access (on-demand, online, and offline) to help bring on board all value chain actors for functional ICT-based value chains.

Furthermore, to optimise interactions, linkages, and service delivery and improve the use of ICT services among smallholder-based value chain actors, this study strongly recommends digital literacy training for farmers and awareness campaigns led by ICT platforms and other stakeholders such as government and telecommunications companies. Digital literacy among farmers will enhance the role of ICTs in creating efficiency in business processes and supporting...
local decision-making, i.e., production information, marketing processes (bulk batching, produce batching/pickups), inputs delivery, extension delivery, etc., making ICT-based value chains functional.

The positive effects of ICT-based financial and non-financial loyalty incentives on farmers’ use of inputs and yields indicated that enhancing relationships through interactions to share information and commit to actions is important to enhance gains from ICT platforms. Notably, this study highlights the role of ICT platforms in fostering relationships, trust, and loyalty between value chain actors, which is critical for correcting market uncertainties that hinder farmers’ uptake of agricultural inputs. This chapter strongly recommends integrating tools and mechanisms that enhance information exchange and interactions to improve trust and build strong buyer-seller relationships among key value chain actors.

Overall, this current study recommends a one-stop centre ICT platform to reduce transaction costs across the value chain and ensure that farmers access all the required services to produce and market their produce without the need to register and navigate different platforms that cause digital fatigue. A one-stop will ensure a well-functioning and coordinated value chain between the demand and supply of agricultural markets (inputs, outputs, microcredit, and associated services) across value chain actors. To do this, ICT platforms need to orient themselves towards the needs not only of the smallholders but also the needs of the different actors that provide services to smallholders for mutual benefit.
Acknowledgements
I would like to express my gratitude to all people who contributed to the completion of this thesis and supported me throughout the PhD journey. First and foremost, I am sincerely thankful to my promoters Dr. Paul Ingenbleek and Prof. Ken Giller. Dear Ken, you gave me a special opportunity to pursue a PhD within the N2 Africa project. I remember vividly the day we discussed about this opportunity while on a field mission in Northern Uganda. It was such an overwhelming moment, and I am so much indebted to you for this special opportunity and for believing in me and the potential that I didn’t see then.

Throughout my thesis research, your guidance, broader views, and perspectives, helped me to think beyond the specific research context. Your critical and constructive feedback on each chapter is immensely appreciated even when the marketing jargon became too much for you. Dear Paul, it is more than words to explain your contributions to bring this thesis to a successful completion. Coming from a practical background, it was not easy to develop an all-round research competence required to carry on the challenges of the PhD study. You unreservedly shared with me your professional expertise which helped me to develop my research competence gradually. You always offered support and solutions even when things became fuzzy, and your patience with me in this process is admirable. The level of details at which you saw each and every section of my research documents, and your critical and constructive comments helped me to advance my research ideas. You allowed me come up with ideas and helped me shape them into what they are today. You frequent checks and calls while in the field and work from home during the COVID pandemic is overwhelmingly appreciated. While the Covid pandemic came with its challenges at personal level, you gave me hope and continued to support and believe in me. For that, I am very much indebted to you. Thank you always bringing me back on track when I lost the momentum due to either health reasons or just the heaviness of the PhD trajectory. Your understanding, guidance, and support was exceptional, particularly during the last year of my study through thesis submission. Thank you so much.
I am grateful to Dr. Peter Ebanyata and Dr. Esther Ronner, for their contributions to my PhD research. First, Peter thank you for your mentorship during our earlier N2 Africa interactions that led me to pursue this PhD. I remember asking you a few questions about the PhD trajectory and you affirmed my abilities and told me it was possible. You taught me so much about research and development within the N2 Africa project, which experience and lesson am grateful for. You believed in me, and that was the most important thing to me. Someone who could affirm with me that I was capable even when I wasn’t sure of myself and what it meant. To Esther, your enthusiasm and support was everything I needed, especially towards the end of my PhD journey. You gladly took on the mantle to support me and did it with one heart. From sitting in the same office at IIITA Uganda to you becoming my cheer leader while in the Netherlands, your moments of pondering became mine. Thank you for supporting me in this journey, your critical questions helped to shape the direction of this PhD thesis. The experience you shared with me and your advice regarding doing PhD far from family, particularly kids, helped me lot, I thank you. I would like to thank the members of the thesis committee Prof. Dr. Bedir Tekinerdogan, Dr. Marcia Kwaramba, Dr. Maria Annosi, and Dr. Rico Liefor for their time and dedication in reviewing my thesis and taking part in the public defense. It is an honor for me to have you on my thesis committee. At Marketing and Consumer Behaviour Group (MCB), I would like to thank all my colleagues for your support, the conducive work environment you created and the insights we shared. I particularly thank my PhD colleagues who willingly shared their experiences and knowledge with me. To Jurrian, thank you for coming to my rescue when my code was messed up. You helped me with a smile that continues to live with me. To my office mates, Paul, Solomon and later Cas, thank you for allowing me brainstorm with you. The time we spent opening marketing text books for concepts and definitions will forever remain in my heart. The hearty conversations we had as far as football, events and others are appreciated because through such conversations I was.
energized to continue on my research. To staff members, thank you for your support, comments and time we shared. Particularly, I want to thank Prof. Hans van Trij for supporting me when the tough going. Thank you for always looking out for me even when you were not part of my research supervisory team. To Ynte, Ilonna, and Brigit, your everyday or other day checks were what I needed to keep me going. Thank you for asking the right questions of how I was doing personally and my family. I am grateful to Ellen Vosse for being so kind and supportive throughout my time within Wageningen and in Uganda. Your dedication is admirable and MCB is lucky to have you. I thank Tamiru for always being available to support me. Right from working with N2 Africa in different countries to pursuing our PhD research and even after for you, we remained friends and available to support each other. I don’t take your friendship and support for granted. I thank all MCB colleagues, former and present, with whom I shared ideas and inspirations during coffee breaks, and the memorable MCB days and PhD days. Giulia and Xin, thank you for always cheering me on before and after you graduated. At Plant Production Systems (PPS), I thank all PPS and N2 Africa colleagues for the interactions we had. I would like to thank my Friends at WUR especially the Africans with whom I shared ideas, worries, and our dreams while being in Wageningen. I am grateful to Emmanuel, Bethlehem, Matthew, Mesfin, Emokol, Leon and the Friday crew. Thank you for allowing me share my bits and pieces during my stay in Wageningen. Emmanuel, we were not only country mates who previously shared offices while I was at IITA and you at IFPRI, but became friends, and shared our PhD journeys. My PhD became yours and yours became mine. It got interesting that we were also researching on the same crop and in the same field location. I am forever indebted to you. To Matthew, thank you is an understatement, you were always there to listen to my worries and held my hand throughout the time I got to know you. Both of us working on digitalization made it easier to discuss and agree to disagree, thank you for being my friend and always checking on me. To Bridget, your home became our home.
Acknowledgements

food in your home ‘slapped’ differently. I am forever

indebted to you for supporting us and bringing us food while at Forum because it got tougher
even to cook a meal.

In Uganda, I would like to thank my former colleagues at IITA and especially the administration
for allowing me use of office facilities at IITA even after the project ended. I also thank the M-
Omullimi company for enabling me conduct my research within your organisation. I want to say, while
it’s a new phenomenon, I have learned a lot and through my research work, I affirm that your work
indeed important for improving access to agricultural services among farmers. I look forward to continuing
our collaborations. I also thank all data collectors for their collaboration with me in collecting data and for
commencing the task with due responsibility. I thank all farmers, particularly those in northern Uganda, for
being so kind to share their time and opinion in conducting my thesis research. Paul Nales and Doereen, I am
so happy to have you as my paronym. To Paul, we have shared so much, the successes and worries together.
You are such a nice colleague that during my last minute stretch you kept reminding me to go slow and not
stay too long. I am sure I didn’t listen to you 70 percent of the time but I appreciate you very much. I look
forward to seeing each other after the PhD. To Doereen, we talked for a while before physically meeting
and indeed you are a very warm person who made me pleased to be on your team. Thank you for bringing
sunshine to the Ugandan Community in WUR.

Lastly but not least, I would like to convey my sincere thanks to my family and friends. First, I
am sincerely indebted to my top cheer leader, ‘G for life’ Leonard, for your unconditional support
throughout my study period and beyond. Leonard, you didn’t hesitate to allow me to go abroad for my study.
You took the mantle to take care of Elsie and our other children without hesitation. Your commitment to
seeing me complete this research was so amazing that without your support the completion of this PhD
was impossible. Your patience with me when
things got tough is admirable and I got you in my corner. Second, to Elsie, I have always said and admired your resilience throughout my PhD for the time I was away from you, either in the field or abroad. Being away from you was the most gruesome experience of my PhD journey but as you grew up, you became so understanding when explained to. You kept asking about my class, exams and teacher.

While you didn’t ask for this PhD as a child, you handled my absence with grace. I apologize for being away from you and not giving you the motherly care you deserved. You inspired me and championed my PhD dream. Thank you for being my inspiration and strength throughout my study and this thesis is dedicated to you. Third, to my mother Rose Abwooli, you gave me the educational foundation that has seen me reach far in life. Thank you for not giving up on us and always available to support us. You fought so many battles to endure that we went to school and gave us the best education you could. My success today is the result of the seed you sow in me. I am eternally grateful for you and may God keep you safe to see the works of your hands. Fourth, to my late dad, the dream you had has come to pass. I remember you constantly telling me how I should go for a PhD and become a doctor. I don’t know why you always said so and I brushed it off but see, here we are. As I write these words, it’s been exactly 7 years and one day since you departed but my memories with you remain on. To my siblings and friends that became family, thank you for your support, and prayers. Fifth, my friends, Kessy, Julie, Tasha, Kai, Hans, Naomi, and Reliq who stepped in to give Elsie the best love she could get, I am forever grateful to you. Christine, you are not only my sister but my friend, thank you for your prayers and support. To Francesca and Maureen, thank you for always making me feel loved from afar. The prayers we had, and the check-ins became my source of strength. Special thanks to my friends that I have not mentioned here, God’s blessed children, F and F among others, thank you for supporting me in one way or another.

Connetie

234
About the Author
Connie Ayiigabor born in Hoima, Uganda, obtained her Bachelor’s degree in Development studies from Makerere University. She joined Swiss contacts where she served as a Junior officer and later project officer managing the Development Programme of the cooperation. During her tenure at Swiss contacts she worked with different value chains including coffee, pineapples, mushrooms, apple bananas and beekeeping. At Swiss contacts she contributed to the development of agricultural export markets working with exporters and producers. She also contributed to the development of a local mushroom training centre which saw increased production of mushroom seed and mushroom production among women in southwestern Uganda. She developed training manuals for farmer organisation development. While at Swiss contacts, she enrolled for a self-funding Master’s programme at Makerere University and obtained a Master’s degree in Rural Development majoring in Agribusiness Development. She joined Technoserve as a Business Development Advisor before joining the International Institute of Tropical Agriculture as a Business Development Officer for the N2 Africa project overseeing the partnerships and Business Development of the project. At IIITA, she contributed to the dissemination and uptake agricultural technologies, and development of agricultural input and output markets, and presented at national and international conferences. In 2018, she started her PhD at Wageningen University, Marketing and Consumer Behaviour group. Her PhD research focuses on the use of digital platforms in the uptake of agricultural inputs among smallholder farmers in an effort to improve farm productivity and contribute to food security for the growing population in Africa and globally.
Completed training and supervision plan
# Completed Training and Supervision Plan

## A) Project related competences

### A1 Managing a research project

<table>
<thead>
<tr>
<th>Name of the learning activity</th>
<th>Department/Institute</th>
<th>Year</th>
<th>ECTS*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managing a research project</td>
<td>WASS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Writing research proposal</td>
<td>WUR</td>
<td>2018</td>
<td>6</td>
</tr>
<tr>
<td>MCB Lunch meetings / seminars / PhD Day</td>
<td>MCB</td>
<td>2018</td>
<td>2</td>
</tr>
<tr>
<td>Searching and organizing literature</td>
<td>WUR Library</td>
<td>2018</td>
<td>0.6</td>
</tr>
<tr>
<td>Scientific writing</td>
<td>Wageningen In’to languages</td>
<td>2023</td>
<td>1.8</td>
</tr>
<tr>
<td>How to write great papers in less time</td>
<td>Prof. Dr. Christina Sichtmann</td>
<td>2021</td>
<td>2</td>
</tr>
<tr>
<td>Reviewing a Scientific Paper</td>
<td>WGS</td>
<td>2018</td>
<td>0.1</td>
</tr>
<tr>
<td>'The role of ICT platforms in smallholder agriculture'</td>
<td>IIITA Research seminar</td>
<td>2018</td>
<td>0.8</td>
</tr>
</tbody>
</table>

### A2 Integrating research in the corresponding discipline

<table>
<thead>
<tr>
<th>Name of the learning activity</th>
<th>Department/Institute</th>
<th>Year</th>
<th>ECTS*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creating frameworks for marketing and consumer behaviour, MCB</td>
<td></td>
<td>2017</td>
<td>6</td>
</tr>
<tr>
<td>Advances in legume science and practice 2 Association of Applied Biologists</td>
<td></td>
<td>2021</td>
<td>0.8</td>
</tr>
<tr>
<td>BREAD-I GC Virtual PhD Course on Firms and Development</td>
<td></td>
<td>2023</td>
<td>4</td>
</tr>
<tr>
<td>The Bureau for Research and Economic Analysis of Development (BREAD), in collaboration with the International Growth Centre (IGC)</td>
<td></td>
<td>2023</td>
<td>4</td>
</tr>
</tbody>
</table>

## B) General research related competences

### B1 Placing research in a broader scientific context

<table>
<thead>
<tr>
<th>Name of the learning activity</th>
<th>Department/Institute</th>
<th>Year</th>
<th>ECTS*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantitative data analysis: Multivariate Techniques</td>
<td>MAT, WUR</td>
<td>2019</td>
<td>2</td>
</tr>
<tr>
<td>Introduction to Rando Room PE&amp;RC &amp; WI MEK</td>
<td></td>
<td>2020</td>
<td>0.9</td>
</tr>
<tr>
<td>Farming systems and rural livelihoods: Paths to sustainable development</td>
<td>PE&amp;RC</td>
<td>2018</td>
<td>3</td>
</tr>
</tbody>
</table>

### B2 Placing research in a societal context.

<table>
<thead>
<tr>
<th>Name of the learning activity</th>
<th>Department/Institute</th>
<th>Year</th>
<th>ECTS*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformative partnerships, collaboration and engagement to address the pressing food system challenges of today and tomorrow</td>
<td>NL-CGIAR</td>
<td>2022</td>
<td>0.3</td>
</tr>
</tbody>
</table>

## C) Career-related competences/personal development

### C1 Employing transferable skills in different domains/careers

<table>
<thead>
<tr>
<th>Name of the learning activity</th>
<th>Department/Institute</th>
<th>Year</th>
<th>ECTS*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brain-friendly Working &amp; Writing</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total** 31.9
The research described in this thesis was financially supported by the Plant Production Systems group, Wageningen University and Research through the project N2Africa: Putting Nitrogen Fixation to Work for Smallholder Farmers in Africa (www.N2Africa.org) and, partially the Marketing and Consumer Behaviour Group.

Cover design by Connetie Ayesiga and Ron Zijlmans || www.ron.nu

Cover images: Shutterstock, Flaticon and RON Graphic power

Printed by Digiforce | www.proefschriftenmaken.nl

Copyright © 2023 Connetie Ayesiga
DIGITALISING AFRICAN AGRICULTURAL VALUE CHAINS
The Role of ICT Platforms in smallholders' uptake of agricultural inputs in Uganda

Connetie Ayesiga