Understanding the Dynamics and Diversity of Smallholder Farmers' Innovation Processes and Agricultural Innovation Systems in Uganda

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Declaration of Authorship

I confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

Rieko Shibata

Abstract

Smallholder farmers' innovations are very important for economic development and poverty alleviation in Sub-Saharan Africa (SSA), where the majority of the population relies on smallholding subsistence agriculture. Fuller understanding of smallholders' innovation systems and processes is a means to improve low innovation uptake and to address the mismatch that exists between innovation support and farmers' needs.

This research was conducted to explore the innovation systems and processes employed by smallholders with a diverse range of socioeconomic and environmental characteristics in Uganda. The study used a wide range of research tools including household and individual questionnaire surveys to 531 farmers, Focus Group Discussions (FGDs) with 166 farmers, in-depth interviews with 90 randomly selected farmers and participatory workshops.

Smallholders' AISs have been found to be highly complex and intertwined with various factors, knowledge and information systems, intra-household dynamics in decision-making authority, and social networks all of which are involved in innovation processes. The knowledge and information systems are influenced by the farmers' access to and perceptions of AIS actors, which then affects the utilisation of the knowledge. The intra-household decision-making authority is determined by gendered roles and responsibilities, reflected in gendered enterprises, and intra-household production asset allocation. Furthermore, low levels of innovation uptake were found to be related to unequal access to innovation networks and exclusive innovation systems.

The original contribution of this study includes empirical evidence that innovation is not only a technical but a social process, and socioeconomically and environmentally different farmers have different innovation systems and different experiences in their innovation processes. This provides a process-based view of AIS with "soft systems thinking" and can enhance the existing AIS framework with pro-poor and inclusive insights.

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List of Abbreviations

ACDP – Agriculture Cluster Development Project
AEP – Agricultural Extension Policy
AEZ – Agro-Ecological Zone
AGRA – Alliance for a Green Revolution in Africa
AIS – Agricultural Innovation System
AKIS – Agricultural Knowledge and Information System
ARUDIFA – Arua District Farmers Association
ASDSIP – Agriculture Sector Development Strategy and Investment Plan
ASSP – Agriculture Sector Strategic Plan
ATAAS – Agricultural Technology and Agribusiness Advisory Services
AU – African Union
BBW – Banana Bacterial Wilt
CAADP – Comprehensive Africa Agriculture Development Programme
CSO – Civil Society Organisation
DAES – Directorate of Agricultural Extension Service
DFA – District Farmers' Association
DRC – Democratic Republic of Congo
EAC – East African Community
EEI – Enabling Environment for Innovations
FAO – Food and Agriculture Organisation
FF – Farmer First
FFS – Farmer Field Schools
FG – Farmers' Group
FGD – Focus Group Discussion
FPR – Farmer Participatory Research
FSR – Farming Systems Research
FY – Financial Year
GMA – Gross Margin Analysis
GoU – Government of Uganda
Ha – Hectares
ICT – Information and Communication Technologies
ISSD – Integrated Seed Sector Development
KI – Key Informant
LC – Local Council

MAAIF – Ministry of Agriculture, Animal Industry and Fisheries
MoFPED – Ministry of Finance, Planning and Economic Development
NAADS – National Agricultural Advisory Services
NAEP – National Agricultural Extension Policy
NAES – National Agricultural Extension Strategy
NARO – National Agricultural Research Organisation
NARS – National Agricultural Research Systems
NAP – National Agricultural Policy
NDP – National Development Plan
NEPAD – New Partnership for African Development
NGO – Non-Governmental Organisation
NWSG – North Western Savannah Grasslands
ODK – Open Data Kit
OECD – Organization for Economic Cooperation and Development
OWC -Operation Wealth Creation
PID – Participatory Innovation Development
PICSA – Participatory Integrated Climate Services for Agriculture
PMA – Plan for Modernisation of Agriculture
PPI – Progress out of Poverty Indicator
PTD – Participatory Technology Development
RAAKS – Rapid Appraisal of Agricultural Knowledge Systems
R&D – Research and Development
REC – Research Ethics Committee
SACCO – Savings and Credit Cooperative Society
SAP - Structural Adjustment Programme
S/C – Sub-County
SDGs – Sustainable Development Goals
SMS – Subject Matter Specialists
SNA – Social Network Analysis
SSA -Sub-Saharan Africa
SSES – Single-Spine Extension System
SWF – South Western Farmlands
T&V – Train and Visit
TIMPS – Technologies, Innovations and Management Practices
TORA – Theory of Reasoned Action
ToT – Transfer of Technology

TPB – Theory of Planned Behaviour

TSP – Technology Supply Push

UBOS – Uganda Bureau of Statistics

UCA – Uganda Cooperative Alliance

UFAAS - Uganda Forum for Agricultural Advisory Services

UGX – Ugandan Shillings

UNADA – Uganda National Agro-Input Dealers Association

UNCST – Uganda National Council for Science and Technology

UNFF – Uganda National Farmers' Federation

USD – US dollars

USTA – Uganda Seed Trade Association

VSLA – Village Savings and Loan Association

ZARDI – Zonal Agricultural Research and Development Institute

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Chapter 1- Introduction

1.1 Study Rationale

1.1.1 Background

Understanding and supporting the innovations of smallholder farmers is key in the agenda for economic development and poverty alleviation in Sub-Saharan Africa (SSA), where the majority of the population relies on smallholder family farming for a livelihood. As recognised by the United Nations' Decade of Family Farming 2019-2028, family farming is crucial for achieving the sociocultural, economic and environmental sustainability of the rural ecosystems and livelihoods: its effects extend to global food systems. Supporting family farming is considered to be a multiplier for more effectively achieving the Sustainable Development Goals (SDGs). Farmers have been making changes in their farming practices for centuries, in accordance with their perceived problems and opportunities coping with the waves of globalization, commercialisation, degraded natural resources, climate change, and various sorts of policy changes surrounding them. However, understanding the multi-dimensional aspects of what shapes farmer's practices and innovation processes is rather limited.

The recent positive trend of agricultural growth in SSA reversing the decades of stagnation and neo-Malthusian pessimism is a manifestation of significant changes at farm level. As various studies suggest, this growth was brought about by increased urban demands for food, and the gradual intensification of small-scale family farming, whereby farmers made a range of innovations or changes by investing in improved seeds, fertilisers, tools, small-scale irrigation and hired labour, with their own savings (Wiggins, 2014). This is an indication that some smallholder farmers have shifted from 'hanging-in' to 'stepping-up' for higher level of productivity, according to the Dorward's categorisation of livelihood strategies and transformations (Dorward, 2009), while other farmers fail to intensify their farming. This demonstrates how important it is to avoid considering smallholder farmers as a single category, but instead to investigate their diversity.

Much evidence suggests that smallholder farmers have become increasingly heterogeneous in recent years. Jayne et al. (2010) reveal that there is a large disparity in land distribution among smallholders, and that about a quarter of smallholder households are becoming landless. A number of studies indicate that farmers' innovations are significantly influenced by their socioeconomic status and social networks. However, there are still limited studies capturing dynamic aspects of the innovation processes for different socioeconomic groups, without being biased towards a certain enterprise or technology.

The role of innovation support systems is critical for farmers seeking to make innovations, as farmers often rely on the novel knowledge and information from various actors in these systems. In a number of SSA countries, the innovation support model and policy have gone through a paradigm shift from Transfer of Technology (ToT) to the Agricultural Innovation System (AIS), following commercialisation trends and the multiplication of involved actors. In accordance with the Structural Adjustment Programme (SAP) and privatisation policy, the governments promoted pluralistic and demand-driven approaches either by adopting the approaches in the existing extension systems or by outsourcing the extension services to the private sector. The downsides of this type of reform, as reported in empirical studies, are inequality arising from advisory services favouring commercial farmers and fertile lands, the side-lining of resource-poor farmers, unwillingness to share information due to competition for markets, the absence of private actors from remote areas, rigid output-oriented and short-term contracts preventing the flexibility of extension services, failure in building farmers' capacity to articulate demand, and weak market linkages (Anderson and Feder, 2003, Garforth, 2004, Klerkx et al., 2006, Parkinson, 2009, Rivera, 2011, Chowa, 2013, Mambo, 2014).

This empirical evidence suggests that AIS should be unpacked and critically examined from the viewpoint of the farmers, who are the main users of AIS, rather than only at sectoral or national levels. If the failure of innovations is attributed to the failure of AIS, efforts should be made to identify the constraints on the use of AIS as perceived by the farmers whose resources and livelihoods are, as discussed earlier, widely diversified. It should be noted that different forms of innovation support have different importance for diverse categories of farmers, especially when agricultural investment from various AIS actors is booming, as in recent years. Innovations "induced" by innovation supporting actors are not socioeconomically neutral. The system is self-targeting. In some cases, the "induced" innovations can result in promoting inequality within the community and increasing vulnerability for those perceived as "laggards" (Dawson et al., 2016). Lack of understanding of diversified farmers' needs often leads to the provision of ineffective and inefficient innovation support, leading to low levels of interest in and uptake of innovations within the community. Therefore, this study aims to unpack smallholder farmers' innovation systems by analysing their real experiences of innovation processes and intends to decrease the knowledge gap, encouraging more pro-poor and inclusive innovation policymaking and implementation in the AIS framework at large.

1.1.2 Research Gaps and Problem Statement

Improving smallholder farmers' livelihoods needs positive changes or improvement in current farming practices and adaptation to the rapidly changing socioeconomic and biophysical environments and conditions. This is urgent, especially in many SSA countries, where the majority of the population relies heavily for subsistence on agriculture on small farms, and the ever-increasing population pressure on the limited and depleted natural resources is raising serious problems for food and nutrition security.

Despite the desperate need for innovation support interventions, smallholder farmers' innovation processes are still a black box. The lack of comprehensive understanding of farmers' innovation systems is perhaps the reason behind the low level of innovation uptake due to the mismatched support, which has been causing "aid fatigue". The recently emerged AIS literature declares, "Agricultural innovation typically arises through dynamic interaction among the multitude of actors involved in growing, processing, packaging, distributing, and consuming or otherwise using agricultural products." (World Bank, 2012, p. 3). Is this really happening in the SSA context, and how? Empirical AIS studies are largely lacking. More importantly, the existing AIS literature does not provide an adequate framework for pro-poor and inclusive innovation systems. The questions remain. What is the "dynamic interaction among the multitude of actors" supposed to be so beneficial for the poor? Are the poor part of the AIS, and how inclusive is the AIS?

The AIS approach is widely appreciated and increasingly adopted by researchers and policymakers, but the shortfalls of the approach are underreported. Such deficiencies include failure to consider the divergent and conflicting interests of interdependent actors

(Klerkx et al., 2012), the negligence of farmers (Spielman et al., 2011, Chowa et al., 2013, Garforth, 2013), excessive concentration on the commercialisation of (high value) commodities and insufficient emphasis on food crops, environmental sustainability or public goods (Assefa et al., 2009). Furthermore, some studies argue that innovation uptake is significantly influenced by the farmers' socioeconomic status and social networks (Adolwa et al., 2016, Saint Ville et al., 2016). However, some limited studies still capture dynamic aspects of the innovation processes for different socioeconomic groups, without being biased towards a particular enterprise or technology. Moreover, there is limited knowledge on AIS as "perceived" by farmers ("soft systems"), rather than "existing" AIS ("hard systems") at national, sectoral or project levels, and the access of different farmers to the various AIS systems.

Therefore, this study intends to contribute to the reduction of the knowledge gaps relating to innovation dynamics at individual, intra-household, and community levels in a holistic manner, and to provide implications for policy and practice in innovation support. The gaps include the different local innovation processes and systems for different socioeconomic categories of farmers, different farmers' perceptions of various types of AIS actors, and the relevance of current policy directions and actual practices to innovation constraints on poor smallholder farmers. "Knowledge" and "information" are critical parts of the farmers' innovation processes, as innovation results from the exchange of knowledge (Spielman et al., 2011) in the form of information. Those two terms should be distinguished: Engel (1997) defines "knowledge" as a personal asset consisting of an implicit concept or idea, and "information" as an explicit pattern produced by social actors and often imposed on a carrier such as radio or paper. However, both knowledge and information should be within the scope of this study, as they can be transformed from one to another and are thus difficult to separate. Furthermore, “network” and “system” are crucial themes for this study, as both define the patterns of exchange of knowledge and information. Networks and systems are similar, but the difference should be made clear. “Network” is a group of people or organisations: more particularly, “social network” means a mechanism connecting individuals to society by patterns of social interaction (Hoang et al., 2006). Social learning is the exchange or even generation of knowledge and information among a group or people or organisations within social networks. “System” is similar to “network”, but wider as the concept of “system” contains social and economic institutions and policies which are formal and informal “rules of the game in a society” (North, 1990). Therefore, the analysis of both “network” and “system” plays a vital role in this study. Above all, this study’s aim is to understand farmers’ innovation processes in the settings of their daily lives, in order to see the real picture of what is happening on the ground, rather than selecting research sites involved in development projects.

1.1.3 Rationale for Study Area -Why Uganda?

This research takes Uganda as a case study because of its large farming population, its rich experience of privatised demand-driven extension systems, and its currently on-going extension reform. Uganda ranks 14th highest in the world for the proportion of its male and female population employed in agriculture (70.4 % of total employment; 65.5 % of male employment and 75.8 % of female employment) in 2016, according to ILOSTAT database. As the majority of them (96.3 %) are subsistence farmers (UBOS, 2014) operating overwhelmingly on small farms, the sector holds great importance for poverty alleviation. Furthermore, the agricultural sector is a leading sector for future economic growth, as it provides a half of all exports and a quarter of GDP in Uganda (World Bank, 2018).

Although Uganda enjoys adequate rainfall and the most favourable natural resources in SSA, food and nutrition insecurity and poverty are alarming, particularly in rural areas where the poverty occurrence is higher than urban areas (rural 25.0%; urban 9.6% in 2016/17 National poverty line) (UBOS, 2018). The threatening factor is that the agricultural output growth at only 2% per annum over the last five years is outweighed by the population growth rate of 3.3% per annum over the same period (World Bank, 2018). In fact, Uganda ranks 4th highest in the world in terms of the population growth rate (3.7% in 2018), according to the World Bank database. Thus, Uganda is the most youthful country in the world, yet high youth unemployment rates and the lack of youths' interests in farming, alongside the increasing population pressure on rural lands and the degradation of natural resources, are posing the biggest concerns. It is evident as Uganda's poverty headcount ratio at $1.90 PPP a day was in constant decline from 1991 (from 66.9%) until 2012 (35.9%), but has increased to 41.7% in 2016 (Ibid.).

Nevertheless, a number of studies reveal the low adoption rate of new technologies such as improved seeds, fertiliser, other inputs, and mechanised traction (Sheahan and Barrett, 2014, World Bank, 2018). Instead, the majority of farmers in Uganda use labour-intensive technologies such as the hand hoe in rain-fed conditions. BMAU (2019) reports that only 15% of the technologies generated by research institutions reach the farming communities. Moreover, despite the fact that women contribute more than 75% to total farm labour (UBOS, 2014), it is reported that women's agricultural productivity is lower than men's by a great degree, as a result of the gender inequality in access to the factors of production such as land, education and extension (MAAIF, 2016a, World Bank, 2016). The land productivity of female-managed plots was about 30% lower than for men, being 60% smaller in size, and 11% less likely to be planted with cash crops (World Bank, 2018).

The research locations were chosen to cover a wider variety of agro-ecological and socioeconomic situations with different degrees of AIS actors' availability, in order to capture the diversity of local innovation processes. The North Western Savannah Grasslands Agro-Ecological Zone (AEZ) (in Northern region) and the South Western Farmlands AEZ (in Western region) were two chosen from total of 10 AEZs in Uganda. Those two regions differ widely in terms of land availability and poverty incidence rates. The Northern region represents a land abundant region (1.9 ha per household) with the highest poverty rate (43.7% in 2012/13), as opposed to the Western region, a land scarce region (1.0 ha) with the lowest poverty rate (8.7%) (UBOS, 2018, World Bank, 2018). This represents the co-existence of "two Africas" (Jayne et al., 2014), land abundant and land constrained, as discussed in the next chapter. Therefore, taking Uganda as a case study provides critical lessons for the rest of SSA in similar contexts.

1.2 Research Aims, Objectives and Questions

The research aim is to understand the dynamics and diversity of smallholder farmers' innovation processes in Uganda, using the AIS approach. Unpacking innovation processes in a holistic manner requires analysis at individual, intra-household, and community levels. The processes entail investigating how individual smallholder farmers perceive, access and utilise knowledge and information from various sources, how they negotiate the necessary resources and implementation of innovations within households, and how innovations spread or fail to spread within communities. Within the innovation processes, the smallholders' knowledge and information systems, intra-household dynamics in decision-making, and innovation networks and systems at community level are particularly important focal points for analysis, as crucial subsystems within the AIS. Eventually, this study intends to provide policy implications and recommendations for more "inclusive" innovation systems, by identifying constraints within the existing AISs.

Research Objective 1: Knowledge and Information Systems

Understanding the knowledge and information sources for farmers' innovations and the reasons behind the choices made by farmers in different socioeconomic groups is critical in order to unpack the complex innovation processes and the AISs from farmers' perspectives.

- What kinds of AIS actors are being accessed and used by farmers with different socioeconomic characteristics and operating in contrasting enabling environments to make innovations?
- How do the farmers' attitudes towards AIS actors affect the actual utilisation of the knowledge and information?

Research Objective 2: Intra-household Decision-making

This study analyses intra-household decision-making processes over their agricultural innovations, and what determines the decision-making authority over the innovation processes, taking an intra-household bargaining perspective. The intra-household dynamics in resource allocation and gender norms is a key theme that emerged during the fieldwork and was found to be crucial in shaping innovation processes. Therefore, this topic was further investigated in order to unpack the diverse farmers' innovations and the processes by which they were applied.

- How do men and women within the same households make decisions regarding the uptake of innovations and the use of products from them?
- What influences decision-making authority by men and women within the household?

Research Objective 3: Innovation Networks and Systems

This study explores multiple innovation case studies at community level in order to understand the innovation processes from network and social learning perspectives as well as to identify the constraints which farmers from different socioeconomic categories face in participating with the innovation networks and systems.

- What are the knowledge and information pathways and networks for innovations?
- What are the constraints on farmers who are excluded from the innovation networks and systems?

1.3 Thesis Outline

This thesis comprises 8 chapters which are outlined as follows. As the thesis is written a collection of papers, the three result chapters (Chapter 5-7) are written in paper form.

Chapter 2 – reviews existing knowledge and literature which provide a framework and a context for this study, and into which the study findings can be fed back. This includes the shifting perspectives on agricultural innovations and the approaches to support innovations, which is followed by the review on how those perspectives have been integrated into the agricultural policies and practices in SSA contexts. Next, the key theories and factors which are crucial to understanding smallholder farmers' innovation processes are reviewed at individual, household and community levels. This chapter ends with the conceptual framework of this study which is based on the literature reviews.

Chapter 3 – presents the methods used to conduct the research. This chapter presents research approaches including theoretical perspective and systems thinking, the selection of research locations, and research tools used in each phase. Data analysis and ethical considerations are explained.

Chapter 4 – sets out the context of this study, focusing on Agricultural Innovation Systems in Uganda, including the agricultural sector's outlook, policies and practices designed to support agricultural innovations, and the extension system. This chapter then presents the socio-demographic and biophysical profiles of four selected study sites, with the focus on the people's livelihood changes over the last two decades.

Chapter 5 – provides the research findings on the knowledge and innovation systems of farmers from different socioeconomic categories, focusing on their utilisation of knowledge, access to information sources, and attitudes towards and perceptions of government, community and private actors. This chapter takes a journal paper form.

Chapter 6 – demonstrates the empirical findings on gendered intra-household decision-making on agricultural innovation processes. It explores the reasons behind the gender imbalances in decision-making by showing empirical findings on social norms on gendered enterprises and division of labour, and on the allocation of productive assets such as land and labour. This chapter takes a journal paper form.

Chapter 7 – explores the innovation networks and systems through analysing smallholder farmers' experiences of innovation processes in four innovation case studies, namely an improved cassava variety, mulching for bananas, changing the sesame planting time, and an improved maize variety. Each case is examined through the lens of inclusive innovation systems. This chapter takes a journal paper form.

Chapter 8- presents the conclusion of the thesis. This chapter shows the key research findings, notably on the knowledge and information systems related to innovations, intra-household dynamics in decision-making processes, and inclusive innovation networks. The original contribution of this study and policy implications are presented, as well as considerations for further study.

Chapter 2 – Literature Review

2.1 Introduction

This chapter explores the literature or existing knowledge on which the research objectives and questions rely and to which the study findings could possibly contribute, thus helping to the knowledge gap. The literature review covers the historical changes in innovation perspectives and those in the Sub-Saharan African (SSA) context, focusing on smallholder farmers' innovation processes, particularly decision-making processes at individual and intra-household levels, and their relationships with actors and social networks at wider community levels. Furthermore, this chapter will set out the conceptual framework on the basis of the literature review.

2.2 Paradigm Shifts of Innovation Perspectives and Practices

This section highlights the ways in which definitions and perceptions of innovation have changed over the years, showing how the earlier diffusion of perspectives on innovation has led to the emergence of newer perspectives arising from critiques of the former, and how these changes are translated both into actual policies and practices of innovation support and extension in SSA.

2.2.1 What is Innovation?

In the past, "innovation" used to be considered as a new technical product or procedure invented in a research facility. However, the understanding of "innovation" has changed considerably in last decades, according to shifting perspectives on how innovation occurs.

World Bank (2012) defines "innovation" as "the process by which individuals or organizations master and implement the design and production of goods and services that are new to them, irrespective of whether they are new to their competitors, their country, or the world". This definition is a product of previous interpretations of the term, such as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (Rogers, 2003), "the notion of creating local change new to the user" (Hall et al., 2006b), and "a new way of doing things" or even "doing new things" which actually works in human practices (Leeuwis, 2004).

The different models define innovation differently. A conventional linear model or a persuasive model defines innovation in terms of its technical aspects. However, an interactive model considers innovation has both technical and social-organisational dimensions (Leeuwis, 2004). Spielman et al. (2009b) highlight three key features of innovation: 1) innovation is the creative use of knowledge as a response to social or economic needs or opportunities; 2) trying something new becomes an innovation only if the new idea or product is successfully integrated into a process; 3) innovations are accepted in social and economic environments. Thus, the way innovation is defined is closely related to how innovation processes are perceived: this will be discussed in the following section.

In most cases, this study adopts the definition of the interactive model, according to which "the creative use of knowledge" is considered as an innovation only if it actually works in everyday practice. In this research, therefore, "innovation" is defined by farmers themselves as a new practice which they think actually worked for them. This implies that the definition of "innovation" depends on farmers' subjective evaluation of its success or failure in their everyday lives.

2.2.2 Changing Approaches to Agricultural Innovations

In the past 60 years, perspectives on agricultural innovations have significantly changed, from adoption and diffusion models to innovation systems thinking models, as summarised in Table 2-1. In the 1960s, the central perspective was Transfer of Technology (ToT), or linear approaches which considered that technological innovations invented at research centres were diffused to farmers, using National Agricultural Research Systems (NARS). In later years, different perspectives, such as Farming Systems Research (FSR), Farmer First (FF)/Farmer Participatory Research (FPR), the Agricultural Knowledge and Information System (AKIS), and the Agricultural Innovation System (AIS), emerged as critiques of linear adoption models. These perspective changes emerged from the debate on what innovations are and how they occur, reflecting differing and shifting contexts, such as post-colonial period, the Green Revolution and recent globalised agricultural markets. However, according to Scoones et al. (2009), we should not conclude that ToT is all bad and systems approaches are all good, as each perspective has its own advantages and disadvantages. Therefore, the following sections will focus on the advantages and disadvantages of each perspective or approach.

Table 2-1: Shifting perspectives on agricultural innovation

	National Agricultural Research System (NARS)	Farming Systems Research (FSR)	Farmer First (FF)/Farmer Participatory Research (FPR)	Agricultural Knowledge and Information System (AKIS)	Agricultural Innovation System (AIS)
Era	Central since 1960s	Starting in 1970s and 1980s	1980s	From 1990s	2000s
Mental model of activities	Supply technologies through pipeline	Learn farmers' constraints through surveys	Collaborate in research	Collaborate in research and extension	Co-develop innovation involving multi-actor processes and partnerships
Actors	National agricultural research organisations, agricultural universities or faculties of agriculture, extension services, and farmers		National agricultural research organisations, extension, farmers (resource-poor)	National agricultural research organisations, agricultural universities or faculties of agriculture, extension services, farmers, NGOs, and entrepreneurs in rural areas	Potentially all actors in the public and private sectors involved in the creation, diffusion, adaptation, and use of all types of knowledge relevant to agricultural production and marketing
Knowledge and disciplines	Single discipline driven	Multidisciplinary (agronomy plus agricultural economics)	Interdisciplinary (more, plus farmer experts)	Interdisciplinary (plus sociology and farmer experts)	Transdisciplinary, holistic systems perspective
Scope	Productivity increase	Efficiency gains (input-output relationships)	Farm-based	Farm-based livelihoods	Value chains, institutional change
Core elements	Technology packages	Modified packages to overcome constraints	Joint production of knowledge	Joint production of knowledge and technologies	Shared learning and change, politics of demand, social networks of innovators
Drivers	Supply-push from research	Scientists' need to learn about farmers' conditions and needs	Demand-pull from farmers	Demand-pull from farmers	Responsiveness to changing contexts, patterns of interaction
Degree of market integration	Nil	Low	Low	Low	High
Innovators	Scientists	Scientists and extensionists	Farmers and scientists together	Farmers, scientists and extensionists together	Multiple actors, innovation platforms
Role of farmers	Adopters or laggards	Sources of information for scientists	Experimenters	Farmers, scientists and extensionists together	Multiple actors, innovation platforms

Role of scientists	Innovators	Experts	Collaborators	Collaborators	Partners, one of many responding to demands
Key changes sought	Farmer's behaviour change	Removing farmers' constraints	Scientist-farmer relationships	Empowering farmers	Institutional change, innovation capacity
Intended outcomes	Technology invention and technology transfer	Farming system fit	Co-evolved technology with better fit to livelihood systems	Co-evolved technologies better fit to livelihood systems	Capacities to innovate, learn and change
Nature of capacity strengthening	Infrastructure and human resource development			Strengthening communication between actors in rural areas	Strengthening interactions between actors; institutional change to support interaction, learning and innovation; creating an enabling environment

Source: Adapted from various authors (Hall et al., 2006a, Sanginga et al., 2008, Assefa et al., 2009, Scoones et al., 2009, Klerkx et al., 2012)

2.2.2.1 Adoption and Diffusion of Innovation Perspectives

Adoption and diffusion theories were popularly applied between 1950 and 1970 to explain how people adopt new agricultural technologies, by particularly focusing on stages in the adoption process, adopter characteristics, and factors determining the rate of adoption (Leeuwis, 2004). The first edition of "Diffusion of Innovations" written by Everette Rogers in 1962 was the most influential book for numerous adoption studies during the period. Rogers (2003) demonstrates the normative theories of the technology adoption process which follows the sequence of "awareness", "interest", "evaluation", "trial" and "adoption", and the associated rational decision-making process which follows the sequence of "knowledge", "persuasion", "decision", "implementation" and "confirmation". The adoption studies typically categorise people into five groups, ranging from "innovators" to "laggards", whereby the distribution is often described as an inverse-U shape. Such studies further investigate the relationship between the adoption index and variables such as personal attributes, types of decisions, communication channels and so forth.

In the adoption and diffusion theories, innovations are developed by research, disseminated by extension and adopted by farmers, as the process is often described as linear, or a pipeline. National Agricultural Research Systems (NARS) and Transfer of Technology (ToT) approach are based on adoption and diffusion theories which have been central since 1960s (Hall et al., 2006a, Klerkx et al., 2012). This perspective emphasises the roles of public research institutes in the generation of innovation, extension in transfer of knowledge, and farmers as recipients. This model proved effective when technological solutions with a wide application were required: for example, in the case of food shortages (Hall et al., 2006a). Based on this linear model of extension, the Training and Visit (T&V) approach emerged for the purpose of increasing productivity with the promotion of the Green Revolution in the 1970s after the period of decolonisation (Anderson and Feder, 2003, Garforth, 2013, Faure et al., 2015). Between the 1970s and 1990s, the T&V system was widely promoted by the World Bank in 70 Asian and African countries, for extending research-validated technology to target farmers who were expected to share their knowledge with their neighbours. The Technology Supply Push (TSP), which claims that exogenous technological change is a driver for social and economic development, similarly argued that governments needed to invest in research so that farmers could use the developed technologies to boost yields (Hounkonnou et al., 2012). According to this model, the process of technology generation and promotion requires a hierarchical, top-down administrative structure (Biggs, 1990). In other words, the top-down political system and a command economy prefer the linear model, as it allows accumulation of power at the centre (Assefa et al., 2009).

This linear model has been widely criticised in numerous publications. Firstly, this diffusion perspective contains "pro-innovation bias" (Leeuwis, 2004) which explicitly or implicitly blames non-adopters as if the proposed innovations were relevant to and preferred by all farmers including "laggards". Furthermore, "innovativeness" bias in the adoption and diffusion perspective is often cited by many authors (Reij et al., 2001, Leeuwis, 2004, Garforth, 2013). The notion of "innovativeness" is based on the "pro-innovation bias" of extensionists or interventionalists. This bias leads to the tendency whereby "progressive farmers" who are often wealthier than others, and have adopted more promoted innovations than others, are considered more innovative than others. This is an unreliable assumption, as the proposed innovations tend to address the problems of those wealthier farmers, ignoring the needs of the marginalized farmers (Hoang et al., 2006). Moreover, the

ToT paradigm failed to categorise farmers into different groups and select technologies appropriate to the specific groups, taking account of different resources, problems and opportunities (Belay and Abebaw, 2004). Thus, the linear model's assumption that technologies are automatically "diffused" to the wider community has been questioned. Technologies are non-neutral and political in nature, therefore there is no technology which is beneficial to all.

Secondly, criticism is directed towards the oversimplification of complex interactions among actors in knowledge generation, transfer and adaptation, which overlook the creative role of farmers in innovation processes (Leeuwis, 2004, Waters-Bayer et al., 2009). Many authors highlighted the evidence that new ideas come from multiple sources, contradicting the linear model's claim that researchers are the sole source of innovations (Biggs, 1990). Rejecting the linear model's portrayal of the adoption of innovation as an individual affair, they argue that a collective process is required by literally all innovations, as they involve co-ordinated changes by various actors, including farmers, traders, input suppliers and others (Leeuwis, 2004), as well as institutional change (Hounkonnou et al., 2012). Hence, many innovation cases cannot be explained by the linear model, which is based on individualistic rational decision-making.

Thirdly, the NARS-based practices are criticised on the grounds that NARS' priorities are slow to reflect technology users' needs and rapidly changing circumstances such as market conditions. Its emphasis on commodity-based priorities leads to situations where small but needy initiatives tend to be ignored unless the respective commodities receive attention for their significant economic importance. The practical problems are the systems' need for massive public funding which is not sustainable (Anderson and Feder, 2003), Subject Matter Specialists (SMSs) not having up-to-date information, a fixed schedule for frontline extension restricting the creativity of and interaction with farmers (Chowa, 2013), and a highly centralised and bureaucratic public system (Parkinson, 2009).

2.2.2.2 Farming Systems Research (FSR)

In 1970s and 1980s, FSR emerged in response to the failure of the ToT approaches, especially in improving scientists' understanding of farmers' constraints and needs. The early forms of FSR began with experiences in Africa, Asia and Latin America, while the recent FSR is actively applied to European contexts (Bingen and Gibbon, 2012). In Africa, this emergence was due to the failure of the Green Revolution, which used top-down ToT approaches strongly influenced by British colonial and post-colonial policies. The earlier FSR focused on the need for partnerships between farmers and scientists in finding technical solutions to improve the yield of specific crops. This was especially so in Africa, which required urgent attentions to improving key food commodities through public sector funded agricultural research. The major approach was to transform NARS into client-oriented, participatory research, by encouraging on-farm research (Bingen and Gibbon, 2012). Besides Anglophone African countries, FSR was also established in the International Research Centres, from the later 1970s. The early FSR aimed to integrate agro-ecological with farm-economic contexts, but its perspective was restricted by the assumption that science and technology were separate from political and other social and institutional factors (Klerkx et al., 2012).

In later stages, the aim of FSR broadened from crop productivity to sustainable livelihoods, including social equity and the protection of natural resources (Klerkx et al., 2012). Although the earlier FSR took the farm as the starting point of an analysis, the scale of analysis has broadened to capture interactions between farms and their natural, social and economic components. Darnhofer et al. (2012) raise three characteristics of the recent FSR: systems thinking, interdisciplinarity and a participatory approach to research; they highlight the necessity of reflexivity, which they see as a vitally important quality in a researcher.

2.2.2.3 Farmer First (FF)/Farmer Participatory Research (FPR)

FF/FPR approaches became prominent during the 1990s, as a critique of top-down ToT approaches which were heavily applied during the green revolution. The FF/FPR perspectives were pioneered by Robert Chambers and his colleagues, the authors of *Farmer First* (Chambers et al., 1989). They insisted that the successful transfer of technologies was confined to irrigated environments with superior infrastructure, but the majority of poor farmers in complex and risk-prone rain-fed environments failed to improve their livelihoods. This model advocates starting with farmers' own capacity for innovation, because inter-disciplinary teams need to collaborate with farmers in research to co-evolve technology with a better fit to livelihood systems (Scoones et al., 2009). The model also explicitly focuses on production and the importance of the environment to the maintenance of sustainable livelihoods, while it is not a focus in the ToT model.

The downside of the FF/FPR approach is the fact that its focus is limited to farms. Scoones et al. (2009) claim that the earlier FF perspectives need to be revisited, as the world has changed significantly since its perspectives emerged, citing more complex value chains in globalised markets, which present both opportunities for higher value agricultural commodities, and challenges such as asymmetric market power.

2.2.2.4 Agricultural Knowledge and Information System (AKIS)

The perspective of AKIS also emerged in the 1990s to overcome the limitations of the linear extension models, demanding the shift from strengthening research or extension institutions to strengthening linkages and communication among system actors (Assefa et al., 2009). According to Leeuwis (2004), the knowledge systems were first developed by Nagel in the Indian context in 1980, and later, the idea of AKIS was theorised in more detail by Röling and Engel in 1990. AKIS is defined as "the articulated set of actors, networks and/or organizations, expected or managed to work synergistically to support knowledge processes which improve the correspondence between knowledge and environment and/or the control provided through technology use in a given domain of human activity" (Röling, 1992, p. 48). Such knowledge processes include the generation, transformation, transmission, storage, retrieval, integration, diffusion and utilization of knowledge and information. The key characteristics of AKIS are its recognition of the multiple sources of knowledge required in innovation processes, and its emphasis on innovation as a process of social learning (Hall et al., 2006a). AKIS comprises public-sector research, extension, educational organizations and farmers, with a strong emphasis on linkages among those actors, unlike the previous linear model. Initially, the AKIS model used to view the knowledge systems with "hard systems" thinking which has clear objective boundaries and common goals independent of the observer. This view was and has still been employed by FAO. However, Röling and others later applied a "soft systems" perspective which acknowledges that a system and its boundaries will be understood by various actors in different ways, as they have diverse objectives (Leeuwis, 2004, Klerkx et al., 2012).

Furthermore, AKIS highlighted the need for strengthening the capacity of research, extension and education systems and the coordination mechanisms among these systems (Rivera, 2011). One of the strengths of AKIS is its recognition that education improves farmers' ability to participate in innovation processes (Hall et al., 2006a). From this perspective, various approaches and tools, such as Rapid Appraisal of Agricultural Knowledge Systems (RAAKS) (Engel, 1997), Farmer Field Schools (FFS), Participatory Technology Development (PTD), and Participatory Innovation Development (PID), were developed (Assefa et al., 2009), and the model has been promoted strongly by FAO (Hall et al., 2006a).

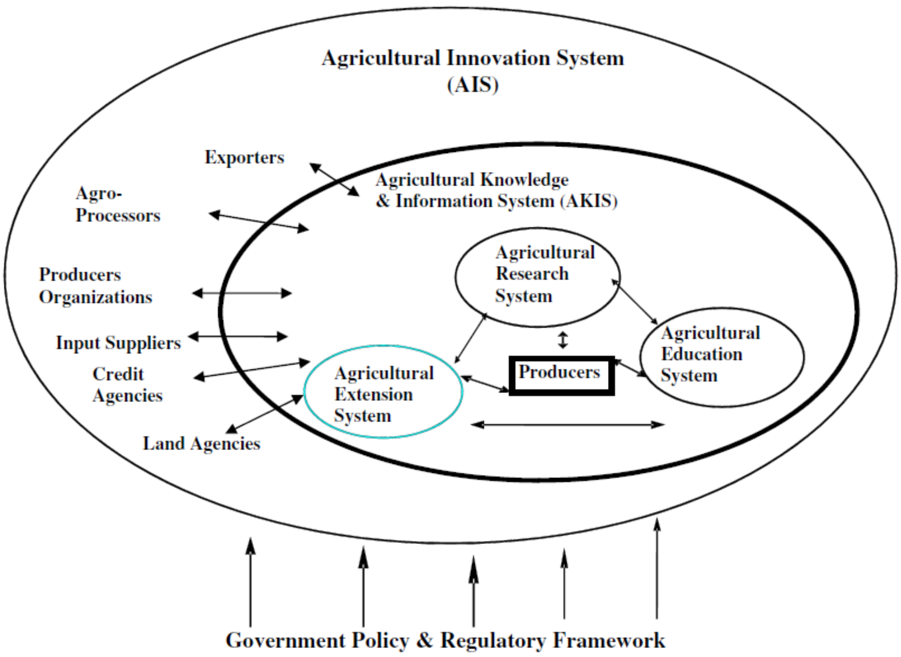
However, in recent years, both NARS and AKIS have been challenged by increasingly globalised contexts including rapid growth of markets, technological change, trade liberalisation, private investment, privatisation of resources, and expansion of information and communications technology (Spielman et al., 2009b). As many authors complain, despite the contribution of AKIS, the focus of the framework is restricted to actors in rural environments, and it pays little attention to the role of markets, the private sector, agro-industry, consumers, and the enabling policy environment (Leeuwis, 2004, Hall et al., 2006a, Klerkx et al., 2012). Leeuwis (2004) further argues that the AKIS framework tends to focus on knowledge exchange in isolation from politics, conflict, reward systems, resource distribution and so forth. Also, according to Hall et al. (2006a), another weakness of the AKIS framework is that it tends to suggest that most technologies will be transferred from researchers to farmers, despite the fact that it recognises the importance of the information that research systems receive from farmers.

2.2.2.5 Agricultural Innovation System (AIS)

In order to address the limitations of linear models, the Agricultural Innovation System (AIS) emerged in parallel with AKIS. Despite the similarity of their views, while AIS was developed from a research perspective, AKIS came from an extension perspective (Klerkx et al., 2012). Unlike AKIS, the theoretical framework of AIS was derived from the industrial sector in developed countries which have a free market economy and are governed by relatively democratic political systems (Assefa et al., 2009). AIS was influenced by ideas on national systems of innovation developed by Lundvall and pioneered by Hall and colleagues in the agricultural domain. Considering the background where AIS was developed, it is noteworthy that second generation problems of promoting technologies, such as pest resurgence, unsustainable land management (Rivera, 2011), and societal challenges such as food insecurity, global warming, animal diseases and depletion of natural resources (Klerkx et al., 2012), became more prominent. Thus, there was less focus on the generation of new knowledge, but there were more pressing needs to address the use and uptake of existing knowledge deployed in systemic thinking.

AIS is "a network of organisations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organisation into social and economic use, together with the institutions and policies that affect their behaviour and performance" (Hall et al., 2006a, p. 16). Various other authors also refer to this concept in similar terms (Spielman et al., 2009b, Klerkx et al., 2012, World Bank, 2012). The actors in AIS cover all actors in the public and private sectors involved in innovation processes. In detail, the system typically consists of public and private extension agents, research institutes and researchers, market traders, and farmers as well as public policies on science, technology, agriculture, education, and investment, as depicted in Figure 2-1. Its explicit emphasis on a broader range of actors involved in innovation, particularly the private sector actors along the value chain, is the typical characteristics of the AIS framework, as might be expected from its industrial origin. The AIS framework recognises the importance of enabling environment and innovation capacities to support the "use" of knowledge, rather than making the knowledge available for relevant actors (Hall et al., 2006a).

Figure 2-1: Agricultural Innovation System



Source: Rivera (2011)

In the AIS approach, innovations are deemed to happen through learning within and between firms and organisations, strengthening individual and collective capabilities, demand and supply-driven science and technology, innovation agents focusing on complex and dynamic interactions, and network-based knowledge dissemination (Spielman et al., 2009b, Klerkx et al., 2012). The concerns of AIS are value chains and institutional change, while those of NARS and AKIS were productivity increase and farm-based livelihoods, respectively. AIS seeks institutional change and innovation capacity-strengthening through co-development of innovation involving multi-actor processes and partnerships (Klerkx et al., 2012).

Nevertheless, recent studies highlight the limitations of the AIS approach. Firstly, many AIS studies tend to have a common goal and a clear boundary, unlike AKIS' soft systems thinking. Therefore, the AIS perspective pays little attention to the divergent and conflicting interests of interdependent actors (Klerkx et al., 2012).

Secondly, most of the critiques are related to AIS' failure to pay sufficient attention to farmers, particularly smallholder farmers, who are key and central actors within the system (Berdegué, 2005, Rajalahti et al., 2008, Assefa et al., 2009, Spielman et al., 2009b, Spielman et al., 2011, Cardey and Garforth, 2013, Chowa et al., 2013, Garforth, 2013). Much of the AIS literature presents innovation systems at project, sectoral and national levels only, leaving out the farmers' real experience and capacities. The interests of poor smallholder farmers, who are often disadvantaged in being integrated in such networks, are neglected or undermined. Spielman et al. (2009b) complain that few studies examine the poverty-related effects of innovation processes by rendering an ex-ante analysis showing that an innovation system would promote institutional and technological changes that were explicitly pro-poor.

Cardey and Garforth (2013) and Assefa et al. (2009) argue that the AIS studies often lack understanding of gendered perceptions and roles in innovation processes, and overlook intra-household issues. Assefa et al. (2009) comment that farmers are not necessarily addressed as a target group from the AIS perspective, while AKIS sets farmers in the centre.

Thirdly, current AIS studies focus on high value agricultural commodities which are important for national and global markets (Assefa et al., 2009). However, Rajalahti et al. (2008) suggest that the AIS approach needs to address a wider range of agricultural and rural issues, such as natural resource management, subsistence farming focusing on staple crop production, and rural non-farm activities. This statement resonates with the criticism made by Assefa et al. (2009) who found that environment, community empowerment, and sustainability were understated in Hall's AIS studies, despite their importance for and interconnectedness with Natural Resource Management (NRM), poverty and environmental aspects in developing countries, particularly in SSA. Assefa et al. (2009) further state that AIS is most interested in developing commercial goods, and AKIS in public goods. Therefore, the study questions the relevance of AIS in addressing challenges in developing countries. The utility of the application of the AIS approach is debatable, as Spielman et al. (2009b) claim that agriculture in SSA is increasingly globalised, which leads to rapid growth of markets, new demographic and agro-ecological pressures, new economic policy (e.g., trade liberalization and regional trade integration), the emerging private investment in knowledge, information, and technology, and increased use of ICTs in exchanging knowledge and information.

Fourthly, another limitation is that the AIS framework is under-tested in the agricultural sector, because it is not well equipped to diagnose interactions among multiple actors and institutional capacity for innovation (Hall et al., 2006a). This is also related to the holism recognised in the AIS perspective, which is "a pitfall" because of many possible interpretations make it difficult for the analysis to have a clear focus (Klerkx et al., 2012). In this regard, Assefa et al. (2009) point out that, compared to AKIS, from which RAAKS, PDT and PID were developed, AIS has not gone beyond analysing innovation processes, and has done little methodological and empirical work on the facilitation of innovations, especially in the contexts of developing-country agriculture (Spielman et al., 2009b). Moreover, Spielman et al. (2009b) claim that the AIS approach has not yet reached a point where it can advise governments on policy options in developing-country agriculture. Nevertheless, in more recent years, many studies have attempted to develop methodologies to facilitate multi-actor innovation processes (World Bank, 2012), including Innovation Platforms (IP) (Hounkonnou et al., 2012) and Communities of Practice (CoP) (Dolinska and d'Aquino, 2016).

Thus, there are some studies comparing AKIS and AIS (Hall et al., 2006a, Assefa et al., 2009, Klerkx et al., 2012), based on which there have been an increasing number of calls to integrate their two perspectives within Agricultural Knowledge and Innovation Systems (AKIS), especially in the contexts of EU policy and research programmes (Klerkx et al., 2012, Adolwa et al., 2016).

2.2.3 Policy and Practices in Innovation Support and Extension in SSA

The stagnation of agricultural growth in SSA has been a major concern since the 1970s, when fear engendered by a neo-Malthusian view prevailed throughout the continent. Due to population growth pressure on the limited arable lands, agricultural land productivity as well as labour productivity had been stagnant since the 1960s: it and even decreased in the 1990s (Takahashi, 2010). During the 90s' liberalisation trend, governments and donor communities largely ignored the agricultural sector and made tremendous cuts in its budget (Takahashi, 2010), in the belief that privatisation would boost agricultural growth by itself. However, the poor agricultural performance and unfulfilled expectations following farmers' adoption of productivity-enhancing inputs drew attention to the underdeveloped rural market (Livingston et al., 2014, Wiggins, 2014). Some place the blame on market failure, caused by high transaction costs and information gaps between farmers and service providers such as input dealers and traders, which were leading smallholder farmers in rural areas to the poverty trap (Poulton et al., 2010). Others stress government failures, citing improper and unstable government policies including inappropriate extension approaches, export bans, or the announcement of public imports of grain (Jayne et al., 2010, Wiggins, 2014). This sluggish trend in the agricultural sector continued to be dominant until the 2000s, when a sign of positive growth was observed. The following sections review ways in which innovation perspectives have changed in the SSA context, and the current trends of innovation support in the region.

2.2.3.1 Changes in Innovation Thinking and Extension Approaches in SSA

In order to stimulate the stagnant agricultural productivity in SSA, various policy directions and extension approaches in supporting agricultural innovations have been undertaken. Among others, ToT had been a predominant approach since 1960s, with an emphasis on NARS. This was based on Roger's linear model of innovation, according to which ready-made knowledge or innovation developed by research is disseminated at farmer level and spreads from early adopters to the laggards (Rogers, 2003, Klerkx et al., 2012). This theory led to the T&V extension approach which was widely promoted by the World Bank in the 1970s-1990s, in association with the promotion of the Green Revolution. The emphasis was on disseminating selected varieties or inputs through research-validated advice, especially among cash crop farmers (Faure et al., 2015).

Nevertheless, the ToT and T&V approaches have been widely criticised due to their underperformance at farmer level, and their dependence on a bureaucratic and inefficient public extension system requiring massive public funding. Ultimately, this model became contradictory to the neo-liberal trend and lost financial support from the World Bank, which carried out the Structural Adjustment Programme (SAP) in the 1980s (Anderson and Feder, 2004, Faure et al., 2015). On the other hand, various participatory approaches, such as FSR and PTD, emerged in response to the limitations of the linear model of innovations, and to the need to understand farmers' rationales and collectively develop technologies suitable for the local conditions.

Objections to a linear model of innovation led to the development of alternative frameworks such as AKIS and AIS after the 1990s. The former framework addresses the necessity for strengthening the capacity of research, extension and education systems and the linkages among them (Rivera, 2011). AIS emerged as a criticism of AKIS in 2000s, with the acknowledgement that the innovation process is driven not only by research but rather interactions among various organisations, enterprises and individuals including agro-processors, input-dealers, and farmers' organisations (Klerkx et al., 2012).

Corresponding to this trend, in the 2000s, pluralistic and demand-driven approaches arose from the mixture of neoliberal and participatory ideologies (Parkinson, 2009). The pluralistic approach was derived from the massive cut in the public budget for providing extension services to farmers, and the common recognition that the private extension sector exists and that farmers seeking advisory services can pay for them. Similar concepts encouraged emphasis on the role of contact farmers as agents of extension and social learning, promoting a farmer-to-farmer extension approach.

In a number of SSA countries, innovation policy and support followed the above-mentioned trends of innovation models and extension approaches. In accordance with SAP and privatisation policy, governments significantly reduced the budgets and personnel for public research-extension systems, and promoted pluralistic and demand-driven approaches, either by adopting the approaches in the existing extension systems or, as in Mali, Mozambique, Tanzania and Uganda, outsourcing the extension services to the private sector.

The outcomes of this reform trend are mixed. The positive aspects reported include the financial benefits acquired by more active farmers' groups and commercial farmers who could take advantage of market opportunities (Parkinson, 2009, Rwakakamba and Lukwago, 2014), the increased number of farmers' organisations, and innovative usage of ICT, such as community radio, which increased the accessibility of technological information (Chowa et al., 2013). On the other hand, the downsides reported from the empirical studies are inequality in advisory services, a bias in favour of commercial farmers and fertile lands, the side-lining of resource-poor farmers, unwillingness to share information due to competition for markets, the absence of private actors from remote areas, rigid output-oriented and short-term contracts depriving extension services of their flexibility, failure in capacity building for farmers' demand articulation, and weak market linkages (Klerkx et al., 2006, Chowa, 2013, Mambo, 2014, Anderson and Feder, 2003, Garforth, 2004, Rivera, 2011, Parkinson, 2009).

2.2.3.2 Recent Trends of Innovation Support and Extension in SSA

Since the food crisis in 2007-2008, the public and private donors and domestic policy makers started to show renewed interest in investing in agricultural development in SSA (Birner et al., 2009, Wiggins, 2014, Mockshell and Birner, 2015). This is a dramatic change compared to the time when there was a concern that donors' assistance to African agriculture fell significantly after the early 1990s, due to their frustration at the poor performance of agricultural programmes over the previous three decades (Jayne et al., 2010).

Aiming to reverse the negative trend of agricultural growth, in 2003, African agriculture ministers made a Maputo declaration to strive for 6% annual growth in agriculture and to devote 10% of their national budgets to agricultural development. The Comprehensive Africa Agriculture Development Programme (CAADP) was created under the New Partnership for Africa's Development (NEPAD) as an Africa-led initiative for agricultural development, and it was adopted by African Union (AU). This pledge still stands in the Malabo Declaration 2014 and many African governments are trying to fulfil the agreement.

Rising prices of food commodities became a new opportunity for the African economy. Wiggins (2014) records that the increased prices were applied not only to cereals alone, but to many other traditional export commodities. The prices of all agricultural products, including food, have increased by 75% between 2005 and 2014.

This led donor communities to renew their interest in investing in agricultural development in SSA. The World Development Report 2008 entitled “Agriculture for Development” (World Bank, 2007b) was only one of many documents in which multilateral and bilateral donors gave reassurances that they would assist agricultural development. The private sector’s initiatives have been enormous. Alliance for a Green Revolution in Africa (AGRA) was formed in 2006, spearheading plans to double yields and incomes for 30 million farming households in 5 years, in partnership with DFID, the Rockefeller Foundation, the Bill & Melinda Gates Foundation, CGIAR, and others. Moreover, the New Alliance for Food Security and Nutrition formed in 2012, which consists of 10 SSA governments and 274 mainly Africa-based private companies (including Coca-cola, Syngenta, and Bayer), raised over $10 Billion in 2014, in partnership with G8, the World Bank, AU, CSOs and various research institutions, for the purpose of inclusive, agriculture-led growth. Wiggins (2014) points out that both domestic and foreign private firms and state agencies from Asia and the Middle East have been showing keen interest in investing in agricultural land.

This scenario implies that actors in AIS in SSA countries are more numerous and varied than ever before. Moreover, commercialisation and intensification, achieved by the use of additional farming inputs, would be expected because of the increased support. This means that much more coordination, from international and national to local government and farmers’ levels, are required. Many governments in SSA are now seeking a new modality for pluralistic and demand-driven extension systems, learning from the experiences of privatised contract systems, such as Uganda's National Agricultural Advisory Services (NAADS).

Poulton et al. (2010) suggest that thorough analysis of existing experimentation is necessary to find conclusive answers on the appropriate modality for extension services. This includes the role of extension staff, the methods to be used, financing, delivery systems and agents, and linkages with the research system. It is clear that extension services should emphasize their role in facilitating market linkages, not only technical advice. Poulton et al. (2010) imply that different systems may be suited to the delivery of different types of information or information on different types of crops. It also depends on whether the subject of their messages is a public or private good. For instance, in the case of food crops and those cash crops where buyers do not have an incentive to supply extension services, willingness to pay is limited, which may require an alternative modality rather than a privately funded extension. Also, the cases which require the solution of longer-term or systemic problems caused by negative externalities, such as pests, diseases and soil fertility decline, may need an area-based conventional strategy rather than a commodity-based approach (Poulton et al., 2010).

2.3 Diverse Smallholder Farmers and Innovations

This section explores the definition and different characteristics of smallholder farmers, as well as the typologies of the various innovations under discussion. This will establish the basis for understanding smallholder farmers' experience and perceptions of innovation in this study.

2.3.1 Diverse Smallholder Farmers

Who are smallholder farmers? In general terms, 2 hectares (ha) (approximately 5 acres) is regarded as a smallholding in a developing country (Hazell et al., 2010, Lowder et al., 2016). Such small farms occupy 12% of the world's agricultural land (Lowder et al., 2016). Nevertheless, "smallholder" is a relative term (Conway, 2014). In SSA, approximately 80% of farms are less than 2 ha. The average farm size in SSA is between 1.6 and 2.4 ha, while it is 1.0 ha in East Asia, 1.6 ha in South Asia, and 111.7 ha in South America. Even within SSA, there is a regional difference. In fact, as Dixon et al. (2004) and Conway (2014) mention, the definition of smallholders differs between countries and farming system zones, because of varieties in farm size, resource endowments, allocation of resources to food, cash crops, livestock and off-farm activities, use of external inputs including hired labour, level of facility (e.g. irrigation) and expenditure patterns.

According to Livingston et al. (2014), it is extremely difficult to capture trends in farm sizes in SSA because much census data is either absent or outdated. However, the evidence suggests that the average land size per capita has not changed or has been slightly declining over the past 30 years, although in some land abundant African countries, the average farm size has increased (Jayne et al., 2014). Thus, there is a variance in trends in terms of per capita land size between African countries. The land abundant territories are concentrated in only eight countries in the continent, which are mostly fragile states (Chamberlin et al., 2014). The key point is "Africa's spatially heterogeneous distributions of rural populations" (Jayne et al., 2014). "Two Africas" co-exist (Jayne et al., 2014), land abundant and land constrained.

As far as land distribution within a country is concerned, SSA displays more equality than other developing regions. For example, 97% of farmers who are smallholders in DRC cultivate 86% of the total land, but in Uganda, only 27% of the land is cultivated by smallholder farmers, who are 75% of the farmers (Livingston et al., 2014). Nonetheless, Jayne et al. (2010) highlight the recent trend of inequitable land distribution between smallholders in Eastern and Southern Africa. Jayne et al. (2010) state that households in the highest per capita land quartile have 5-15 times more land than the lowest quartile households, raising the example of Kenya, where the mean farm size, including rented land, is 5.91 ha at the top, and 0.58 ha at the bottom. Moreover, their findings point out that at least 25% of the smallholder households in SSA are almost landless, having access to only 0.10 ha or less per capita.

Landholding size is positively related to various variables such as productive potential, wealth, entrepreneurship, effort, and kinship between the household head's family and the local chief (Jayne et al., 2010). As mentioned earlier, "two Africas" are apparent in recent years, whereby increasing land shortages and land fragmentation are seen in favourable areas with good access to markets and services on one hand, and continuing land abundance is seen in remote areas on the other (Jayne et al., 2010, Headey and Jayne, 2014, Jayne et al., 2014). Therefore, even in the same country, different regions present different challenges to the smallholder farmers.

The diversity among households is attributed to various factors, including resource endowments (land, labour, capital), access to markets and institutions, and income, as well as subjective elements such as choice of crop production portfolio, effort and risk perceptions (Ruben and Pender, 2004). This means that even within each of the “two Africas”, there is heterogeneity at household level. This diversity calls for different approaches to diverse categories of smallholder farmers in different land conditions, as suggested by Ruben and Pender (2004) and Tittonell (2014) in Table 2-2 and Table 2-3, respectively.

Table 2-2: Different development pathways in different regions

Agroecological potential	Market Access	
	High	Low
High	**High-potential areas** (e.g. Central Kenya, Eastern China) • High value diversification crops • Commercial dairy and horticulture • Intensive food crop production • Non-farm employment	**Remote LFAs** (e.g., much of East African highlands; parts of SE Asia) • High value perennial tree crops (coffee, cocoa) • Intensive food crop production (for local consumption) • Forestry and cover crops • Temporary migration
Low	**Marginal LFAs (Less-favoured areas)** (North Africa, Semi-arid areas in India and China) • Small-scale irrigation for cash crops • Semi-intensive livestock, pigs and poultry, aquaculture • Commercial agroforestry and forestry (e.g., olives, nuts, wood) • Off-farm employment and work in urban areas	**Marginal and remote LFAs** (much of the arid and semi-arid parts of Africa) • Extensive livestock production • Low external input cropping, mixed crop livestock systems • Soil and water conservation; water harvesting • Zero tillage; minimum grazing • Agroforestry and forestry for timber and non-timber food products • Temporary migration and emigration

Source: Ruben and Pender (2004)

Table 2-3: Typology for household categorisation in western Kenya (densely populated region)

Farm type	Resource endowment and production orientation	Main characteristics
1	Predominantly high to medium resource endowment, mainly self-subsistence oriented	Variable age of the household head, small families, mostly constrained by land availability (lack of family labour compensated by hiring-in). Permanent sources of off-farm income.
2	High resource endowment, market-oriented	Older household head, numerous family (starting land subdivision), mostly constrained by labour (hired-in) due to large farm areas; cash crops and other farm produce are the main source of income.

3	Medium resource endowment, self-subsistence and low input market-oriented	Young to mid-aged household head, young families of variable size in expansion, mostly constrained by capital and sometimes labour, farm produce and marketable surpluses plus complementary non-farm enterprises
4	Predominantly low to medium resource endowment, self-subsistence oriented	Young to mid-aged household head, variable family size, constrained by availability of land and capital, deriving income from non-farm activities (e.g. ox-plough service, handicrafts)
5	Low resource endowment, self-subsistence oriented	Variable age of household head, variable family size, often women-headed farms constrained by land and capital, selling their labour locally for agricultural practices (thus becoming labour-constrained)

Source: Tittonell (2014)

2.3.2 Typology of Smallholder Farmers' Innovations

Diverse smallholder farmers in diverse biophysical and socioeconomical conditions make different types of innovations. As described in the previous section, what "innovation" is and how "innovation" occurs have changed over the last decades, from the technical domain to multiple domains, including the technical, economic, social and organisational. Accordingly, there are various ways of categorizing agricultural innovations in order to understand and analyse a wide range of innovations. Leeuwis (2004) captures multi-dimensional aspects of farming practices and innovations by using hierarchical levels (shown in Table 2-4), domains, and points in time, and argues that the careful coordination of those dimensions shapes farmers' practices. Hall et al. (2006b) and Assefa et al. (2009) claim that innovation usually consists of a series of small improvements in a continuous process of upgrading, rather than a radical change. In the reality of SSA, many studies (Kristjanson et al., 2012, Wiggins, 2014) suggest that innovations are marginal: for example, they may be confined to merely "individual production objects" rather than extending to "aggregate production objects" or even a "farming system", according to the Leeuwis' hierarchy of innovations.

Table 2-4: Farming practices at different hierarchical levels

Level 1: Individual production objects	the items that farmers directly manipulate and/or work with –an improved piece of equipment, an adapted way of handling existing equipment, a novel way of tilling a particular piece of land, a new crop variety, a change in fertiliser dosage or timing, an adapted way of making compost.
Level 2: Aggregate production objects	a different pattern of grazing a herd, a new fencing lay-out in the grazing land, a change over to a new cattle breed, a new machinery-sharing arrangement with neighbours.
Level 3: Farming system	adoption of the whole system – a change from mixed farming to specialised farming, moving from conventional farming to biological farming, enlarging the farm, switching to a new cropping system, engaging in on-farm food processing
Level 4: Farm in its environment	relocation of the farm, improved arrangements with input suppliers, shortening the chain between farmer and consumer, establishing co-operatives to enhance the bargaining power of farmers, developing suitable conditions for multi-functional agriculture

Source: Leeuwis (2004)

The domains are categorised as "technical domains" including such matters as soil fertility, crop protection, and animal health, "economic domains" including income, profitability, marketability, taxes, and investments, and the "domain of social-organisational relationships", including relationships with input-providing organisations, state organisations, NGOs, and community members (Leeuwis, 2004). This categorisation is a rather horizontal views of "innovation" which often involves a combination of technical, institutional and other changes, as Hall et al. (2006b) and Assefa et al. (2009) imply.

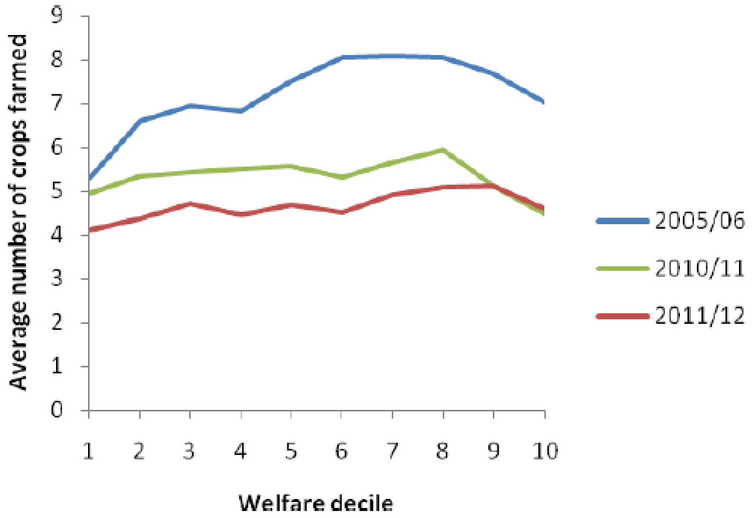
Different points in time also shape "innovation" in farming practices. Categories of this kind include the "short-term" (operational decisions), "medium-term" (tactical decisions) and "long-term" (strategic decisions) (Leeuwis, 2004). Farmers manage their farms with careful coordination of practices based on these various dimensions.

2.3.3 Factors affecting Smallholder Farmers' Innovations

A variety of factors affect the characteristics of innovations, the degree of diversification of innovations, and innovativeness. Most innovation studies investigate the relationship between economic status (wealth, off-farm income, number of cash income sources) and innovativeness (mostly translated into the number of innovations), and conclude that there is a positive correlation between them (Nielsen, 2001, Foster and Rosenzweig, 2010, Kristjanson et al., 2012, van Rijn et al., 2012). In contrast, Gabb (2013), who studied farming changes that farmers of Central Uganda had made in previous years, concluded that poorer, and especially female, farmers adapted the most diverse range of key changes. Similarly, Reij et al. (2001) support the idea that there is no direct relationship between innovativeness and economic status, and claim that poorer farmers were just as innovative as rich ones, because of their high motivation to improve their situation.

Moreover, Uganda National Panel Survey (MoFPED, 2014) demonstrates a relationship between crop diversification and level of household welfare (Figure 2-2), which suggests that agricultural households grow fewer types of crop than in past. In the past, there was a clear inverted-U relationship between household welfare and the number of crops grown, but the shape has become flattened. The report suggests the explanations could be a reduced need to diversify crops because of less vulnerability and more gains from specialisation, due to benefits from the introduction of pesticides, herbicides and drought-resistant varieties. Other reasons include increasing land constrains forcing farmers to cultivate fewer crops (MoFPED, 2014).

Figure 2-2: Crop diversification by household welfare decile in Uganda



Source: Uganda National Panel Survey (MoFPED, 2014)

Size and quality of landholdings are also believed to shape the characteristics of innovations (World Bank, 2007b), though Nielsen (2001) argues that there was no statistically robust correlation between farm-size and the number of innovations in his case study.

The level of food security also affects the characteristics of innovations and innovativeness. Kristjanson et al. (2012) reveal that the least food secure households are making few farming practice changes. Similarly, Mazur and Onzere (2009) found that moderately food-secure and food-insecure farmers could not adopt new practices due to lack of resources such as labour, money and time, while food-secure and agricultural trade farmers could hire labours for planting, weeding, and harvesting.

Gendered division of labour is a key factor shaping the characteristics of innovations that farmers adopt. Women are often more likely to be engaged in subsistence farming, while men grow cash crops. This explains the higher adoption rate for food crop related changes for women, while more men welcome cash crop related changes. This gender difference in characteristics of innovations is highlighted in various case studies, including Ghana's pineapple farming (World Bank, 2007b), Uganda's banana-related practices (Miiro et al., 2001), Uganda's new technologies and practices for traditional and export market crops (Mazur and Onzere, 2009) and multiple innovations in Central Uganda (Gabb, 2013). On the other hand, some authors argue that the innovativeness is equal between men and women. Reij et al. (2001) claim that the concept that most innovators are men is biased, and point out that most surveys concentrate on the household heads, who are predominantly male. Similarly, Nielsen (2001) revealed that there was no statistically significant difference in the number of innovations carried out by male-headed as opposed to female-headed households.

With regard to the aspect of education level and farming experience, numerous studies imply a positive correlation with innovativeness (World Bank, 2007b, Foster and Rosenzweig, 2010, van Rijn et al., 2012). Other factors include the number of information-related assets (e.g. radio, TV, cell-phone) owned by the household, the number of natural-resource or farm management groups that household members belong to, and whether the household has an on-farm source of agricultural water.

Moreover, there are a number of studies which testify that farmers' social networks shape the characteristics of innovations and adoption trends. Bandiera and Rasul (2006), who studied the adoption rate of sunflowers in Mozambique, found that the probability that a farmer will adopt a new technology increases when there are few adopters in his network, and decreases when there are many.

The above-mentioned factors are objective variables, but they do not necessarily explain how these differential characteristics set smallholder farmers on different pathways to different kinds of innovation. This requires the exploration of farmers' decision-making processes, which will be discussed in the next section.

2.4 Smallholder Farmers' Decision-making Processes with Regard to Innovation

This section explores the frameworks or models used to study smallholders' decision-making processes with regard to innovation, at individual and household levels.

2.4.1 Basic Decision-making Models

Learning how smallholder farmers make decisions is the basis of understanding their innovation processes. As the innovation perspectives have been shifting (2.3.2), this topic has been much debated, as shown below.

2.4.1.1 Linear Decision-making Model

Numerous studies have focused on predefined innovations whose uptake was a concern. Among those adoption and diffusion researches, Rogers (2003) raised a linear model for innovation adoption which is built on normative decision-making theories (Leeuwis, 2004). In his model, adoption of innovations goes through the following stages: awareness of or knowledge about a new innovation, interest or persuasion, evaluation or decision-making, trial or implementation, and finally adoption or confirmation.

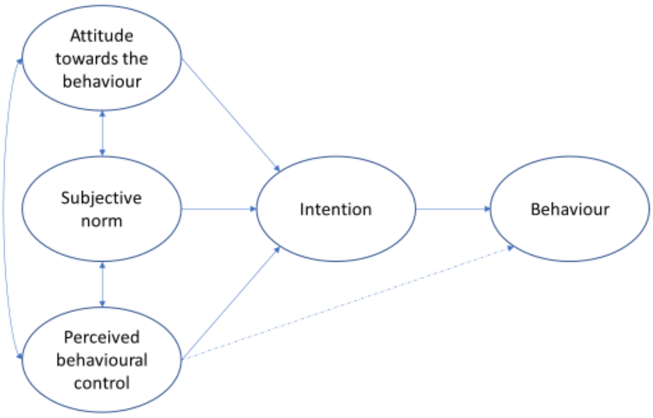
This linear decision-making model corresponds with the perspective on the adoption and diffusion of innovations, which is already discussed in 2.2.2.1. The adoption and diffusion theory has been widely criticised over the years, mainly due to its oversimplification of complex decision-making processes (Engel and Salomon, 1997, Leeuwis, 2004, Spielman et al., 2011). This linear model is based on rational decision-making which is often practically impossible. Agricultural decisions are not made solely by individuals but influenced in complex ways by other actors such as other household or community members and other heterogeneous actors (Garforth et al., 2004, Leeuwis, 2004, Spielman et al., 2011). Recent studies point out that decision-making is the final outcome of much longer learning processes than Rogers' simple model. This traditional model ignores issues of risk, power, conflict, religion and trust.

2.4.1.2 Socio-psychological Model

As an alternative approach to understanding farmers' complex decision-making processes, the Theory of Reasoned Action (TORA) and Theory of Planned Behaviour (TPB) initially developed by Icek Ajzen in 1986 have been widely applied in a number of studies, yet so far few have considered developing countries (Garforth et al., 2004, Yamano et al., 2013, Lalani et al., 2016). The frequency of citing TPB as a theory to predict human social behaviour has rapidly increased since its inception (Ajzen, 2011). TPB aims to identify determinants of socio-psychological constructs which influence individual behaviour in three dimensions: attitude, subjective norm, and perceived behavioural control (Ajzen, 1991) (see Figure 2-3). TORA, however, focuses mainly on the first two dimensions, presenting attitudes as a combination of outcome belief and outcome evaluation, and the subjective norm as a combination of normative belief and motivation to comply (Garforth et al., 2004). The perceived behavioural control in TPB, which means self-efficacy (belief in one's own ability) and controllability (external factors), was later added to TORA. Although TPB and TORA emerged from health-related fields (e.g. smoking/drinking behaviour), these theories have been applied to agriculture-related issues in order to study farmers' decisions on farm business diversification (Hansson et al., 2012), livestock management (Garforth et al., 2004), conservation agriculture (Lalani et al., 2016) and other matters.

Other studies point out the shortfalls of this approach due to its emphasis on the snapshot of rational decision-making rather than the continuous learning process, and its limitation to a specific technology or agenda (Leeuwis, 2004). Leeuwis (2004) argues that farmers' practices are not shaped by conscious ex-ante decision, but rather influenced by path dependency, routine and multiplicity of aspirations. This criticism resonates with other authors who reject TPB by denying the importance of consciousness as a causal agent, and arguing for the importance of implicit attitudes and other unconscious mental processes (Aarts and Dijksterhuis, 2000, Wegner, 2003).

Figure 2-3: Theory of Planned Behaviour

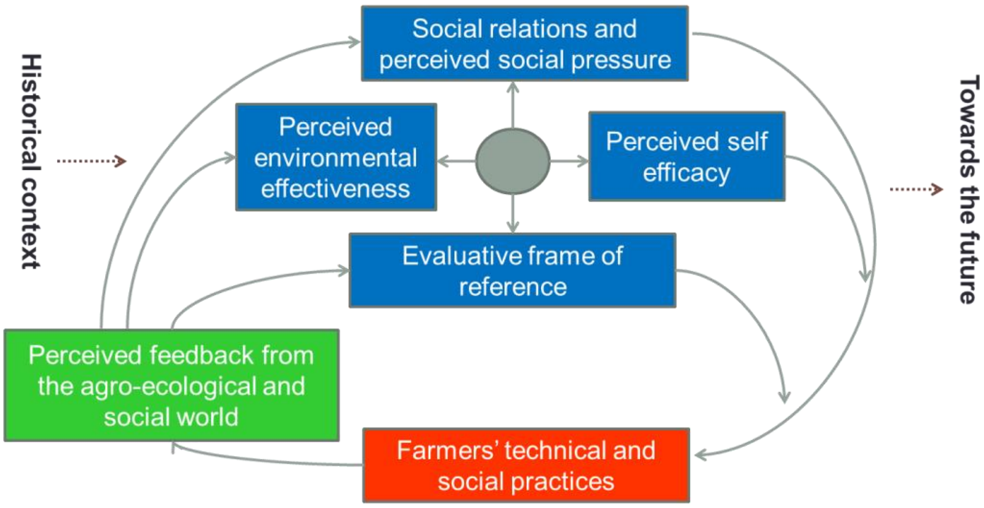


Source: Ajzen (1991)

2.4.1.3 Dynamic Rural-Sociological Model

Among others, Leeuwis (2004) raises another alternative model of four key variables shaping individual farmers' practices: social relations and perceived social pressure, perceived effectiveness of the social environment, perceived self-efficacy, and an evaluative frame of reference, as shown in Figure 2-4 and Table 2-5. This model seems to have similarities with TPB, as it has all three key dimensions of TPB within the model (attitude, subjective norm, and perceived behavioural control). However, Leeuwis' model is more elaborate, specifically adapted to farmers' farming practices in rural settings, and moreover it lays more explicit stress on social capital, resource endowment, risk issues and AIS actors, which must all be considered when undertaking viable farming activities.

Figure 2-4: Model of basic variables that are relevant to understanding individual farmers' practices and responses



Source: Leeuwis (2004)

Table 2-5: Leeuwis' model of basic variables for understanding farmers' practices (static view)

Social relations and perceived social pressure (to be allowed and/or expected to)	Perceived desires and expectations from other actors x Resources that others are perceived to mobilise in order to persuade x Valuation of expectations, resources and relationships
Perceived effectiveness of the social environment (to be able to)	Perceived effectiveness of the agro-support network + Perceived effectiveness of (inter)community organisation (collective resources…etc.)
Perceived self-efficacy (to be able to)	Perceived ability to mobilise resources + Perceived availability of skills and competence + Perceived validity of the evaluative frame of reference + Perceived ability to control or accommodate risks
Evaluative frame of reference (to believe and to aspire)	Perceived technical and socio-economic consequences x Perceptions of uncertainty, likelihood and risk x Valuation of consequences and risks regarding aspirations

Source: Leeuwis (2004)

Leeuwis (2004) demonstrates not only a static view but a dynamic innovation process seen from the farmer's perspective, as shown in Table 2-6. It is argued that innovation takes place when a "problem" occurs, consisting of perceived tension between an existing state of affairs and a desired state of affairs. The problem is recognised through feedback from the agro-ecological world and the social-organisational world. Thus, this holistic model is not a linear but an iterative process, means that this model can capture dynamic pictures of farmers' behavioural changes, rather than the snapshot view offered by TPB. In the meantime, Leeuwis (2004) claims that the farmers' practices are not simply the outcome of rational decision-making processes combined with objective problem analyses, but are heavily influenced by routine and path dependence ingrained by previous practices. This means that this model is not based on hard systems thinking but a soft systems model.

Table 2-6: Dynamic process of innovations

Changed perceptions about reality	e.g. a given farming system may become increasingly looked upon as causing environmental degradation.
Changed human aspirations	e.g. farmers may increasingly strive to meet consumer concerns, which may render current practices problematical.
Changed social environment	e.g. the labour needed to sustain a particular farming system may become increasingly scarce.
Changed natural/physical circumstances	e.g. a farming system may start to yield less optimal results due to ecological change.
Changed social opportunities	e.g. new international trade agreements may create new market opportunities.
Changed technical opportunities	e.g. the availability of computer technology may trigger people to rethink current agricultural practices and technologies, and search for applications of such opportunities in agriculture.

Source: Leeuwis (2004)

2.4.2 Intra-household Decision-making in Innovation Processes[1]

The fact that innovation processes are profoundly gendered is often neglected in innovation literature and innovation support interventions, and this results in a low uptake of innovations (Reij et al., 2001, Cardey and Garforth, 2013, Kingiri, 2013). Men and women

[1] This section (2.4.2) overlaps with Chapter 6 (6.2).

make innovations and benefit from them differently. On the one hand, traditionally defined gender division of labour is a key factor which shapes the characteristics of innovations that farmers adopt. Women are often more likely to be engaged in subsistence farming, while men grow cash crops (Moser, 2012). This explains the higher adoption rate of food crop-related changes for women, while more men welcome cash crop-related changes. This gender difference in the characteristics of innovations has been highlighted in various case studies, including Ghana's pineapple farming (World Bank, 2007b), Uganda's banana-related practices (Miiro et al., 2001), and Uganda's new technologies and practices for traditional and export market crops (Mazur and Onzere, 2009).

Gender difference in innovation uptake is attributed to unequal access to resources resulting from gendered roles and responsibilities. A study by the Future Agricultures Consortium found that the households with more land, assets and resources took advantage of opportunities, often leaving out female farmers with less resources (Wiggins, 2014). The other empirical evidence suggests that women are often more likely to be engaged in subsistence farming and less likely to cultivate cash crops, because soil fertility, tenure security of plots, and participation in the credit market were lower for women than for men (World Bank, 2007b, Mazur and Onzere, 2009, Fisher and Carr, 2015, Doss and Morris, 2001). Such gender inequality in access to resources often hinders innovation uptake.

In this section, an explanation of important intra-household decision-making models will be followed by reviews of the determinants of decision-making power and the gender dynamics appearing in innovation contexts.

2.4.2.1 Bargaining Models

Innovation is a process which constitutes a series of intra-household decisions that are strongly affected by existing decision-making patterns of production and consumption and perceived institutions such as social norms and culture. Earlier studies of "New Home Economics" founded by Becker (1965) applied a unitary model which assumes a household is a single production or consumption unit, thus failing to understand intra-household dynamics (Moghadam et al., 2011, Agarwal, 1997, Wolf, 1990). As a result, various interventions intended to support household production and consumption turned out to be ineffectual. The bargaining framework emerged to claim that the outcomes of households' decisions are affected by the allocation of resources and power relationships within the household, as opposed to the unitary model's predictions (Doss, 2013, Doss, 2001, Anderson et al., 2017, Browning et al., 2010, Meinzen-Dick et al., 2011).

Agarwal (1997) and Doss (2013) further categorise the bargaining frameworks as cooperative bargaining models, collective models and non-cooperative bargaining models: they work on the assumption that households in the first two groups have achieved Pareto optimality, so that no one could be better off without making someone else worse off, while the third group have not. The cooperative bargaining and collective models argue that individual household members bargain over the allocation of pooled resources and the management of household expenditure, so that there are different outcomes due to different preferences among household individuals. On the other hand, non-cooperative bargaining models assume that the household individuals make separate decisions on their own resources, as resources are not pooled, but rather spent individually (Doss, 2001), although Malapit (2012) claims that cooperative models and non-cooperative models are not mutually exclusive.

Much of the literature supports the non-cooperative models or a combination of models from the three groups as best explaining the intra-household decision-making in developing country contexts (Udry, 1996, McPeak and Doss, 2006, Kebede et al., 2014, Browning et al., 2010, Njuki et al., 2011). This could be true in SSA, where resources are not often pooled but typically controlled by men (Njuki et al., 2011), and decisions are seemingly governed by strong social norms or institutions maintaining gendered roles and responsibilities, not necessarily aiming to maximise household productivity by daily negotiations among household individuals. In other words, in any model, gender inequalities in decision-making authorities are apparent; in cooperative and collective bargaining models, the production and consumption decisions are affected by the gender inequalities in bargaining power often led by unequal asset endowment and control. In parallel, in non-cooperative bargaining models, gender inequalities in asset endowment limit the share of decisions under women's control.

2.4.2.2 Determinants of Intra-household Bargaining Power

A variety of studies suggest that the determinants for bargaining power are income and employment, ownership and control over assets such as land, livestock, and agricultural equipment, and social networks, access to credit, institutionally determined and individual perceptions of social norms on gender roles and responsibilities, women's education, age, health, and their participation in the market, spousal contributions to households, and fall-back position (Anderson et al., 2017, Doss, 2013, Fisher and Carr, 2015, Mishra and Sam, 2016, Agarwal, 1997). Meinzen-Dick et al. (2011) demonstrate that the key determinant of the bargaining power is ownership and control of assets, categorising them into natural resource capital, physical capital, human capital, financial capital, social capital and political capital. The ownership and the types of such assets are gendered, conditioned and perpetuated by sociocultural context and intra-household allocation rules (Quisumbing et al., 2015, Johnson et al., 2016, Doss et al., 2018). Those studies which investigate determinants of bargaining power can provide significant insights for understanding decision-making patterns even in innovation contexts.

Thus, many studies suggest that innovations or adoptions of technology are influenced by gendered allocations of resources such as land, labour, credit, agricultural inputs and extension, as well as gender norms. However, few studies have attempted to reveal it in an intra-household context. Moreover, many adoption studies typically focus on only one specific crop or technology, failing to capture holistic views of innovation processes (Leeuwis, 2004), except some studies such as that by Anderson et al. (2017), who attempted to cover multiple farm and household decision-making domains for the same households. Furthermore, conventional adoption studies fail to present qualitative investigations of the reasoning behind farmers' decision-making patterns.

2.4.2.3 Intra-household Dynamics in Innovation Processes

Intra-household dynamics influence the adoption of new agricultural technologies but are seldom examined by literature on adoption studies. Furthermore, many empirical studies reveal that women farmers have relatively low rates of adoption of agricultural technologies associated with higher productivity. Although many articles consider the gender of the farmer or the gender of the household head as a determinant of adoption, they do not consider the intra-household context and the bargaining framework which may affect the technology adoption (Doss, 2001, Doss, 2013, Haider et al., 2018)

Some of the first contributions to analyse technology adoption in an intra-household context were those of Von Braun (1988) and Jones (1983), who investigated how the allocations of labour changed when irrigated rice was introduced in West Africa. Those articles demonstrate that women's lack of bargaining power allows the benefits of the new technologies to be captured by men, as predicted in the earlier year by Boserup (1970). More recently, Fisher and Carr (2015) found in their study on the adoption of Drought-Tolerant (DT) maize in eastern Uganda that female farmers have much lower adoption rates of DT maize than male farmers, due to differences in resource access. They also discovered that married men whose wives have their own plots are less likely to adopt DT maize, probably because the wives can choose to concentrate on their own plots and refuse to work on those of their husbands: since technology adoption increases demands on time, this refusal could be a crucial factor. Also, Haider et al. (2018) analysed fertiliser adoption in Burkina Faso, demonstrating that technology adoption status differs among household members, depending on whether their plots are collectively or individually managed. Furthermore, Anderson et al. (2017) analysed the differences in the extent of female partners' authority over 13 different household and farming decisions in rural Tanzania, showing that women's age, education, health and labour activities affected perceptions of decision-making authority. Thus, it is clear that intra-household bargaining, based on a set of gendered and socio-cultural dynamics relating to resources and labour (re)allocations, influences the adoption of innovations. It is also noteworthy that gendered division of labour by crop and by task is not static, but changes in accordance with new economic opportunities (Doss, 2001). This implies that change in the economic value of a certain crop may change gender power relations, affecting intra-household resource allocation and decisions about who benefits from the crop.

Moreover, literature on intra-household decision-making about the outputs of innovations is also scarce. Women and men in SSA do not always pool household incomes: some may negotiate and choose to spend the money under their control differently (Meinzen-Dick et al., 2011, Doss, 2013, Njuki et al., 2011). Some studies have shown that women's bargaining power affects the household budget shares spent on food, education, health, private goods, or other goods. However, the practical difficulty of distinguishing between goods for the entire family and purely for individual members makes it cumbersome to assess the bargaining power of household individuals. Doss (2013) also suggests that consumption patterns may be strongly related to factors affecting bargaining power, particularly income and asset ownership.

2.4.3 Roles of Aspirations and Perceived Constraints in Decision-making

The previous sections discussed the importance of exploring farmers' decision-making processes in order to understand their perceptions and practices with regard to innovation. This section reviews the empirical studies on the farmers' aspirations or motivations and perceived constraints, which can influence decision-making on innovations.

In the various studies, the main drivers for innovations are reported to be income, own consumption or food security, reduction of labour or input costs (Miiro et al., 2001, Nielsen, 2001, Reij et al., 2001, Gabb, 2013), domestic efficiency, self-reliance, market opportunity, nearby projects, awareness raised by mass media (Taylor, 2013), problems such as pest attacks (Leeuwis, 2004), and social status (Mazur and Onzere, 2009). Miiro et al. (2001) found that the drivers were weak for soil and water conservation benefits. Furthermore, Gabb (2013) identifies wealth and gender as influences on the importance of drivers. All these findings are in line with Leeuwis' model of the dynamic innovation process, which addresses changes in human aspirations, social environments, naturally occurring physical circumstances, social opportunities, technical opportunities, and perceptions of reality (Leeuwis, 2004). However, most of these studies describe static drivers only, not capturing the dynamic process whereby the drivers of innovations have changed over time.

Key constraints on innovation include lack of money, lack of land, lack of labour, poor transportation, lack of access to market, and lack of information (lack of new ideas to try), lack of access to input markets, lack of ownership, environmental changes, immediate personal problems such as food insecurity and illness, inadequate training, previous experiences of failure, poor stakeholder coordination, and inappropriate microfinance services (Nielsen, 2001, Mazur and Onzere, 2009, Gabb, 2013). As in the case of drivers for innovation, different gender and wealth groups experience different constraints. Compared to poor farmers, wealthier farmers placed more importance on market constraints. Labour constraints were of special concern to female farmers, as they relied mostly on the labour provided by their children during school holidays, while men could access the labour of all household members (Mazur and Onzere, 2009, Gabb, 2013).

Theft is also identified as one of the key obstacles that every innovator is experiencing (Nielsen, 2001), which is considered to be partly a result of neighbourhood jealousy or envy in the wider community, especially when access to innovation is deliberately or unintentionally limited to a small number of farmers, undermining other farmers' self-confidence by emphasising how difficult it is to make the innovation work (Miiro et al., 2001, Leeuwis, 2004, Taylor, 2013). In connection to this issue, some studies revealed that the problems of theft and witchcraft are due to the community's "levelling mechanism", designed to equalise its wealth, while, on the other hand, Sugiyama (2011) reports that this mechanism is an enhancing factor for innovations.

2.5 Smallholders' Agricultural Knowledge and Innovation Systems

The previous sections reviewed decision-making processes mainly at individual and household levels, but smallholder farmers' innovations cannot be fully understood without exploring multi-actor networks and systems involved in dynamic processes which may enable or disable the innovation processes. It is widely acknowledged that innovation is a social process involving collective action, coordination, and the exchange of knowledge among a multitude of different actors in a wider social system (Leeuwis, 2004, Agwu et al., 2008, Sanginga et al., 2009, World Bank, 2012). The innovation process is affected by various types of social interactions including network-building, social learning, feedback (Leeuwis, 2004), negotiation, and other factors such as levelling mechanisms (Sugiyama, 2011), and social attitudes and practices (Hall et al., 2006b, World Bank, 2007a).

2.5.1 Knowledge and Information Sources for Innovations

AIS provides a wide range of information and knowledge sources, enabling farmers to make innovations. They include other community members, local leaders, NGOs, private businesses, radio, and government departments. A number of AIS studies with hard systems thinking attempt to capture static or infrastructural views on how AIS looks as a snapshot: some, for example, use Social Network Analysis (SNA) (Spielman et al., 2011, Adolwa et al., 2016). Agricultural censuses in some SSA countries capture data on which sources of information or knowledge household heads utilise in their farming practices. The result of the Ugandan Agricultural Census in 2008/9 in Uganda, for example, shows that most households rely either on community radio or other farmers for various types of agricultural information, on topics such as weather, crop varieties, new agricultural practices, farm machinery, credit facilities, plant diseases and pests, and marketing, while the contribution of public extension was minimal (UBOS, 2010). Nevertheless, an agricultural census does not describe in-depth processes or record the degree of importance of information sources.

Consequently, such hard systems thinking lacks insight on what constitutes the networks, and fails to understand “co-evolutionary processes” (Klerkx et al., 2012) such as the dynamics of users’ preferences, the quality of interactions, formal and informal institutions, and so forth. Firstly, the sources of information have been changing in accordance with policy and technological changes. Sseguya et al. (2012) argue that the ToT approach, which has been dominant in Uganda since 1950s, has limited community members’ ability to share information with other AIS actors. However, with the decentralisation that began in 1997, most communities reported increasing reliance on NGOs and community members as major sources of information on agricultural technologies; moreover, new information and communication technologies, such as the internet and mobile phones, promoted farmers’ linkages with domestic and international markets (Sseguya et al., 2012). Thus, the combinations of actors involved with AIS have been changing over time, in accordance with changes in institutional environments, such as extension policy and practices.

Secondly, the actual use of information sources or channels is shaped by accessibility to AIS actors, but, more importantly, profoundly influenced by cognitive factors, such as farmers' pro-activeness in information-seeking behaviour (Klerkx et al., 2017) and their perceptions of the reliability of the information's sources (Hall et al., 2006b, Sseguya et al., 2012, World Bank, 2012, Zanello and Srinivasan, 2014). Sseguya et al. (2012) revealed that the most trusted sources of information were NGOs and community members, while government programmes and private businesses were the least trusted, and their information consequently least applied. The main information gaps identified were in relation to savings and credit management, conflict management and marketing skills, and access to produce markets.

2.5.2 Social Networks and Social Learning[2]

Innovation processes entail both social networks and social learning. In recent years, a number of studies with an innovation systems approach have increasingly recognised the important role of social networks and social learning in knowledge exchange, experimentation, and risk mitigation, especially when adopting new innovations which involve uncertainties (Bandiera and Rasul, 2006, World Bank, 2007b, Mazur and Onzere, 2009, Conley and Udry, 2010, Spielman et al., 2011, Maertens and Barrett, 2013). Social networks are mechanisms connecting individuals to society with patterns of social interaction (Hoang et al., 2006), and are often defined by social and economic institutions which are formal and informal "rules of the game in a society", such as laws, regulations,

[2] This section (2.5.2) is the same as the literature review section of Chapter 7 (7.2.2).

contracts, norms and customs (North, 1990). Social learning, which goes beyond individual learning, is defined as a learning process in which interdependent social actors simultaneously develop complementary understandings of relevant reality, problems, and boundaries, in order to effect desirable changes or innovations (Leeuwis, 2004, Leeuwis and Aarts, 2011).

Social networks and learning facilitate, or at times limit, innovation processes by affecting members' access to knowledge and information (Spielman et al., 2011), often described as "social capital" and a key asset for individuals (Putnam, 2000, van Rijn et al., 2012). The functions, or characteristics, of ties in social networks are often described as formal or informal, horizontal or vertical (Hoang et al., 2006), or as bonding strong ties or bridging weak ties (Darr and Pretzsch, 2008, Saint Ville et al., 2016). The informal, horizontal, and bonding strong ties are linkages with frequent contact and communication, often seen in farmer-to-farmer interactions, while the formal, vertical, and bridging weak ties are characterised by infrequent contact, such as linkages between farmers and researchers (Adolwa et al., 2016).

Various innovation studies consider what structures of social networks contribute to innovation diffusion more efficiently and effectively. Some argue that the informal, horizontal, and strong ties of social networks are more effective in innovation dissemination than formal, vertical, and weak ties. Horizontal communication is particularly relevant for poorer farmers, who are found to rely more on informal farmer-to-farmer interaction, while wealthier farmers receive more information from extension services and prominent farmers (Reij et al., 2001, Hoang et al., 2006, Matous et al., 2013). Some studies also find that less knowledgeable farmers tend to be more responsive to information obtained from their peers (Bandiera and Rasul, 2006, Conley and Udry, 2010). Darr and Pretzsch (2008) and Adong et al. (2012) argue that farmers' groups are the most effective pathways of innovation dissemination among farmers. The community's culture and norms, such as its levelling system and food-sharing, also either hinder or contribute to the innovation diffusion over time (Sugiyama, 2011).

In contrast, others highlight the significant role of bridging and vertical ties in obtaining novel knowledge and information. An early study, conducted by Granovetter (1973) emphasised the significant role of weak ties in diffusing novel knowledge or information to a larger number of people. He notes that people from different circles connect "us" to a wider world. In more recent studies, Adolwa et al. (2016) found that the presence of weak knowledge ties is critical for the awareness and acquisition of skills in soil fertility management, comparing cases in Kenya and Ghana. Thuo et al. (2014) argue that weak ties, such as those with researchers, extension workers, input sellers, and buyers, have a significant impact on farmers' acquisition of information about new groundnut varieties in Kenya and Uganda.

Nonetheless, many agree that both the bonding and bridging ties of social networks are necessary for innovation, and they simply play different roles in innovation processes: weak ties for acquisition of novel knowledge, and strong ties for exchange of complex knowledge (Spielman et al., 2011, Adolwa et al., 2016, Saint Ville et al., 2016), described as "search" and "transfer" by Hansen (1999) and "innovation" and "imitation" by Shaw-Ching Liu et al. (2005). Furthermore, Darr and Pretzsch (2008) find that the effectiveness of either cohesive or weakly knit networks depends on whether information is abundant or scarce. Under conditions of information abundance, strong networks disseminate innovations more effectively than weak networks, while in a situation of information scarcity, the pattern is reversed. Similarly, Bandiera and Rasul (2006) analysed sunflower adoption in Mozambique and demonstrated that the information availability within the network adversely affected social learning, which suggests that positive social effects are observed when there are few adopters in the network, and negative effects when there are many.

2.5.3 Facilitating and Discouraging Factors for Innovation Networks and Systems

It is widely acknowledged that innovation networks and systems play a key role in innovations. Hall et al. (2006a) summarise the typology of supportive and restrictive attitudes and practices affecting innovation processes, as shown in Table 2-6. Social learning or interactive knowledge exchange is important as discussed above, but such interactions should be facilitated by supportive attitudes, including trust, openness, respect and proactive networking (Hall et al., 2006a, Sseguya et al., 2012, World Bank, 2012, Zanello and Srinivasan, 2014). On the other hand, negative attitudes such as mistrust, secretiveness, and top-down approaches restrict social learning.

Table 2-7: Typology of attitudes and practices affecting key innovation processes and relationships

Innovation processes and relationships	Supportive attitudes and practices	Restrictive attitudes and practices
Interacting, knowledge flows, learning	• Trust • Openness • Transparency • Confidence • Mutual respect •Flat management structure • Reflection and learning from successes and failures • Proactive networking	•Mistrust of other organizations • Closed to other ideas • Secretiveness • Lack of confidence •Professional hierarchies between organizations and disciples • Internal hierarchies •Top-down cultures and approaches • Failures are covered up

		•Limited scope and intensity of interaction in sector networks
Inclusiveness of poor stakeholders and the demand side	•Consultative and participatory attitudes	• Hierarchies • Top-down cultures and approaches
Risk-taking and investing	• Confidence • Professional incentives	• Conservative

Source: Adapted from Hall et al. (2006a)

With broader perspectives, Klerkx et al. (2012) have compiled the key enablers and disablers of innovation systems performance analysed by various authors (Hall et al., 2001, Klein Woolthuis et al., 2005, Spielman et al., 2008, van Mierlo et al., 2010, Brooks and Loevinsohn, 2011), as shown in Table 2-7. Among others, the roles of "niches" or intermediaries have recently been recognised as change agents which facilitate innovation systems through the articulation of expectations and visions, the building of social networks, and learning in multiple dimensions at technical, production, market, cultural, infrastructural, policy, social and environmental levels (Klerkx et al., 2012). Kivimaa et al. (2019) classify such intermediaries into five categories: systemic intermediary, regime-based transition intermediary, niche intermediary, process intermediary, and user intermediary. Transitional innovations for sustainable agro-food systems require reflexive interactive learning between niches and existing regimes (Bos et al., 2009, Elzen et al., 2012, Ingram, 2015).

On the other hand, the systemic imperfections or key disablers of innovation systems' performance include infrastructural, hard and soft institutional, strong and weak network-related capabilities and market structural failures (Klein Woolthuis et al., 2005, van Mierlo et al., 2010). The system of innovation (SI)-based policy framework designed by Klein

Woolthuis et al. (2005), contains a proposal to analyse the problem of "missing actors" in parallel to a variety of systemic failures. Such actors include demand side actors (e.g. consumers), companies, knowledge institutes, and third parties (e.g. intermediaries, consultants).

Table 2-8: Key enablers and disablers of innovation systems performance

Key Enablers	♦ Shared visions, well-established linkages and information flows among multiple actors ♦ Conducive incentives that enhance cooperation, adequate market, legislative and policy environments ♦ Learning within and between firms and organisations in order to innovate ♦ Strengthening individual and collective capabilities to innovate ♦ Demand and supply-driven science and technology ♦ Innovation agents focusing on complex and dynamic interactions ♦ Network-based knowledge dissemination ♦ Both embedded and disembedded knowledge dissemination: in both tacit and codified forms ♦ Decentralized management of innovation processes ♦ Strategic niche development and management/ Interactive reflexive design (vision articulation, social network building, learning processes of multiple dimensions)
Key Disablers	♦ Infrastructural failures (physical, knowledge and financial infrastructures) ♦ Hard institutional failure (formal laws and regulations) ♦ Soft institutional failure (informal rules, norms, values, and culture) ♦ Strong network failure (e.g. actors locked into their relationship) ♦ Weak network failure (e.g. actors are not well connected) ♦ Capabilities failure (technical and organisational capacity of systems) ♦ Market structure failures (e.g. monopoly, imperfection of knowledge market)

Source: Adopted from Klerkx et al. (2012) and Klein Woolthuis et al. (2005)

Empirically, there is no doubt that both bonding and bridging networks play significant roles in innovation, as discussed earlier, but the cases in which social networks do not function well are often ignored or under-reported. "Strong network failure" is identified as a key disabler of innovation system performance, such as the actors being locked into their relationship (Klein Woolthuis et al., 2005), as shown in Table 2-8. With regard to bonding networks, for instance, Matous et al. (2013) found that farmers who are socially well connected within the community tend to be less receptive to agents' recommendations, described as "cognitive social capital" by van Rijn et al. (2012). Meanwhile, Ishikawa et al. (2014) reported that model farmers with greater technology absorption skills tend to be less effective in disseminating the technology to other farmers. Furthermore, the unobserved characteristics of farms, such as soil fertility, prevent social learning from neighbours, as observed in a comparison study of rice and wheat growers in the Indian Green Revolution (Munshi, 2004), and a coffee pruning case in Peru (Weber, 2012).

"Weak network failure" where actors are not well connected is also a key disabler, as shown in Table 2-8. The bridging network fails to operate when contact farmers do not play a desirable brokering role. Some studies on bridging social capital have focused on mediators' characteristics. Many claim that access to formal innovation actors, such as extension staff, increases with farmers' wealth and the size of their personal networks, and with greater proximity to the village centre and other households, and with the same religion and ethnicity as their agents (Bandiera and Rasul, 2006, Hoang et al., 2006, Spielman et al., 2009a, Matous et al., 2013, Ishikawa et al., 2014). It is often the case that extension agents focus on those farmers with larger personal networks who are believed to influence many other farmers. This applies particularly to public extension agents, who strive to meet prescribed technology adoption rates under increasing pressure from a short-term output-oriented extension policy (Matous et al., 2013). Nevertheless, Hoang et al. (2006) and Leeuwis (2004) have warned that the contact farmers, selected for their superior wealth and influence, are not representative of the community: due to existing power relations within the village, the already marginalized farmers have been left out.

The more recent work on social network analysis, using an innovation system approach, has contributed significantly to more elaborative understanding of the wider innovation systems and networks beyond linear actors, i.e., researchers, extension officers, and farmers. The AIS framework acknowledges the importance of those who operate in more extended spheres, such as market actors and consumers (Hall et al., 2006b, Spielman et al., 2009b, Klerkx et al., 2012, World Bank, 2012). However, such studies often neglect the smallholder farmers' function as a central part of the innovation system or network (Berdegué, 2005, Rajalahti et al., 2008, Assefa et al., 2009, Spielman et al., 2009b, Spielman et al., 2011, Cardey and Garforth, 2013, Chowa et al., 2013, Garforth, 2013), and, more importantly, the relevance and inclusiveness of the network for diverse farmers, especially the poor (Fressoli et al., 2014, Dawson et al., 2016, Nemes and Augustyn, 2017), as discussed in the next section.

2.5.4 Inclusive Innovation Networks and Systems[3]

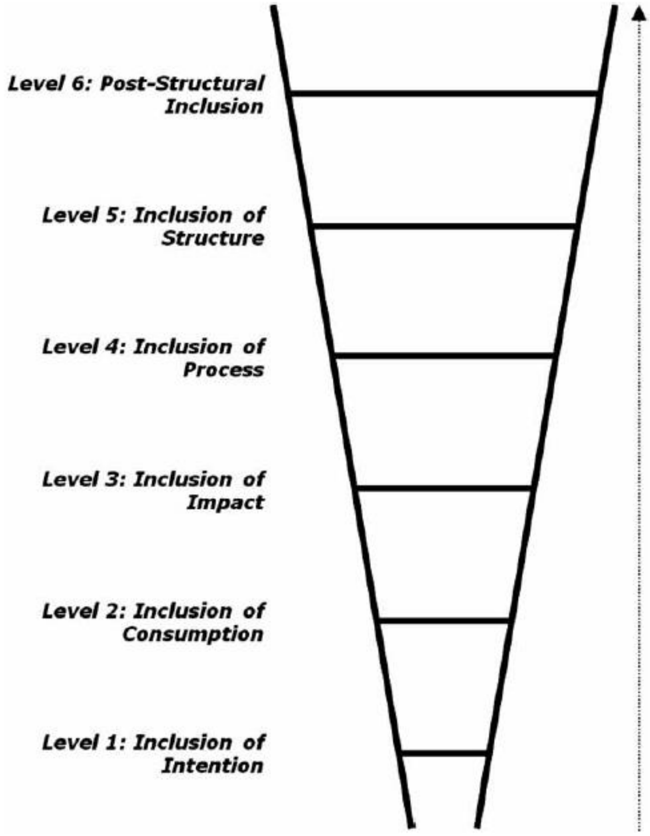
The previous section has shown how enablers and disablers affect the function of innovation networks and systems. However, some critical questions remain. Who occupies the centre of these networks and systems? Are the neediest smallholder farmers included or excluded, and, given that they are mostly subsistence farmers, how do innovation networks and systems affect their livelihoods? Importantly, "inclusiveness" affects the innovation systems performance. The key enablers for inclusive innovation processes are consultative and participatory attitudes of actors, shared visions, well-established linkages and information flows among multiple actors, incentives that enhance cooperation, learning within and

[3] This section (2.5.4) partially overlaps with the literature review section of Chapter 7 (7.2.2).

between groups of actors, network-based knowledge dissemination, and decentralised management of innovation processes, as shown in Table 2-7 and Table 2-8 in the previous section.

There is an increasing level of intellectual engagement with "inclusive innovation" in accordance with the growing commitments of international and national organisations to this policy: these include OECD, the World Bank, with its interest in "inclusive growth" (Pouw and Gupta, 2017), the UN's Post-2015 Development Agenda (Heeks et al., 2014) and the following Sustainable Development Goals (SDGs) whose key objective is expressed as "leaving no one behind" – in other words, "inclusive development". The inclusive development which has emerged in the 21st century is defined as "focusing on social wellbeing and protecting the ecosystem services of nature through redefining political priorities" and implies tackling inequality (Pouw and Gupta, 2017). Similarly, "inclusive innovation" has attracted scholarly attention over the last two decades, due to experiences in developing countries where the economic growth and innovations through formal scientific and technological systems rarely addressed the needs of the poor (Santiago, 2014). Foster and Heeks (2013) define "inclusive innovation" as "the inclusion within some aspect of innovation of groups who are currently marginalised", and further suggest that inclusive innovation has one or more of four features of "inclusivity"; namely (1) inclusivity of innovation precursors (the problems to be addressed by innovation are of relevance to the poor), (2) inclusivity of innovation processes (the poor are involved in the development of innovative goods and services), (3) inclusivity of innovation adoption (poor consumers have the capability to absorb innovations), and (4) inclusivity of innovation impacts (innovative goods and services have a beneficial effect on the livelihoods of the poor). Similarly, Heeks et al. (2014) present the "ladder of inclusive innovation" as shown in Figure 2-5 below: Level 1 (Intention): the intention of that innovation is to address the needs or wants or problems of the excluded group, Level 2 (Consumption): the innovation is adopted and used by the excluded group, Level 3 (Impact): the innovation has a positive impact on the livelihoods of the excluded group, Level 4 (Process): the excluded people are involved in the development of the innovation, Level 5 (Structure): The innovation is created within a structure that is itself inclusive, and Level 6 (Post-Structure): The innovation is created within a frame of knowledge and discourse that is itself inclusive. Furthermore, recent studies argue that the inclusiveness depends not only on the diffusion of innovations to the poor (Level 2) but also on their participation in innovation generation processes (Level 4 and above), and question the value-neutrality of innovation, redefining it as a political process extending beyond technological and socio-economic processes (Papaioannou, 2014, Papaioannou and Srinivas, 2019). This argument is simultaneously maintained in the realm of "responsible innovation", as "inclusion" is highlighted as one of the key dimensions of "responsible innovation" which involves consideration of power relations (Stilgoe et al., 2013), particularly in collective innovation processes (Owen et al., 2012). These dimensions provide a useful framework for analysing various innovation cases.

Figure 2-5: Understanding the different levels of inclusive innovation



Source: Heeks et al. (2014)

Recent literature increasingly promotes the application of the SI or SoI (Systems of Innovation) framework to "inclusive innovation", for a grounded and comprehensive understanding of innovation processes, actors and relations, and policy, as shown in Table 2-9. However, there is still little literature applying such a framework to the context of a developing country's rural sector.

Table 2-9: Comparison between conventional systems of innovation and literature-based inclusive innovation issues

	Conventional systems of innovation	*Inclusive innovation issues from literature*
Overall scope	Development as economic growth • Macro-level analysis	Development as socio-economic inclusion • Micro-level analysis of

		livelihoods
Innovation	Located innovation pre-, durante- and post-production • Growth-oriented innovation • Supply-driven innovation • Technical innovation	Incremental innovation with a focus on diffusion processes • Local needs-oriented innovation • Demand-driven innovation • Non-technical innovation
Actors	Main focus on: • Higher-income markets/consumers • Formal supply-side organisations in industrial sectors • Intermediaries as information/knowledge brokers	Main focus on: • Low-income consumers • Non-traditional, informal, demand-side innovators • Innofusion intermediaries
Learning	Learning by doing plus using and interacting: • Learning about production and implementation • Learning about technology • Coherence and profit-maximisation as guides	• Learning about diffusion and use • Learning about wider social processes
Relations	Formal, close relations preference	Value of both close and loose, flexible relations
Institutions	Formalised, relatively static, direct-impact overarching institutions	Shortfall of formal rules in practice, and importance of informal institutions at local level

Source: Foster and Heeks (2013)

While micro-level analysis of livelihoods in informal settings is crucial for studying inclusive innovation systems (Foster and Heeks, 2013, Santiago, 2014), as discussed above, there are few empirical studies in this area. In the context of developing countries, Berdegué (2005) advocates pro-poor innovation systems by claiming that opportunities for innovation are unevenly distributed among the rural population. He insists that the poor are driven by "push factors" (responses to negative incentives, such as depleted soil fertility or drought), rather than "pull factors", including new market opportunities for high value crops and new technologies which are often drivers for the non-poor. This resonates with the categorisation of household livelihood strategies and transformations as "hanging-in" and "stepping-up" (Dorward et al., 2009), where the former is driven by push factors and the latter by pull factors. Among the limited number of empirical studies with a holistic approach, Singh et al. (2016) analysed farmers' decision-making on livelihood adaptation in response to a range of relevant risks in drought-prone northwest India, and found that perceived adaptive capacity and perceived efficacy affect farmers' responses and shape the household's long-term response trajectories. Another empirical example of "inclusive innovation" systems is the Promoting Local Innovation in Ecologically Oriented Agriculture and Natural Resource Management (Prolinnova) programme in Africa and Asia, which enhances the innovation systems in which farmers are involved (Waters-Bayer et al., 2009). Prolinnova uses Participatory Innovation Development (PID) approaches (as mentioned in 2.2.2.4) and advocates the inclusion of farmers on the upper levels of the above-mentioned "inclusive innovation" ladder of Heeks et al. (2014), enabling them to contribute to the inclusive innovation process and structure (and even post-structure). Thus, it is important to understand innovation systems from the farmers' point of view, querying their inclusivity, and holistically including the livelihood strategies and outcomes of the poor.

2.6 Effects of Innovations

What are the consequences of the above-mentioned local innovations? This section reviews the outcomes of innovations both at macro and micro levels. At macro level, the recent upward trend of increased agricultural productivity is striking. In line with the rapid GDP growth in Africa since the late 1990s, agricultural production has shown a remarkable growth rate, with an annual average of 3.2% and 0.8% per capita in the last two decades, after many years of stagnation (Hazell, 2014, Wiggins, 2014). Remarkably, this growth was achieved by the increased land and labour productivity, with only moderate expansion of the cultivated land. The growth rates for land and labour productivity between the early 1990s and the late 2000s were 45% and 24% respectively (Wiggins, 2014).

How can this macro trend be explained by the micro evidence at local level? According to the studies conducted by IFPRI and the Future Agriculture Consortium (Wiggins, 2014), this growth was brought about by the increased productivity of small-scale family farming, triggered by rising demand in domestic markets resulting from rapid urbanisation, rather than export markets. The smallholders gradually intensified their farming over the decades, by investing in improved seeds, fertilisers, tools, small-scale irrigation and hired labour, using their own savings rather than credit from banks, without making a dramatic change in their farming system. It is reported that both land and labour markets were intensely active in rural communities. This is evidence that some smallholder farmers shifted from "hanging-in" to "stepping-up", achieving higher levels of productivity by responding to the larger-scale changes which increased urban demands for food, according to Dorward's categorisation of livelihood strategies and transformations (Dorward, 2009).

Previous studies suggest that the smallholder farmers in SSA are wary of commercialisation and hesitate to specialise in cash crops over food crops, so deliberately make small changes at a slow pace. A number of case studies also reveal that the farmers are making a wide range of innovations, but they are minor and marginal changes with low risk approaches without major disruptions to the farming system or substantial changes to land, labour or water allocation (Nielsen, 2001, Kristjanson et al., 2012, Gabb, 2013). Intercropping, changes in crop varieties, changes in herd size, and changes in animal feeding have become widespread, while changes in the types of animals being raised and the adoption of new breeds are limited (Kristjanson et al., 2012). Hence, in practice, innovations are limited to merely "individual production objects" rather than extending to "aggregate production objects" or even the entire "farming system", according to the Leeuwis' hierarchy of innovations (Leeuwis, 2004).

Furthermore, it is observed that not all farmers could intensify their farming and seize the market opportunity. As mentioned above, innovation or technology adoption is associated with farmers' socioeconomic characteristics. The study of the Future Agricultures Consortium found that the households with more lands, assets and resources took advantage of opportunities, often leaving out female farmers with less resources (Wiggins, 2014). The other empirical evidence suggested that women were often more likely to be engaged in subsistence farming and less likely to cultivate cash crops, because soil fertility, tenure security of plots, and participation in the credit market were lower for women than for men (World Bank, 2007b, Mazur and Onzere, 2009, Gabb, 2013). In Uganda, where women provide over 70% of the labour force engaged in agricultural production, which is one of the highest rates among SSA countries, they have less access to the factors of production such as land, credit, and extension services than men, and control less than 20% of the outputs. Consequently, land managed by women produces 17% less per acre on average than the land managed by men or jointly by other family members (MAAIF, 2016a, World Bank, 2016).

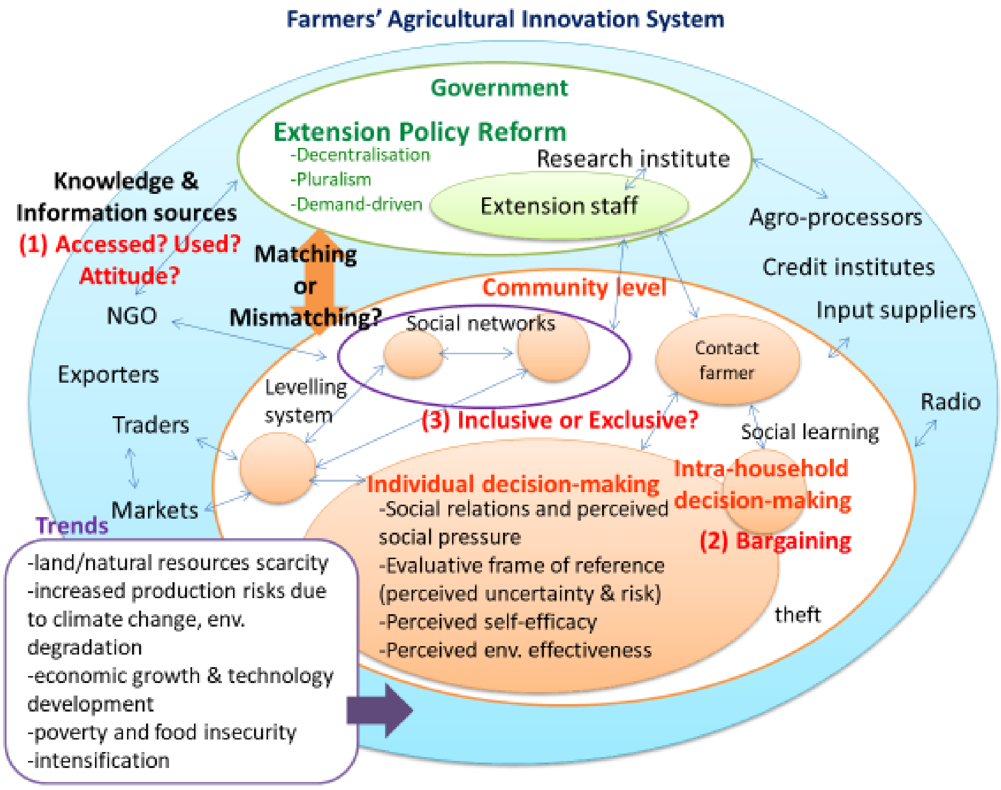
It has been clear that commercialisation has widened socioeconomic gaps, while small-scale commercial farming has potentially benefited the rest of the community by hiring their labour. Jayne et al. (2010) point out that there is a large disparity in land distribution among smallholders in the studied countries in Eastern and Southern Africa, and moreover that about a quarter of the smallholder households are becoming landless. Dawson et al. (2016) reports a case where the green revolution policy in rural Rwanda exacerbated the landlessness and vulnerability of the rural poor. The Poverty Status Report in Uganda (MoFPED, 2014) reveals that perceptions of poverty over the last decade have changed from basic material factors to land and labour constraints. It claims that households hiring out land, selling labour, and being without land are the three most important indicators of poverty. This implies that somebody's innovations (e.g. commercialisation) have implications for others' livelihood conditions (e.g. landlessness).

2.7 Conceptual Framework

The aim of the research is to understand the diversity and dynamics of smallholder farmers' innovation processes, and eventually to extract policy implications to fill the gaps between farmers' innovation processes and innovation support systems. Adapting the AIS framework, this study analyses farmers' interactions with multiple actors related to innovations, from a systems thinking perspective. However, the existing AIS framework, for example Rivera's AIS model (as depicted in Figure 2-1 in Section 2.2.2.5), is modified by placing the smallholder farmers at the centre, so that the systems can be unpacked from the farmers' perspective. In such a way, this study intends to contribute to the existing AIS framework, which understates the real experiences of farmers engaged in innovation processes and narrowly focuses on a certain commodity (often a high value commodity), technology or innovation which often involves only a selected (wealthy) category of farmers rather than innovations that are more generic but important for farmers' livelihoods. Moreover, by doing so, this study intends to add value to the current AIS framework with more “pro-poor”, “inclusive” and “responsible” insights, which are very important for developing country contexts, as other authors (Berdegué, 2005, Foster and Heeks, 2013, Heeks et al., 2014, Santiago, 2014, Papaioannou and Srinivas, 2019) advocate.

A Conceptual Framework (Figure 2-6) was formulated, based on the findings from the literature combined with the author’s interpretation and ideas, and provides a picture of innovation systems at different levels (farmer, household, community, wider systems) with key components and elements which are crucial for this study. As farmers were placed at the centre of this diagram as main actors of innovation, understanding farmers’ perceptions in their innovation processes was a major approach taken by this study. At the farmers’ level, this study attempted to explain the factors influencing farmers’ practices that lead to their adoption of innovations, adopting Leeuwis’ four variables (Social relations and perceived social pressure; Evaluative frame of reference; Perceived self-efficacy; Perceived environmental effectiveness) as opposed to Rogers’ linear decision-making theory. In particular, this study provided an analysis showing which knowledge and information sources, such as contact farmers or model farmers, the government, the private sector, markets, and NGOs were accessed by the smallholder farmers and used for their innovations (as shown in (1) Accessed? Used? Attitude? in Figure 2-6 below). The quality of interactions with AIS actors was further investigated in the light of the farmers’ attitudes towards the AIS actors. At the household level, intra-household dynamics was one of the major themes this study explored (as shown in (2) Bargaining in Figure 2-6), since decision-making at household level cannot be fully understood by an individual decision-making model, because it does not take account of intra-household power dynamics. To address this, the bargaining framework beyond the unitary model was used to investigate the relationship between intra-household dynamics and innovation processes. At community and broader system levels, as shown in the framework, agricultural innovations are influenced by various factors such as social networks, social learning and a levelling system, which are profoundly affected by the quality and quantity of interactions with AIS actors. A major contribution of this study was the analysis of such innovation networks and systems from the perspectives of various socio-economic categories of farmers in different enabling and agroecological environments. This serves the purpose of assessing whether the innovation networks and systems are inclusive or not (as seen in (3) Inclusive or Exclusive? in Figure 2-6). Above all, AIS actors, and government extension policy and practices, which are expected to play a major role in supporting smallholder farmers' innovations, either directly or indirectly as a body coordinating with other AIS actors, should receive special attention, as this provides policy implications. As the framework suggests, the entire AIS system is not static but dynamic, responding to various trends, such as population growth, scarcity of land and other natural resources, and increased production risks due to climate change and environmental degradation. Farmers' innovation processes were understood within the framework of such trends, including their underlying drivers and constraints.

Figure 2-6: Conceptual framework of smallholder farmers' AIS



Source: Author building on others' work (Leeuwis, 2004, Rivera, 2011, World Bank, 2012)

2.8 Conclusion

This chapter reviewed the existing literature about innovation thinking, with particular reference to the aspects that increase understanding of smallholder farmers' innovation processes, particularly their decision-making and their interactions with knowledge and information sources or other actors. As set out in the conceptual framework, this study was built on the AIS framework, in order to understand the wide range of relationships between smallholder farmers and innovation systems.

Chapter 3 – Research Methods

3.1 Introduction

This chapter demonstrates the methods applied to the conduct of this research, including the theoretical perspective and other key approaches, whose selection was based on the nature of the research objectives and questions. In short, a mixed methods research was adopted for this study, including systems thinking and participatory approaches. This is informed by the research aim of understanding farmers' perspectives and experiences of innovation systems and processes consisting of complex and interdependent subsystems and components, as explained in the previous chapters. The chapter further presents the overall research design and specific research tools used in three different phases with a reflexive approach. In addition, it indicates data analysis strategies, as well as ethical consideration and challenges faced during this study.

3.2 Research Approach

Four elements, namely epistemology, theoretical perspective, methodology and methods, are the core of any social research (Crotty, 1998). They are closely interconnected. Epistemology signifies the theory of knowledge embedded in the theoretical perspective. The theoretical perspective is the philosophical stance informing the methodology. Finally, the methodology is the strategy or rationale governing the choice of methods or techniques used to gather and analyse data. In this section, the first two elements, epistemology and theoretical perspective, will be presented in most detail, while methodology and methods will be discussed in the following sections.

3.2.1 Theoretical Perspective

The theoretical perspective applied to this research was based on the nature of the research objectives and questions. The main aim of this research is to understand farmers' attitudes and behaviour, individually and collectively, in response to innovation processes, and their perceptions of the Agricultural Innovation System (AIS) actors. As Leeuwis' four variables in shaping farmers' practices suggest (Leeuwis, 2004), local innovation processes are to a great extent based on farmers' perceptions, which are often influenced by social interactions. Due to the in-depth nature of this research problem, the main research approach of this study followed interpretivism and constructivism in epistemological and ontological orientations respectively. It is considered that social reality can be constructed by the subjective interpretation or understanding of their world. With this theoretical orientation, qualitative methods were used to understand the subjective meanings, with an emphasis being placed on language (Bryman, 2012).

Furthermore, this study employed an inductive or theory-generation approach whereby a hypothesis or research question was not rigidly set prior to the data collection, and findings emerging during the analysis stage became guides to identification of the patterns used to construct the theory. It should, however, be noted that theory and data repeatedly interact in the iterative research processes. As grounded theory suggests, this study applied the repetitive interplay between the collection and analysis of data. Ison (2012) highlights the difference between reflection and reflexivity, by claiming that the latter is the higher order form of the former. Reflexivity asks why we do what we do, while reflection simply involves what is being done. Therefore, this study has taken a step-by-step reflexive approach whereby the findings from the Phase I data collection are the basis of the Phase II data collection strategy.

In parallel with the constructivist position, this study also took the pragmatist view that selection of methods depended on the research objectives, instead of a prior inclination to a particular philosophical orientation. Hence, quantitative methods were partially used, for example, in EEI ranking based on Census data and the Household Survey alongside subjective Wealth Ranking. Data from a sufficient number of samples was collected by formal probability sampling, where possible, in order to preserve the findings' statistical significance. This approach complements the in-depth qualitative approach by enhancing our objective understanding beyond the case study to some extent. Therefore, mixed methods with both qualitative and quantitative approaches were applied to this study.

3.2.2 Systems Thinking, Interdisciplinarity and Participatory Approach

This study adopted the perspective of Farming Systems Research whose three core characteristics are systems thinking, interdisciplinarity and a participatory approach (Darnhofer et al., 2012). Firstly, the fundamental approach of this study applied systems thinking, which entails a comprehensive understanding of "problematic" situations as phenomena of systems whereby various components such as farmers, farms, and environments are interconnected in a dynamic and complex manner. Examining innovation processes requires systems thinking, as the process is not only a technological matter but involves social and economic components as well as farmers' perspectives. Moreover, agricultural innovation systems entail a number of sub-systems, such as knowledge and information systems, production systems and market systems, which are all interconnected. As other authors advocate (Engel, 1997, Ison, 2012), to study a "system" requires drawing a “boundary” within the wider “whole” in order to set a level of analysis and clarify a set of entities to examine.

Secondly, this research adopted a participatory approach, by aiming to understand farmers’ behaviours and subjective perspectives in response to innovation processes, through using a variety of participatory tools (e.g. mapping, timeline, network analysis, participatory budgeting, and effects diagrams) as well as in-depth interviews. Innovation processes cannot be fully understood without capturing smallholder farmers’ subjective logic and the situations underlying their innovation adoption processes. With this recognition, this study employed established and field-tested resources consisting of participatory approaches and tools, such as RAAKS (Engel and Salomon, 1997), PICSA (Dorward et al., 2015), TAPipedia (FAO Agrinatura, 2017a, FAO Agrinatura, 2017b), innovation history (Douthwaite et al., 2006), participatory resource mapping and cost-benefit analysis (CADSAL, 2011), and gender analysis (Feldstein and Jiggins, 1994).

3.2.3 Comparison of Multiple Case Studies

Case study is a detailed examination of one or more individuals, groups, organizations or events: its strengths are that is insightful and strong on reality (Wellington and Szczerbinski, 2007). This study is a case study whose research sites were selected from two extreme cases (advantaged/disadvantaged villages) in two different agro-ecological Zones (AEZs). They were examined for the purpose of capturing a wide range of innovation processes in different contexts and comparing cases where possible, in accordance with the aim of the study which focuses on the diversity and dynamics of the innovation systems. However, the case study approach is often criticized as it is not representative and cannot be used as a basis for generalization (Wellington and Szczerbinski, 2007). Thus, in this research, the findings from different target villages are not necessarily applicable to the rest of the country. Nevertheless, Yin (1994) advocates the use of multiple case studies over an extended periods in different sites, which then have the potential to provide material for generalizations.

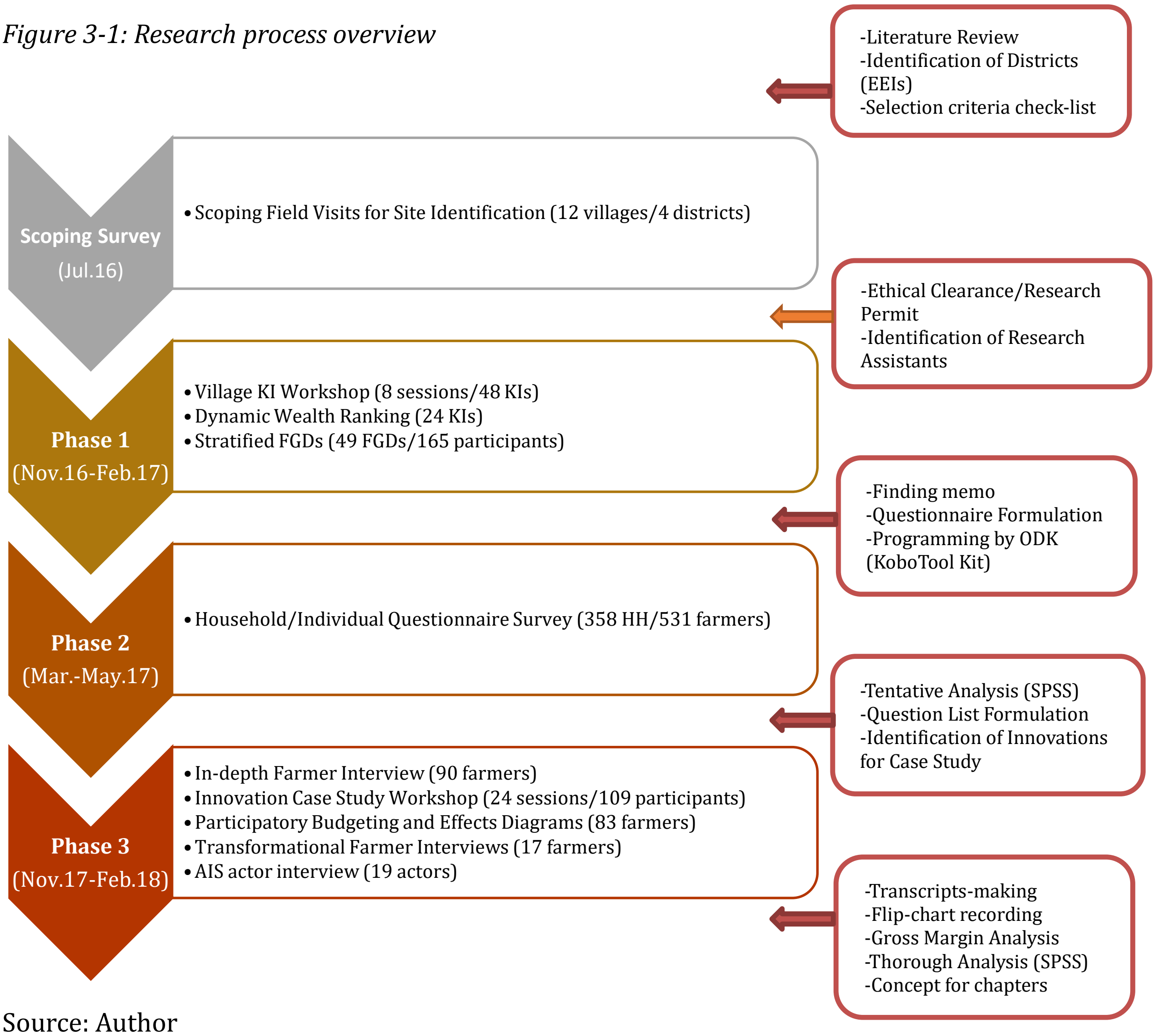
Therefore, the nature of research design in this study is longitudinal comparison, whereby changes in characteristics and processes of innovations that have been made by different socioeconomic segments of community in the last few decades are compared. Furthermore, the comparisons were made between villages with different enabling environments for innovations in different agro-ecological zones under the same agricultural policies in the same country. This research method was qualitatively dominant, with in-depth interviews at individual, household and organisational levels. However, some applications of quantitative methods were made where possible, in order to enhance objective understanding of various aspects and to extend the relevance of research findings beyond a single case.

3.3 Research Design

The entire process of research started with an iterative process that involved going back and forth between literature reviews and identification and revision of research questions, between October 2015 and October 2016. The main themes of the literature reviews initially focused on local innovation processes, the evolution of extension thinking and approaches, and the agricultural extension policy in Uganda. As the research progressed, however, more literature reviews, involving data analysis, were added.

During the research design process, a scoping field visit was conducted in July 2016 in order to select research villages and seek for agreement with village officials, as well as to establish a logistical assessment for data collection. The findings of the scoping study were fed into the final research plan, which was completed in October 2016. During the field research preparation period, ethical clearance was obtained from the University of Reading as well as a research permit from the Uganda National Council for Science and Technology (UNCST), followed by approval from the locally accredited institute for Research Ethical Clearance in Uganda. The nature of this study required hiring multiple research assistants during the research period to ensure thorough understanding of meanings in local contexts and languages. Therefore, during this preparation period, three different sets of research assistants were recruited, as the research sites (four villages) extend over three different language zones (Lugbara, Madi, and Banyankore/Bakiga). In two of four villages where Banyankore/Bakiga was spoken, the same set of research assistants was hired in order to maintain as much consistency as possible during the field data collection.

Figure 3-1: Research process overview



Source: Author

The main field research was conducted in three phases (Figure 3-1). During Phase 1, village workshops with key informants and Focus Group Discussions (FGDs) were conducted in the selected four villages between November 2016 and February 2017, with the help of two research assistants, one acting as a facilitator and the other as a translator, in each village. Phase 2, a household and individual questionnaire survey incorporating the findings from Phase 1, was conducted between March and May 2017, with the involvement of four enumerators in each village. During the face-to-face interviews with questionnaires, smart phones were used to input data. The results of the questionnaire survey were tentatively analysed in order to formulate in-depth interview questions and to prepare workshops in the following phase. In Phase 3, in-depth farmer interviews, innovation pathway and network workshops, Participatory Budgeting and Effects Diagrams, and interviews with key AIS actors were conducted between November 2017 and February 2018. The detailed process in each phase will be further explained below.

3.3.1 Selection of Research Location

Although the research ambitiously aims to cover Sub-Saharan Africa (SSA) at large for the general trend of agricultural development, Uganda was purposively chosen for its high rate of population depending on farming and its nation-wide experiences of pluralistic and demand-driven extension as a frontier in this region.

According to Uganda's National Census 2014 (UBOS, 2014), 68.4% of the working population are engaged in agriculture, among which only 3.7% are in commercial farming and the rest at subsistence level. The agricultural sector's contribution to overall GDP for the same year was merely 23%, significantly decreased from 50% in 1990. While the average annual GDP growth rate since 2010 stays at approximately 5%, which is above the average annual population growth rate of 3%, the agricultural sector's growth fluctuates between -0.2% and 3.6% (World Bank Group, 2015). It is noteworthy that Uganda has one of the highest rates of labour force contribution of women (70%) in agricultural production and the highest population rate of youth among SSA countries.

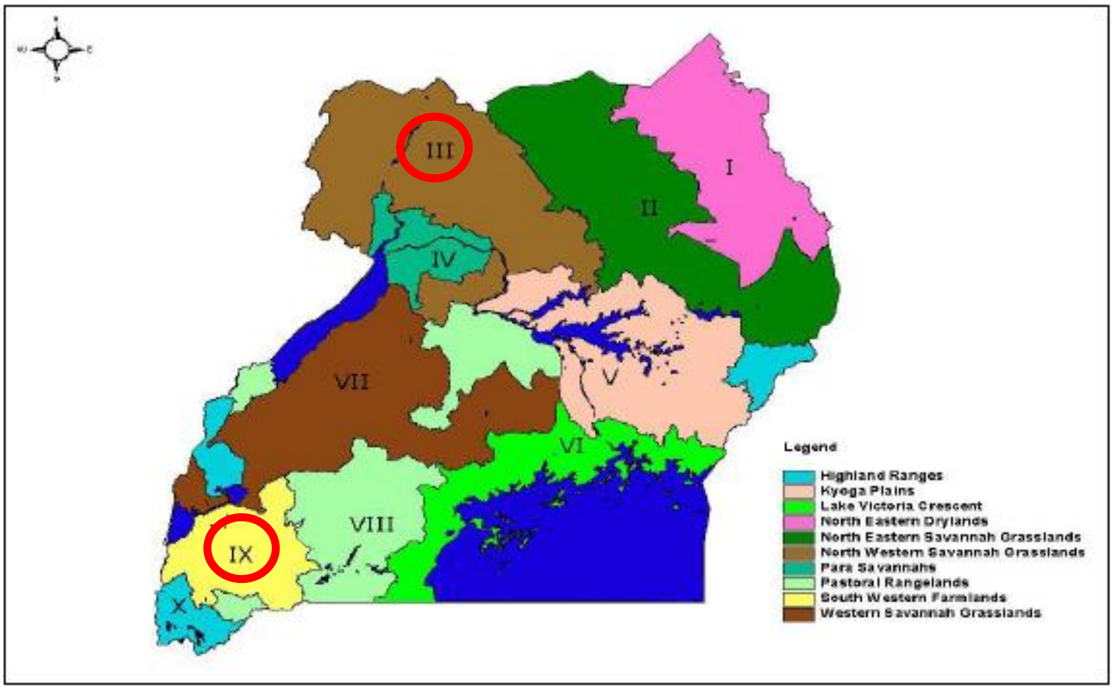
Uganda, as mentioned earlier, has experienced the typical paradigm shift of innovation thinking from ToT to AIS, and proceeded to privatisation in accordance with SAP, like other SSA countries. The country's experiences with NAADS have drawn international attention as one of the first countries in SSA which implemented public-funded private sector contracted extension services, although the programme is now scrapped, and the country is re-establishing a public extension system with a pluralistic emphasis.

For the purpose of capturing a wide variety of situations surrounding farmers' innovations in terms of agro-ecological conditions and degrees of access to various agricultural related services, the author created an Enabling Environment for Innovations (EEI) ranking for all districts in Uganda (Appendix 1), based on a set of criteria purposively chosen from the readily-available data from Agriculture Census 2008/9 (UBOS, 2010). The weighted criteria of EEI include gender, access to extension, credit, market, input dealers, storage facilities, research centres, quality seed/tree nursery sites, and transportation, food security, and availability of other income sources, as summarised in EEI's indicators at District level (Appendix 2). The Agriculture Census is the latest version available at the time of research site selection, as it is conducted only every 10 years. This poses its limitation due to the potentially out-dated data being based on old districts before the creation of new districts.

The EEI indicators were used to identify research districts (districts with high and low EEI ranks) in the same AEZ. The selection was made only from the districts where the primary income source of the majority of household heads (over 80%) is crop production. Furthermore, among 10 AEZs in Uganda (MAAIF, 2016a), the AEZs which have the largest disparity between the highest and the lowest EEI rankings were selected, namely North Western Savannah Grasslands AEZ and South Western Farmlands AEZ (Map 3-1).

Although literature about Uganda's AEZs is scarce, we do have the following information. The North Western Savannah Grasslands AEZ is located in the Northern and West Nile systems (Musiitwa and Komutunga, 2001). The areas with a long rain unimodal system are covered by heavy grey and brown soils with high fertility, and a variety of crops including cotton, finger millet, pigeon peas, groundnuts, sorghum, cassava, sunflower, cowpeas, tobacco, and sesame are grown rotationally. The average area under cultivation per household is larger than other regions, and communal cultivation has been commonly practised. The area used to be infested by tsetse fly, but the recent eradication of the fly made cattle keeping possible in the area. In the South Western Farmlands AEZ, both the south western pastoral system and the banana-finger millet-cattle system (Musiitwa and Komutunga, 2001) are seen. The soils in both systems are sandy loams with dark-grey silty clays, and the areas receive two short rain peaks in April and October, while the latter system receives higher rainfall. The former area is inhabited by cattle keepers (Bahima people) who barter their livestock products such as milk and ghee for food crops grown by Bairu people in the latter system. In the latter system, tea, coffee, banana, millet, and groundnuts are grown.

Map 3-1: Agricultural production zones of Uganda



Source: MAAIF (2016a)

The four districts selected through EEI ranking are the Arua district (high EEI) and the Adjumani district (low EEI) for the North Western Savannah Grasslands AEZ, and the Bushenyi district (high EEI) and the Isingiro district (low EEI) for the South Western Farmlands AEZ.

3.3.1.1 Village Selection through Field Scoping Visits

For each AEZ, one village with the highest EEI features and another with the lowest were finally identified. Initially, for each of four districts, at least two villages (one village with the highest EEI features and another with the lowest) were identified by the District Production offices, Sub-county offices, and other key stakeholders such as District Farmers' Associations, during the field scoping visit in July 2016. The criteria used to identify relevant sub-counties and villages were access to land (size and quality), other natural resources (e.g. reliability of rain, irrigated water), hired labour, extension services, credit, market, traders, input dealers, agro-processors, nurseries (e.g. tree nurseries, quality seed multiplication sites), research centres, public transportation, roads, means of transportation, farming tools, and storage facilities, percentages of female-headed households, levels of food security, and engagement in other economic activities, in accordance with the criteria used for EEIs. The information was collected by using the word template (Appendix 3). Due to the lack of objective data at lower administrative levels, the selection of sub-counties and villages was based on the subjective judgement and knowledge of the informants. However, the above-mentioned criteria helped to reduce the subjective bias of informants.

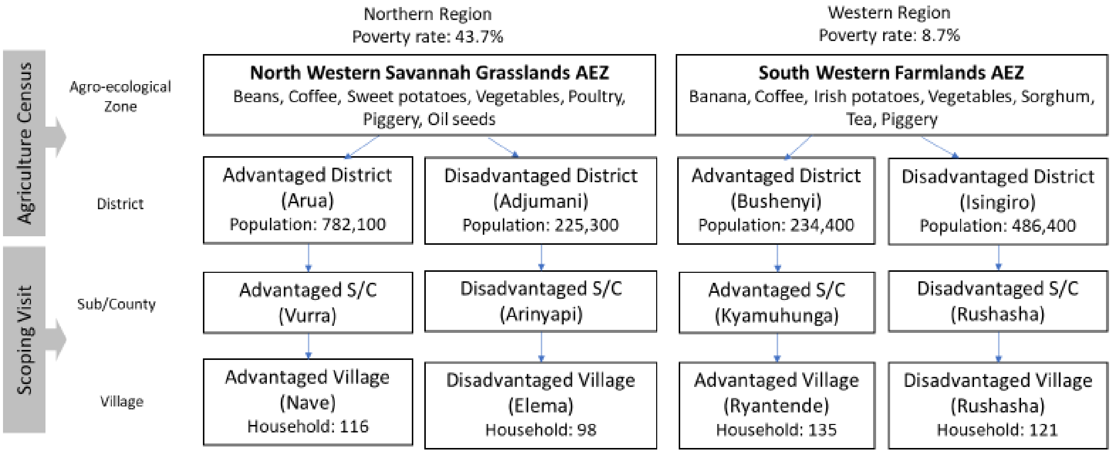
A total of 12 villages were visited in 4 districts during the scoping study, and finally four villages were selected. The findings from the visit with the details of all the visited villages recorded in findings from field scoping visits. The field scoping visits revealed that there is clearly an enormous disparity between advantaged and disadvantaged villages in terms of enabling environments for innovations and degrees of AIS actors' presence, even within the same districts and the same AEZs. The advantaged villages seem to enjoy a great degree of commercial activities (e.g. the production of tea in Bushenyi, bananas in Isingiro, and beans, maize, and cassava in Arua and Adjumani) with some extremely progressive farmers employing other farmers on their farms. On the other hand, the majority of farmers in the disadvantaged villages typically experience a low level of income, lower utilisation of hired labour, bad road conditions, and lack of services nearby, resulting in costly services, low population density, and lack of traders. It was also confirmed that different AEZs seem to have different characteristics, especially in the crops that people grow and the area of available land (e.g. abundant land in the Northern region/North Western Savannah Grasslands vs scarce land in the Western region/South Western Farmlands).

Picture 3-1: Scoping field visits

Left picture: Model farmer's tea plantation in Western Uganda
Right picture: Field visit to villages in Northern Uganda

The EEI tool and scoping visit greatly contributed to the successful identification of research villages with a high degree of contrasts in land area, agricultural potential, commercialisation, remoteness, and density of AIS actors. Due to time constraints and the in-depth and exploratory nature of the study, this research focused on four villages in two different AEZs with the highest/lowest EEI features (see Map 3-2 below), instead of eight villages (with the highest/lowest EEI features in each of four districts in two different AEZs) originally planned.

Figure 3-2: Location selection framework



Map 3-2: Locations of 12 visited villages and 4 initially selected villages

Source: UBOS (2015)

- Nave village (Arua District) = highest EEI features in NWSG Agro-ecological zone
- Elema village (Adjumani District) = lowest EEI features in NWSG Agro-ecological zone
- Ryantende village (Bushenyi District) =highest EEI features in SWF Agro-ecological zone
- Rushasha village (Isingiro District) =lowest EEI features in SWF Agro-ecological zone
- Other villages visited

3.4 Research Tools

A Mixture of both qualitative and quantitative methods was used in this study. The tools used in the study are explained in more detail below, following the three-phase research process as shown in Figure 3-1. Various participatory tools (e.g. map, wealth ranking, timeline, network analysis, participatory budgeting and effects diagram) were used to facilitate in-depth discussions during the entire process of the field study, in focus group discussions, surveys and interviews. A research protocol was prepared for each stage of data collection, and research assistants were pre-trained based on those protocols and manuals (Appendix 4 for Phase I, Appendix 10 for Phase II, and Appendix 11 for Phase III).

3.4.1 Phase I Tools

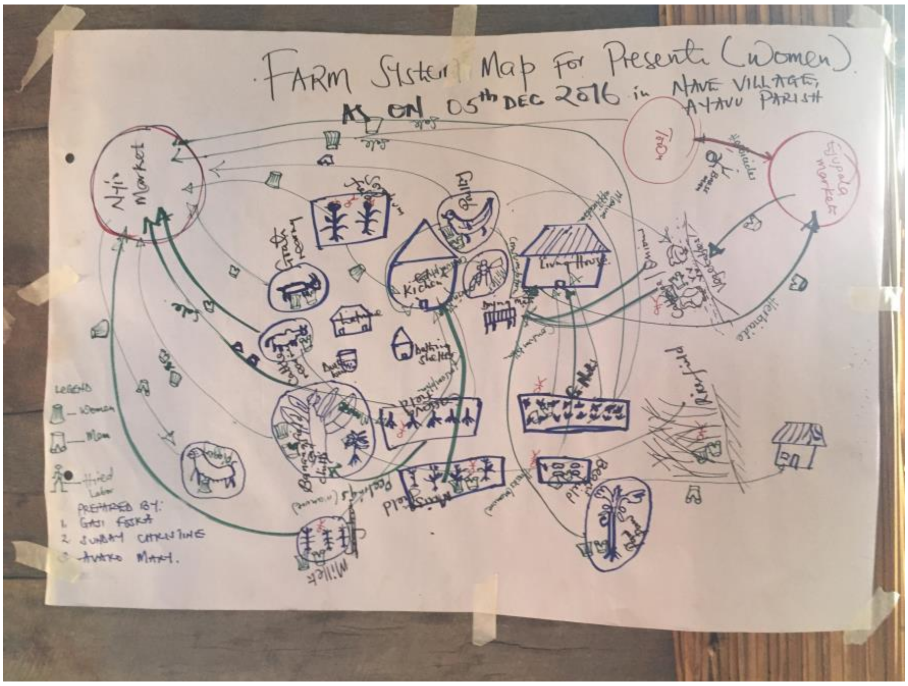
3.4.1.1 Livelihood/Farm System Mapping

The Livelihood/Farm System Mapping was conducted during the village workshop, engaging 12 Key Informants (six male and six female farmers with a mixture of different age groups) in each village (48 informants for 4 villages in total) for the former activity and six KIs for the latter. The purpose of this workshop was to understand the general contexts of livelihoods, farm systems, and resource endowments in the village at large.

During the Livelihood/Farm System Mapping activity, two maps of the area 20 years ago and at present were made by two different gender groups separately, which was followed by a plenary session where a series of questions were asked. The older participants worked on the map of 20 years ago, and the younger participants on the present-day version. The participants were asked to start by drawing their houses in the centre of the flipchart, and then draw what typical farming and non-farming activities in the village are/were, as well as related resources such as land, water sources, markets, storage and so on. The participants were further facilitated to connect the identified activities and resources with lines and arrows, and to draw legends showing who were engaged in those activities (men, women, children, hired labour, etc.), referring to Feldstein and Jiggins (1994).

In the plenary session, each group presented the map they made, and the whole group discussed how the livelihoods, farm systems and resources had changed over time. The flipcharts were all photographed for recording purposes. The findings of this workshop were also recorded in the word file template, which consists of main livelihoods (crops, livestock, non-farm activities), responsibilities of men, women and both, work done by hired labour (cash/in-kind), and agricultural-related resources (land, water source, market, storage, etc.) for 20 years ago and the present day, and changes between these periods (Appendix 5). These findings were recorded separately for women's and men's workshops in each village.

Picture 3-2: Livelihood/Farm system map (drawn by women in Nave village)



3.4.1.2 Dynamic Wealth Ranking

Wealth Ranking was used for extracting wealth factors based on farmers' perception of "wealth", and all households were grouped into three wealth categories based on their present wealth status, referring to the other established studies (Grandin, 1988, FAO, 1990, Tefera et al., 2004). This activity involved six KIs (three men and three women) per village. In the beginning, all the KIs were asked in the plenary session to identify wealth categories (3-4 categories) in local terms, with typical characteristics for each wealth category (Appendix 7). Flipcharts were used to facilitate the discussion. After consensus was reached among the KIs, they were asked to make three pairs (men, women, mixed) to work on ranking separately from each other, in order to triangulate their perceptions. The KIs were given a pile of cards, each of which showed a serial number and the name of a household head. They were then asked to write which wealth category that they perceive that each household belonged to, and to write it down on the back of each card.

Furthermore, for the purpose of capturing dynamic transformation between different wealth categories, the KIs were additionally asked to identify the households which made movements between different wealth categories during the last few decades, with reasons where possible. The result of wealth rankings from three different pairs was aggregated and the mean score was noted. The data was compiled in MS Excel.

Picture 3-3: Wealth ranking

Left picture: Wealth Ranking in Elema village

Right picture: Wealth Ranking in Nave village

Table 3-1: Wealth ranking result

Village	Type of HH	Wealth			TOTAL
		Rich	Moderate	Poor	
Nave	Male-headed HH	19	44	15	78
	Female-headed HH	1	29	8	38
		20	**73**	**23**	**116**
Elema	Male-headed HH	9	49	8	66
	Female-headed HH	0	26	6	32
		9	**75**	**14**	**98**
Ryantende	Male-headed HH	13	42	34	89
	Female-headed HH	3	21	22	46
		16	**63**	**56**	**135**

Rushasha	Male-headed HH	4	28	62	94
	Female-headed HH	1	6	20	27
		5	**34**	**82**	**121**
	TOTAL	**50**	**245**	**175**	**470**

3.4.1.3 Stratified Focus Group Discussions

The purpose of these socioeconomic group-based Focus Group Discussions (FGDs) is to feature the consolidated or aggregated perceptions about innovation processes and AIS actors involved which might be unique to each socioeconomic group. Usually, five participants from each socioeconomic category were selected, in various combinations of wealth, gender, age and independence, using stratified random selection. As a result, 49 FGDs were conducted with 163 participants in all four villages, as stated in Table 3-2.

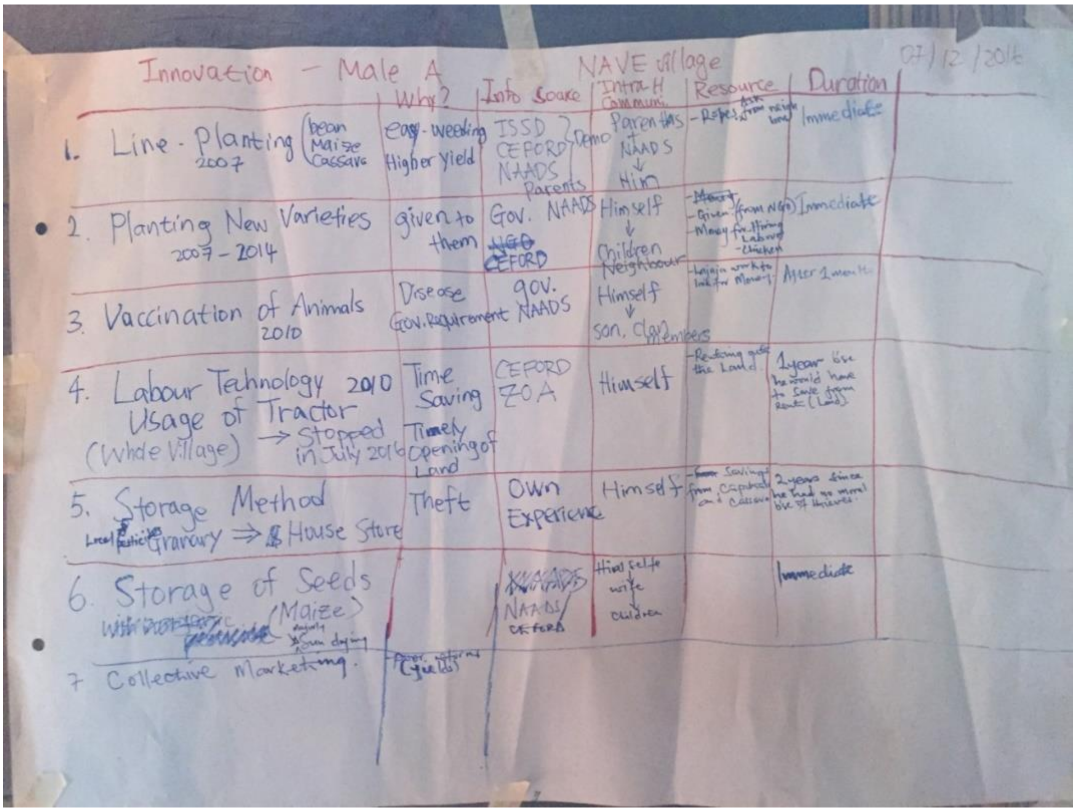
Table 3-2: Number of stratified FGD participants

Stratified group		Village			
Wealth	Gender	Nave	Elema	Ryantende	Rushasha
Rich	Male-head	5	5	1	2
	Female spouse	4	5	2	2
	Female-head	0	0	3	1
	Male youth	2	2	0	0
	Female youth	1	2	0	0
Moderate	Male-head	5	4	3	5
	Female spouse	0	3	4	5
	Female-head	5	5	4	2
	Male youth	5	3	1	3
	Female youth	4	1	2	3
Poor	Male-head	5	4	6	4
	Female spouse	4	1	3	5
	Female-head	4	4	9	4
	Male youth	0	2	1	2
	Female youth	0	0	0	2
Total		**44**	**41**	**38**	**40**
				Grand Total	**163**

During the FGDs, all participants were firstly asked to state their main livelihoods, land area and use, and crop/livestock type and size. This was noted down carefully by both the local facilitator and the author; their notes were cross-checked after each session.

Secondly, a participatory innovation process framework in matrix form, which includes innovation, reasons, information sources/occasions, intra-household communication, resources used, and duration of time between knowing and practising innovation, was made with participants on a flipchart. Before the exercise, participants were given a definition of “innovation” as any new changes in what farming activities they did, and how they did them, referring to the definition made by Nielsen (2001). The participants were then asked to list all the new changes/innovations made in their farms in last 10 years, including the changes which were abandoned by the time of research. The framework focused on the innovations in which the participants were directly involved rather than those adopted by other members of their households. The initial plan was that each participant should write down a change or innovation on a small post-it note and stick it on the flipchart; however, due to the frequent strong winds, the author and her translator wrote down the answers directly on a flipchart on the participants’ behalf. The emphasis was placed on capturing not only technical, but also institutional or organisational changes: conceptualisation of non-technical changes, however, was not easy for participants.

Picture 3-4: Innovation process framework (Poor men's FGD in Nave village)



Thirdly, the participants' perceptions of innovations were explored, using questions about the most difficult and the easiest innovations, the most important innovations for their livelihoods, innovations that they wished to make in future, and the reasons for their answers. In the following section, changes in innovation types and agricultural extension services to which they had access were discussed. All the data captured during each FGD were recorded in the pre-formulated word template (Appendix 6). The results were compared and analysed across different socioeconomic groups in each village. A list of innovations (Appendix 8) was created to identify pre-selected innovations which would be further investigated through the questionnaire survey in the ensuing phase.

3.4.2 Phase II Tools

3.4.2.1 Household and Individual Questionnaire Survey

The purpose of the Household and Individual Survey was to apprehend largely quantitative aspects of innovation processes, as well as obtaining a detailed objective picture of the characteristics of each household. The questionnaire consists of two sections: a Household Section and an Individual Section. The first section covered basic household information, using 10 questions to compute Progress out of Poverty Indicators (PPIs), attributes of household heads and spouses, farming assets, access to agricultural services by household, land size and use, family and hired labour, crop and livestock management, and sources of income and food. This section was answered by either the household head or spouse if any, which was alternately specified by the author in order to limit gender bias. The Individual Section was about the innovations that an individual had implemented during the previous 10 years, the adoption rate of pre-selected innovations (the most frequently mentioned during FGDs in each village. See Appendix 8), future innovations and perceived constraints, access to information from various AIS actors and the respondents' attitudes towards them, and their experience of public extension services. This Individual Section was answered by both household head and spouse separately.

The questionnaire was formulated, incorporating the findings from stratified FGDs. The questions that the author wanted to investigate with quantitative data were included in the questionnaire, and the findings of FGDs helped with creating possible answer choices. The questionnaire was first developed with MS Word (Appendix 9), and then programmed in KoboTool Box (Open Data Kit: ODK) and installed in smart phones. This tool was piloted by some farmers before fully rolling it out. The smart phones were used primarily for easier data input and processing at a later stage, when the interviews were conducted face to face.

Picture 3-5: Household and individual questionnaire survey

In order to ensure the potential statistical power of the emerging findings, this survey took a census approach, targeting all the household heads available during the time of survey, and their spouses. Due to the large number of samples to be covered, four enumerators were deployed per village. The gender of the enumerators was balanced to lessen possible gender bias. Finally, the household questionnaire was answered by 358 households, and the individual questionnaire reached 531 individual farmers, as tables below describe. The data was exported to IBM SPSS version 24 for analysis.

Table 3-3: Number of households surveyed

	Wealth			
Village	**Rich**	**Moderate**	**Poor**	**TOTAL**
Nave	18	68	22	108
Elema	9	56	10	75
Ryantende	0	37	31	68
Rushasha	4	33	70	107
	31	**194**	**133**	**358**

Table 3-4: Number of individual respondents for questionnaires

Village	Gender	Wealth			TOTAL
		Rich	Moderate	Poor	
Nave	Married men	14	30	3	47
	Single men	1	2	10	13
	Married women	16	46	5	67
	Single women	1	16	7	24
		32	**94**	**25**	**151**
Elema	Married men	8	27	2	37
	Single men	0	7	3	10
	Married women	9	25	0	34
	Single women	0	17	5	22
		17	**76**	**10**	**103**
Ryantende	Married men	0	23	13	36
	Single men	0	1	1	2
	Married women	0	26	17	43
	Single women	0	10	11	21
		0	**60**	**42**	**102**
Rushasha	Married men	3	25	40	68
	Single men	0	2	4	6
	Married women	3	26	50	79
	Single women	1	5	16	22
		7	**58**	**110**	**175**
TOTAL		**56**	**288**	**187**	**531**

3.4.3 Phase III Tools

3.4.3.1 In-depth Farmer Interviews

The purpose of the In-depth Farmer Interviews was to understand more qualitative sides of the innovation processes, focusing on “why” and “how” questions. The specific questions asked were formulated after tentative analysis of Household/Individual Questionnaire Survey results. As indicated in the Phase III Research protocol (Appendix 11), the questions were mainly about drivers of innovations, the reasons why they chose particular information sources for their key innovations, the reasons for their preference for these information sources, their pro-activeness in accessing information, their reasons for seeking for approval from their spouses, intra-household profit-sharing situations, strategies to overcome perceived constraints on their future innovations, the reasons why they had not adopted the pre-selected innovations, and their experiences of government extension services. The stratified random sampling was applied to select three respondents from each socioeconomic category (wealth, gender). Consequently, a total of 90 farmers were interviewed as shown in the Table 3-5 below. All the interviews were audio-recorded, and transcripts were initially written by the research assistants, and double-checked with the author's notes. The information in the transcripts was then extracted to make a matrix for each theme for the purpose of comparing the responses across different socioeconomic categories of farmers.

Table 3-5: Number of respondents for in-depth interviews

		Wealth			
Village	**Gender**	**Rich**	**Moderate**	**Poor**	**TOTAL**
Nave	Men	3	3	3	9
	Wives	3	3	1	7
	Female-head	1	2	5	8
		7	**8**	**9**	**24**
Elema	Men	3	4	3	10
	Wives	3	3	1	7
	Female-head	0	3	3	6
		6	**10**	**7**	**23**
Ryantende	Men	0	3	3	6
	Wives	0	3	3	6
	Female-head	0	3	3	6
		0	**9**	**9**	**18**
Rushasha	Men	3	3	3	9
	Wives	3	3	3	9
	Female-head	1	3	3	7
		7	**9**	**9**	**25**
TOTAL		**20**	**36**	**34**	**90**

3.4.3.2 Innovation Network Case Study Workshop

Innovation Network Case Study Workshops were conducted for the purpose of examining the dissemination process of key innovations, using participatory tools: Innovation History (Douthwaite and Ashby, 2005, Douthwaite et al., 2006, FAO Agrinatura, 2017b) and Social

Network Analysis (SNA) (FAO Agrinatura, 2017a). Three innovations per village were chosen from a list of innovations which had the highest adoption rate based on the results of the Individual Questionnaire Survey. Each innovation case was investigated separately in both men's and women's sessions, to elicit gender-balanced views of the innovation pathways. As a result, 24 workshop sessions covering 12 innovations were attended by 52 men and 57 women in total (Table 3-6). In each session, approximately five participants were randomly chosen from the list of adopters obtained during the Individual Questionnaire Survey, ensuring a wealth balance. The author and her research assistant facilitated the workshops with those two participatory tools, using flipcharts and post-it notes. All the flipcharts based on innovation history and network analysis were photographed; using these photographs, the author re-formulated the findings using MS Powerpoint, as some examples show below.

Table 3-6: Innovation cases and number of participants for innovation network case study workshops

Village	Innovation Case	Men's Session	Women's Session
Nave	New cassava variety (Nase14)	4	4
	Line-planting (beans/groundnuts)	5	4
	Pesticides	5	6
Elema	Changing of planting time for sesame	4	3
	Line-planting	5	5
	Improved maize variety	4	5
Ryantende	Mulching of bananas	4	3
	Manure application	5	5
	Banana Bacterial Wilt (BBW) control	3	7
Rushasha	Mulching of bananas	6	5
	Forking of bananas	4	6
	Manure	3	4
TOTAL		**52**	**57**

Figure 3-3: Innovation timeline for improved cassava variety in Nave village

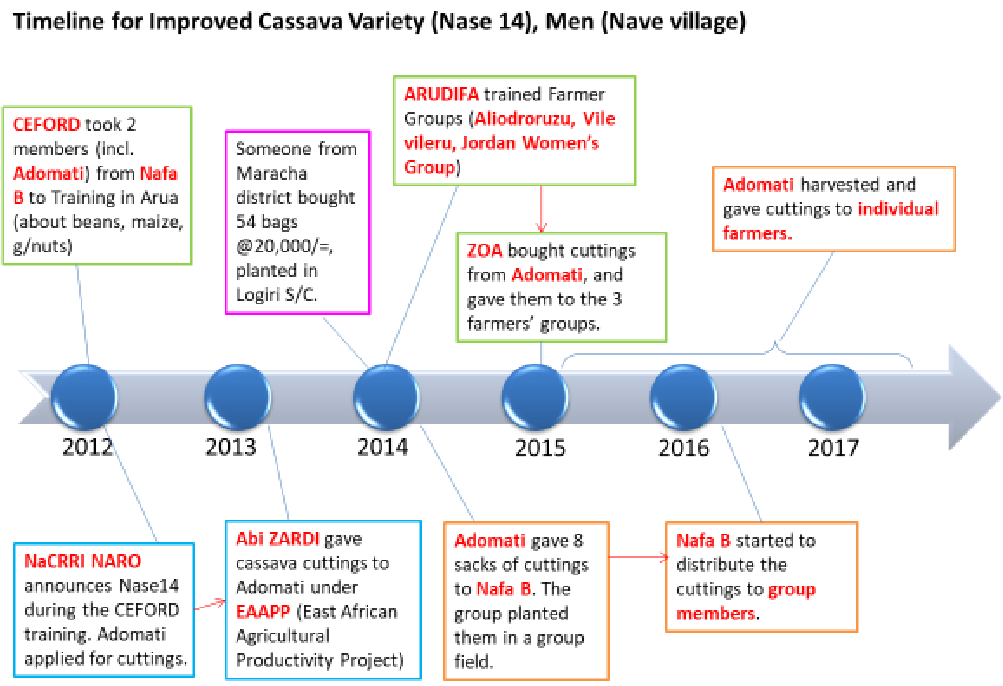
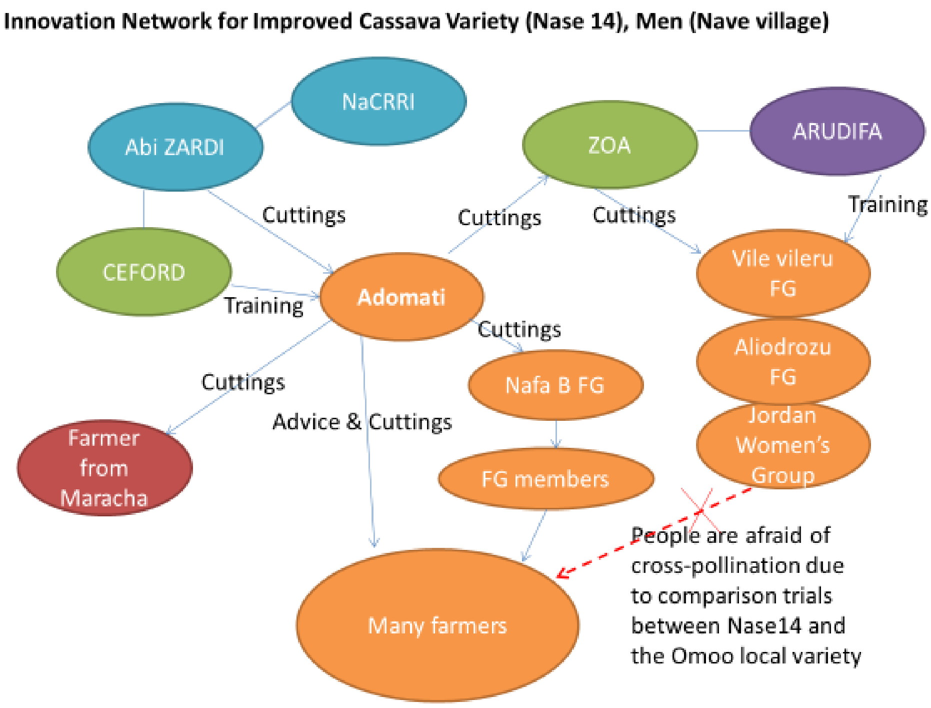


Figure 3-4: Innovation network for improved cassava variety in Nave village



3.4.3.3 Interview for Wealth-transformed Farmers

The farmers who increased their wealth status in the last 10 years because of agriculture-related innovations were identified by the Dynamic Wealth Ranking and additional interviews with some KIs (village chairpersons) in each village. The 17 identified farmers were visited and interviewed about the detailed pathways to their transformed status. The interviews were audio-recorded, and transcripts made for analysis. After identification of a key innovation which contributed the most to increasing their wealth, the effects of the innovations were investigated with the participatory activities, using Participatory Budgeting and Effects Diagrams (a detailed explanation is given below).

Table 3-7: Number of transformational farmers interviewed

Village	Number of transformational farmers		Number of farmers Interviewed	Transformational Innovations
	Down	Up		
Nave	3	7	4	Tomato, Onion, Cassava processing
Elema	19	6	4	Expansion of cassava, sesame, animals
Ryantende	3	6	4	Manure of bananas, Introduction of Tea
Rushasha	3	0	5	Mulching of bananas, Expansion of banana production

*The farmers interviewed in Rushasha were selected from 7 slightly improved farmers.

3.4.3.4 Participatory Budgeting and Effects Diagrams

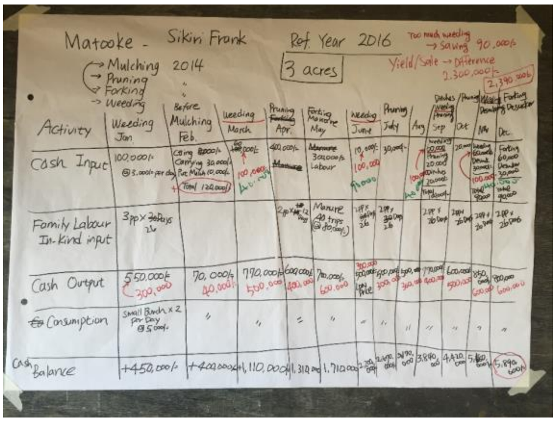
In Phase III of the data collection process, the qualitative aspects of innovation effects or outcomes were investigated by the use of two participatory tools: Participatory Budgeting and the Effects Diagram (Dorward et al., 2015, Clarkson et al., 2018). Two to three innovations per village were purposively selected by the author, as shown in the Table 3-8 below, based on the relatively higher frequency with which they were mentioned as key innovations during the Individual Questionnaire Survey, and the claims of the wealth transformed farmers about which innovations contributed the most to increase their wealth.

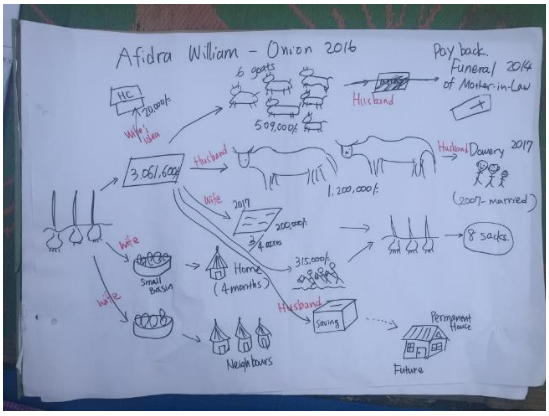
Table 3-8: Innovation and number of respondents for participatory budgeting and effects diagram

Village	Innovation	Rich	Moderate	Poor	TOTAL
Nave	Horticultural crops (Onion/Tomato)	4	4	4	**12**
	Line-planting for beans	4	5	1	**10**
	Cassava processing	1	0	0	**1**
Elema	Expansion of land size	2	7	2	**11**
	Improved Maize Variety	2	3	3	**8**
	Irrigation	2	0	0	**2**
Ryantende	Manure for banana	1	7	5	**13**
	Piggery	0	2	3	**5**
	Tea	1	0	0	**1**
Rushasha	Banana-related innovations (mulching, expansion of plantation)	3	5	3	**11**
	Irish Potato-related innovations (introduction, new variety, line-planting)	1	3	5	**9**
TOTAL		**21**	**36**	**26**	**83**

The Participatory Budget was used to evaluate the innovations' monetary impact and clarify the input process, while the Effects Diagram was used to reveal their more multidimensional aspects. The intra-household decision-making on outputs was simultaneously investigated during the Effects Diagram exercise. A detailed account of the procedures involved in using those participatory tools is provided in the Phase III Research Protocol (Appendix 11). The author and her research assistant met one farmer at a time and facilitated both participatory activities using flipcharts and pens. In total, 83 farmers were interviewed separately: the breakdown is shown in Table 3-8. Although in the beginning the author encouraged the participants to write and draw by themselves, it was finally found easier for the author to write and draw on behalf of the most participants. All the flipcharts were photographed and re-typed in MS Excel files, in order to perform Gross Margin Analysis (GMA) and the systematic comparison of farmers across socioeconomic categories.

Picture 3-6: Participatory budgeting and effects diagram





Left picture: Participatory Budgeting
Right picture: Effects Diagram

3.4.3.5 AIS actor KI Interviews

The 19 Key AIS actors, identified during the scoping exercise (field visits for village identification), workshops, and interviews, were visited for further interviews. The purpose of the interviews was mainly to understand current innovation support, while identifying constraints on AIS and innovations that the farmers did not adopt. The open-ended questions were about innovation types that the actors supported, target groups and targeting strategy, partnership with other actors, and constraints, as indicated in the Phase III Research Protocol (Appendix 11). The interviews were audio-recorded and transcribed.

Table 3-9: List of AIS actor KIs interviewed

Village	AIS actors interviewed
Nave	Arua District Production Office Vuura S/C Extension Office Arua District Farmers Association (ARUDIFA) CEFORD (NGO) Abi ZARDI Research Institute Integrated Seed Sector Development (ISSD) Arua District OWC
Elema	Adjumani District Production Office Arinyapi S/C Extension Office

	Adjumani District Farmers Association Adjumani OWC Radio presenter (NGO)
Ryantende	Bushenyi District Production Office Kyamufunga S/C Extension Office Bushenyi OWC Mbarara ZARDI Research Institute
Rushasha	Isingiro District Production Office Rushasha S/C Extension Office Isingiro OWC

3.5 Data Analysis

A variety of analysis strategies, including both qualitative and quantitative methods, was applied during the entire research process. These strategies mainly aimed at the comparison of various innovation characteristics and processes among different gender and wealth groups, and comparison of different time dimensions to capture changes over 10 years. The analysis further explores the comparison between different contexts, such as different AEZs (land-abundant/extensification (Northern region) vs land-scarce/intensification (Western region)) and different EEIs (e.g. advantaged vs disadvantaged villages).

3.5.1 Quantitative Data Analysis

Various statistical analyses were performed on the quantitative data, particularly that obtained from the Household and Individual Questionnaire Survey, using IBM SPSS software. The main analysis used was the Pearson chi-square test when both an outcome and predictor variables are categorical (Field, 2013). This test was used to compare categorical data, such as information sources for their key innovations, across the different categories of farmers (wealth, gender, village). Furthermore, binary logistic regression was used to identify statistically significance levels of multiple predictor variables towards one outcome categorical variable (Field, 2013). This analysis was mainly applied to confirm the farmers' socioeconomic attributes and their choice of information sources as their key innovations. SNA (Borgatti et al., 2013, FAO Agrinatura, 2017a) has been increasingly applied by other studies (Spielman et al., 2011, Adolwa et al., 2016) in innovation contexts in recent years. Although the initial intention was to quantitatively analyse the questionnaire data on pathways for pre-selected innovations, using UCINET software, the use of the software was limited to visually representing the pathways for pre-selected innovations. Instead, SNA was incorporated in Innovation Network Case Study Workshops which investigated more qualitatively the experiences and views of the AIS actors involved in each innovation case and the interactions between the actors. Additionally, Gross Margin Analysis was conducted to analyse quantitative data obtained from Participatory Budgeting, using MS Excel. The initial part of the research site selection process also involved quantitative data analysis, by creating EEI ranking based on the Agricultural Census data.

3.5.2 Qualitative Data Analysis

Regarding qualitative data, following basic procedures of grounded theory initially developed by Glaser and Strauss in 1967 (Bryman, 2012), coding was practised on finding memo (FGDs) and interview transcripts (Farmer in-depth interviews) to extract concepts and categories which were then compared across different socioeconomic categories of farmers. Unlike the tools of grounded theory supporting theoretical sampling and saturation, stratified random sampling was used to select respondents for FGDs and Farmer in-depth interviews. The coding was done according to the respondents' responses to main themes or questions during the interviews. The analysis was intended to avoid losing the context of what was said, and therefore the language of the respondents was recorded as accurately as possible. The framework approach in thematic analysis (Bryman, 2012) was employed to compare the responses by creating matrices with MS Word and Excel. Furthermore, the data obtained by a series of participatory activities (e.g. livelihood/farm-system mapping, innovation timeline and network case study workshops, and the Effects diagram) were analysed by coding, based on the finding memo (e.g. recorded discussions about changes of livelihood/farm-system in previous 20 years), and observing the visual data to extract key themes (e.g. comparing the Effects diagram across different socioeconomic categories of farmers). NVivo 12 Pro was partially used to manage qualitative data more efficiently, and to explore relationships among codes.

3.5.3 Mixed Methods for Analysis

More importantly, the mixed method research combining both quantitative and qualitative data analysis was the central data analysis approach used by this study. In this approach, the hypothesis emerging from quantitative data analysis was used to confirm the generated theory using qualitative data, and *vice versa*. The analysis goes back and forth between qualitative and quantitative data in an iterative process. Specifically, this study started the data collection with qualitative research methods, using participatory mapping and FGDs. The research findings of these qualitative methods were then used to formulate the closed questions of the Household and Individual Questionnaire survey, using the quantitative research method. In the following stage, the hypothesis of potential theory or themes that emerged from the results of this questionnaire survey was confirmed or explored by qualitative methods such as in-depth interviews. Furthermore, the emerging findings of the in-depth interviews were confirmed by the questionnaire results. The mixed methods thus helped to triangulate findings, explain findings generated by the other method, develop instruments or tools, and confirm and discover, as Bryman (2012) lists a variety of ways to combine quantitative and qualitative research.

3.5.4 Sampling Strategy

Concerning sampling strategy, the quantitative research (e.g. Household/Individual Questionnaire Survey) employed a census approach, covering all the target villages. While the Household Survey aimed at covering all the farming households, the Individual Survey reached all the farming individuals (both household heads and their spouses if any) available during the time of survey. As a result, the research obtained household data from 358 households and individual data from 531 farmers in four villages. This census strategy was adopted to maximize statistical power over the samples. Additionally, the innovation networks (e.g. which individual learned the innovation from which other individual in the village), which the author initially attempted to draw, required data from possibly all the farmers in each village.

In contrast, qualitative data were collected from fewer samples. The stratified random sampling method was used to reduce bias in the selection of respondents, by first making a list of all respondents in the respective category, allocating a serial number to each respondent, and selecting the samples using a random number generator available on the website (www.random.org). This stratified random sampling method was applied for stratified FGDs participants (49 FGDs with 165 participants), in-depth farmer interviews (90 respondents), innovation pathway and network case study workshops (24 workshops with 109 participants), and participatory budgeting and effects diagrams (83 farmers). In the initial stage of research, the KIs for Village Workshops of livelihood/farm-system mapping (8 workshops with 48 KIs) and Dynamic Wealth Ranking exercise (24 KIs) were purposively selected by a village chairperson in each village, based on the given conditions that the KIs have good knowledge of the farming practices in the community and of all households in their respective villages, and that they are balanced in terms of gender and age. For the interviews with transformational farmers, the result of the Dynamic Wealth Ranking facilitated the identification of all the transformational farmers in the village, and the selection of the final 17 respondents was based on the village chairpersons' and opinion leaders' views on whether the transformation was made by any agricultural innovations or not, and the respondents' availability for interview. Moreover, the selection of the 19 respondents for AIS actor interviews was based on references to key actors made by farmers during research activities.

3.6 Ethical and Other Considerations

3.6.1 Ethical Assurance

To ensure ethical research conduct, my identity as a student of the University of Reading as well as my supervisor's contact details were made clear to all the participants; participants' anonymity, confidentiality, and freedom to withdraw from the research process at any point of research were guaranteed; and the purpose of the research and the criteria for selecting participants were clearly conveyed. Participants' Information Sheets, setting out the ethical issues mentioned above, written in local languages, were given to the participants prior to any research exercise. Moreover, the research assistants, who are native speakers of the local languages, verbally explained these matters, to ensure that the messages were understood by all the participants. As a requirement from the Uganda's Research Ethics Committee

(REC), Consent Forms translated into local languages were signed by all the participants.

During the entire research process, the author tried, as hard as possible, to ensure that the research provided positive impacts on the target communities. She and her research assistants were frequently asked by the participants what material benefits their participation in the research would bring for them, and whether the research was to provide a large project for them in the near future. However, the author consistently requested the participants' understanding of her intention to improve the innovation systems for the benefit of smallholder farmers in the region. It was important to communicate the research purpose directly to the participants, as well as ensuring thorough communication with village leaders in advance.

Monetary compensation for participation was avoided, in order to preserve data quality by keeping it free from any interference by financial incentives. However, an in-kind compensation for the time the participants spend for research activities was provided in the form of basic domestic items (e.g. soap bars), after consultation with village chairpersons. Furthermore, the tangible communication cost of mobile phones, which were necessary to make appointments with selected participants, was repaid to contact persons. The author made a presentation about smallholders' innovation processes, focusing on knowledge and information sources and gender inequality in decision-making processes involving innovations, at the 1st National Extension Symposium in Uganda in March 2018, which was attended by AIS actors, especially district production officers in the target districts who were interviewed during the research. This could show those research participants that their contribution to this research is put to use to some extent by potentially supporting stakeholders' and policy-makers' better understanding of smallholders' situations with regard to innovation.

The Research Clearance letter issued by the UNCST was always kept with the author during her research and was available when the need arose. The UNCST's requirement for the researcher to report herself at the Residential District Commissioners of all the four target districts was satisfied. All the respective district and S/C offices and village chairpersons were made aware in advance by written letters, whenever the research was being conducted in the villages. Satisfying this basic protocol was crucial for building a trusting relationship with the authorities and the respective community members, as well as ensuring security for the research team members.

3.6.2 Challenges during Research Process

During the research process, including data collection and analysis, the author encountered numerous expected and unexpected challenges. Although the author tried to the best of her ability to mitigate and solve them, they may have affected the quality of her data and incurred potential problems with data analysis.

Operational Definition of "Enabling Environment for Innovations (EEI)": Advantaged/Disadvantaged locations

For the purpose of comparing innovation processes between different locations with different degrees of enabling environment for innovations, first, the two districts (the most advantaged district and the most disadvantaged district within the same AEZ) were selected for each of two AEZs, by using EEIs created by the author (explained in 3.3.1). Unfortunately, the data used for selecting districts were not available at village level. The author responded by interviewing the respective district production offices during the scoping visit to identify the most advantaged or disadvantaged S/Cs in their districts (triangulated by the views of District Farmers' Associations where available). She then interviewed the respective S/C production offices to identify the most advantaged or disadvantaged villages.

The biggest challenge, however, was the contradiction of "enable-ness". In "agricultural high potential areas", land is usually scarce (disadvantaging factor), while it enjoys higher access to agricultural services such as extension, credit, market, input-dealers, agro-processors, and better roads and public transportation (advantaging factors). On the other hand, land-abundant areas are often located in isolation from those enabling agricultural institutions. It was often heard that farmers migrate from land-scarce areas to land-abundant areas for searching for more extensive lands. Another difficulty was to define "enable-ness" in diverse livelihood contexts. The majority of farmers make their living in a variety of ways, including growing crops, keeping livestock, fishing in the rivers and streams, and engaging in off-farm activities such as casual labour and charcoal burning. The advantaged/disadvantaged factors differ somewhat in each livelihood type or farming system. For example, high potential agricultural lands are often considered as better areas for crops, rather than livestock. While the crops yield better with higher precipitation on highlands which often face a land-scarcity constraint, the more arid lowlands have their own advantages for animal husbandry. On the other hand, the lowlands close to rivers may provide good crops, if riverbank irrigation or flooding irrigation are employed, as well as advantages for fishing.

Despite these dilemmas, efforts were made to focus on agricultural services, rather than how land-scarce the region was, or its inhabitants' livelihoods. Thus, despite its land scarcity, the area with good road condition, and access to institutions including extension services, veterinary services, markets, agro-input dealers, and agro-processors, was selected as the advantaged area.

Operational Definition of "Innovation" and Recalling Challenge

The definition of innovation was not easily understood by the participants, which made it cumbersome for farmers to identify the key innovations they had practised over the previous 10 years during FGDs and Questionnaire Surveys. It was first explained that an innovation was any change in farming practices. Then the following passage from Nielsen (2001) was read to the participants:

> *An innovation is something new. For example, it can be a new maize variety, composting, use of new tools, line planting instead of broadcasting or a new combination of crops. Some innovations come from outside, like chemical fertilizer, while others are developed by farmers themselves, like herbicide made from local plants. We are interested in both innovations that you have made yourself and innovations that you got from elsewhere. We also call it an innovation if you try new planting times or change the spacing of crops compared to what you used to do. So an innovation is anything new you are doing in your farm.*

While this explanation helped the participants to some degree to identify their own innovation experiences, the passage may have influenced their recollection of their innovations. The time span of innovations was set at 10 years, in order to capture the significant changes or innovations which could stay in their memories, rather than focusing on the more recent innovations which farmers could recall better, but which were not necessarily major changes. This is why the farmers were able to identify their innovations, but sometimes had difficulties in recalling the details, such as the year of introduction, information sources, intra-household decision-making processes.

Unit of Analysis and Operational Definition of "Smallholders": Who are smallholder farmers?

The unit of analysis of this study at large was smallholder farmers in different locations in different AEZs. Nonetheless, the definition of smallholders is very fuzzy. In general term, 2 hectares (approximately 5 acres) is regarded as a smallholding in a developing country (Hazell et al., 2010). Nevertheless, "smallholder" is a relative term (Conway, 2014). Dixon et al. (2004) mention that the definition of smallholders differs between countries and farming system zones, because of their varieties in farm size, resource endowments, allocation of resources to food, cash crops, livestock and off-farm activities, their use of external inputs including hired labour, level of facility (e.g. irrigation) and their expenditure pattern.

A clear definition of smallholders in the research site context is non-existent. Although the main theme of this study is smallholders, it is cumbersome to draw a clear line between smallholders and non-smallholders in varied situations found even within the same AEZs. Defining smallholders by land area may appear to be the easiest solution, but it does not seem reasonable to focus on high agricultural potential areas with better institutions that are characterised as small farms with intensified farming, leaving out the low potential areas usually found in remote regions where average land area per capita is larger. More especially in the land-abundant Northern region, land opening capacity and the extent of land opened matter more than landholding size. Some poor farmers rent out part of their abundant land to other farmers who have resources to cultivate, while they engage themselves in casual labour for other people's farms. Even in the land scarce Western region, there are few farmers who have more than 5 acres. However, the types of crops (market-oriented crops vs home food crops) and soil fertility heavily relying on the capacity to apply manure and compost seem to be important determinants. Even within the households which own land larger than 5 acres, if women are allocated merely a quarter acre of land to cultivate, would they be called smallholders?

It was the biggest dilemma to start data collection in the field without knowing who "smallholders" were. Therefore, the author decided to target the entire farming population in the target villages without setting pre-selection criteria in advance, as it is impossible to determine "smallholders" before fully comprehending the farmers' attributes and the farming capacity of each household and individual. For this reason, the study targeted all households and individuals residing and farming in the four villages. Nonetheless, the study excluded temporary casual workers in tea plantations (who are called "tea pluckers") who do not farm in the residing villages, while including those who farm but engaged in tea plucking at the same time. The landless farmers who farm on rented land were included. Furthermore, the study excluded a few individuals who farm in the villages without residing there. Although those exceptional cases emerged during the data collection process, the author strove to make clear the criteria governing exclusion or inclusion of respondents, and to be as consistent as possible.

Accessibility to Large-scale farmers

Although the study aimed to cover all the farming households and individuals in the target villages, a challenge in access to the rich farmers in Ryantende (an advantaged village in the Western region) emerged during the first step of the data collection. The study attempted to conduct stratified FGDs with rich farmers identified by Wealth Ranking, but the village chairperson was of opinion that the rich farmers would not gather in one place with other farmers. Instead, he advised the research team to visit them individually. Finally, nine rich farmers were individually visited, but only six farmers answered the questions, while others were not available at the time of visit or were unwilling to answer. During the interviews, the author soon realised that the farmers ranked as “rich” in Ryantende are all large-scale commercial farmers who own extensive land (e.g., 50-150 acres). Some who answered the questions were also found to be untruthful. Due to these difficulties in accessing and getting reliable information from the rich segment of the village, the author decided to leave out this group from the following phases of data collection. Nevertheless, it was a good learning point to know the general profiles and innovation processes of the wealthiest in the village, as a comparison with other farmers.

Picture 3-7: Large-scale commercial farms in Ryantende village

Diversity of Local Languages and Language Barrier

The research sites (four villages) are stretched over three completely different language zones. Two villages (Ryantende and Rushasha) in the Western region are in

Banyankore/Bakiga-spoken region, while the other two are in Lugbara (Nave village) and Madi (Elema) language regions.

This required three different sets of research assistants and enumerators and may have incurred potential bias in the data collection procedure among different research teams. Nonetheless, in order to reduce this potential bias, the author strove to ensure consistent data collection methods, by briefing and training research assistants and enumerators, using a research protocol document prepared for every stage. Furthermore, to bridge this potential gap among research teams, the author was constantly present and controlled the whole data collection process, except quantitative data collection (Household and Individual Questionnaire Survey). During this questionnaire survey, the author provided training to all the enumerators (four enumerators per village) on how to enter data using mobile phones. During the training session, a joint testing session was conducted. In the field, all the enumerators jointly interviewed the same respondent as a start, for the purpose of ensuring the consistent understanding of responses and data entering methods. Furthermore, the author supervised all the enumerators rotationally during the survey. In every evening during the survey, the author checked all the entered data and immediately rectified any mistakes on the following day.

The additional difficulty was that, in the whole process of data collection, the author had to rely entirely on translations by her research assistants, which might have caused any interpretation and translation bias, and delayed the interviews and workshops, which may have frustrated the respondents and participants. Gender and disciplinary balance was considered where possible, in terms of composition of research teams. As the author has a social science background, the research assistants were mostly chosen from agronomists who have at least diploma certificates (most have a BA or BSc).

Table 3-10: Composition of research assistants/enumerators

	Language	Phase I	Phase II	Phase III
Nave Village	Lugbara	1 male facilitator 1 female translator	2 male enumerators 2 female enumerators	1 female assistant
Elema Village	Madi	1male facilitator 1 female translator	3 male enumerators 1 female enumerator	1 male assistant
Ryantende Village Rushasha Village	Banyankore/ Bakiga	1 female facilitator 1 male translator	2 male enumerators 2 female enumerators	1 female assistant

Exploratory Research with a Large Volume of Data

Appropriately for the beginning of an exploratory study, the research objectives and questions set prior to the field data collection were rather descriptive in nature, without being based on an explicit prior hypothesis. Hence, the relationships among different variables in different contexts had to be explored and examined in every stage: as Wellington and Szczerbinski (2007) describe this type of problem as a common challenge for qualitative research. This was particularly difficult, however, because there were so many potential variables.

The data obtained from quantitative and qualitative tools were both bulky. For example, stratification of farmers in socioeconomic groups in terms of wealth level and gender has produced nine different socioeconomic categories of farmers in each village, hence nine separate FGDs. The lengthy questionnaire had numerous questions which captured a wide range of aspects, including attributes of households and individual farmers, farm management such as crop/livestock types and labour allocation, innovation experiences entailing information sources, year of implementation, necessary inputs, intra-household decision-making, and access to various AIS actors. Attempts were made to capture all the potentially interesting variables, so that their relationships could be investigated at any later stage as issues emerged. The ambition to examine multiple case studies (four villages as four extreme cases), covering different aspects of innovation processes including purposes, access to and utilisation of knowledge and information, resources used, intra-household decision-makings, and effects of innovations, while capturing all agricultural-related innovations without specifying certain crop or animal, or a certain topic, all contributed to this large volume of data.

The phasal research design with reflexivity helped to focus on relatively narrower themes after every stage. Hence, tentative analysis after every phase was important. The author strove to identify themes emerging from the tentative analysis which were then incorporated in the following stage of data collection in order to examine them more deeply. Furthermore, during the data analysis, provisional hypotheses emerging from in-depth interviews provided some clues to relationships among respective variables from the bulky sets of quantitative data. This process was then put in reverse, by letting quantitative data findings illuminate the meaning of the data behind by using qualitative data from in-depth interviews and FGDs.

3.7 Conclusion

This chapter has presented the research methods devised to achieve the research objectives, to fully understand smallholder farmers' views of innovation systems and processes through investigating their real experiences, as envisaged in the previous chapter on Conceptual Frameworks. The process of research site selection, the details of the research tools used in each phase of the data collection, and the data analysis strategies have all been demonstrated here. The context, drawn from this study's document and field research, will be presented in the next chapter.

Chapter 4 - Context: Agricultural Innovation Systems in Uganda and Study Site Profile

4.1 Introduction

This chapter presents a brief overview of the AIS in Uganda, including the agricultural sector's outlook, actors, policies and practices, as a context of the study. Furthermore, the socioeconomic and environmental profiles of the four identified research locations provide useful background for the following results and discussions.

4.2 Agricultural Sector Overview

There is no doubt that agriculture is a leading economic sector, important for inclusive growth in Uganda. Agriculture accounts for 70.4% of total employment (65.5% of male employment and 75.8% of female employment) in Uganda, according to the ILOSTAT database in 2016. This is the 14th highest in the world. As the majority of them (96.3 %) are subsistence farmers (UBOS, 2014), the sector is potentially very important for poverty alleviation (World Bank Group, 2015, World Bank, 2018).

Uganda is the best positioned amongst the Sub-Saharan African (SSA) nations in terms of natural resources such as fertile soil and climate, with two rainy seasons in the most areas of the country. Its various agricultural systems are governed by physical factors such as rainfall and water availability, soils and landforms, and socio-economic factors such as population, infrastructure and market (Musiitwa and Komutunga, 2001). Because of the diverse agricultural systems, a variety of food crops and cash crops are grown in Uganda. The main food crops are maize, millet, sorghum, rice, cassava, sweet potatoes, Irish potatoes, beans, cow peas, field peas, pigeon peas, groundnuts, soya beans, sesame, and bananas, while the cash crops include coffee, tea, cotton and tobacco (UBOS, 2018). Apart from cultivation and livestock husbandry practices, fishing is widely practiced in the area near the large freshwater lakes and rivers. Agricultural products have accounted for 54% of all exports over the last decade. Coffee is the main agricultural export commodity for Uganda, providing 31.7% of the agricultural export revenues on average between 2010 and 2014, followed by fish and fish products (10.4%), animal or vegetable fats and oils (7.9%), and tea (6.6%) (MAAIF, 2016a).

However, despite Uganda's high natural potential, including abundant land and water resources for agriculture and adequate rainfall, agricultural performance is below expectation and the growth is well below population growth. In 2017/18, the sector's contribution to GDP was 24.2% (12.8% for food crops, 4.3% for livestock, 3.5% for forestry, 2.1% for cash crops, and 1.5% for fisheries). The growth of the agricultural sector has been slow for the period from 2010 to 2014, with an average annual rate of 2.2%, which is lower than the agricultural output growth of 3 to 5% in other East African Community (EAC) members (World Bank, 2018). Moreover, the agricultural sector growth rate in Uganda is lower than the average annual GDP growth rate of 5.2% and the average annual population growth rate of 3% (MAAIF, 2016a).

The fact that population growth exceeds agricultural production growth is particularly worrying, as it directly affects the food and nutrition security of the population. This could be related to the declining average farm size per household. World Bank (2018) reports that the share of households operating less than 2 ha increased from 74.7% (2005/6) to 82.8%

(2015/16), and the average farm size operating less than 2 ha declined from 0.80 ha to 0.73 ha during this period. Importantly, land scarcity is coupled with a low technology adoption rate, which hampers agricultural productivity. Uganda's adoption levels of improved seeds, inputs and mechanisation are amongst the lowest in the SSA (Sheahan and Barrett, 2014). Only 7% of farmers rented ox-ploughs, and only 8% of small farmers apply inorganic fertiliser. It is reported that the small farm sizes discourage farmers from using "modern" technologies and commercialising their production, due to the limited economies of scale (World Bank, 2018). As a result, the current productivity for major food crops such as maize, millet, rice and sorghum is reported to be extremely low, reaching only 20-33% of the potential yield for rain-fed agriculture (Ibid.).

4.3 Support Systems for Agricultural Innovations in Uganda

4.3.1 Agricultural Policy

Agriculture is considered as an important sector in Uganda's economy and food and nutrition security, according to the major national policy documents, namely Uganda's *Vision 2040* and *National Development Plan* (NDP) II 2015/6-2019/20 (GoU, 2015). *Vision 2040* advocates for "a transformed Ugandan society from a peasant to a modern and prosperous country within 30 years", and NDP II aims at "strengthening Uganda's competitiveness for sustainable wealth creation, employment and inclusive growth". Thus the government's long-term vision is to transform the agricultural sector from subsistence farming to commercial farming.

In order to achieve such national visions for the agricultural sector, the National Agricultural

Policy (NAP) was formulated in 2013 with six objectives: (1) ensure household and national food and nutrition security for all Ugandans, (2) increase incomes of farming households from crops, livestock, fisheries and all other agriculture related activities, (3) promote specialization in strategic, profitable and viable enterprises and value addition through agro-zoning, (4) promote domestic, regional and international trade in agricultural products, (5) ensure sustainable use and management of agricultural resources, and (6) develop human resources for agricultural development (MAAIF, 2013). To operationalise this policy, the Agriculture Sector Strategic Investment Plan (ASSP) 2015/16-2019/20 was formulated and approved by Cabinet in 2016, following its predecessor's sector strategy, the Agriculture Sector Development Strategy and Investment Plan (ASDSIP) 2010/11-2014/15. The review of the ASDSIP highlighted the importance of involving community-based seed producers in planting material and seed production, the need for the commitment of national and local political leaders to supporting technology uptake, the demand for developing physical infrastructure, and the need to establish national and local level commodity platforms. This became a basis of ASSP, which targets four objectives: (1) increasing agricultural production and productivity, (2) increasing access to critical farm inputs, (3) improving agricultural markets and value addition, and (4) improving service delivery through strengthening the institutional capacity of Ministry of Agriculture, Animal Industries and Fisheries (MAAIF) and its agencies. The interventions focus on 12 priority commodities: bananas, beans, maize, rice, cassava, tea, coffee, fruit and vegetables, dairy, fish, livestock (meat) and four strategic commodities: cocoa, cotton, oil seeds and oil palm.

4.3.2 System Actors

There are a wide range of agricultural innovation system actors in Uganda, as summarised in Table 4-1. The national institution expected to lead the way in spearheading and coordinating the implementation of the ASSP is the MAAIF. As a part of the decentralisation reforms, however, MAAIF was no longer supposed to be involved in direct implementation, but only to focus on policy formation and regulation. This resulted in staff reduction by 80%, causing disruption within the Ministry. There are 411 approved positions, but the actual number of staff as of 2017 was only 279 (World Bank, 2018). At the local government level, district and sub-county offices are expected to play a key role in implementing the sector programme, particularly in agricultural extension, but the proportions of positions filled is extremely low, with, for example, only 11.5% of the fulfilment rate (77 staff out of 672 positions) at district level and 13.8% at sub-county level (1,000 staff out of 7,248 positions) (MAAIF, 2016a). A shortage of frontline extension staff and their immobility, due to lack of transportation and a low operational budget, have been serious problems in extension service delivery. The current farmer-extension worker ratio is 1,800:1, according to the speech made at Uganda's Second National Extension Symposium by Minister of MAAIF (22nd March 2019). The process of re-hiring extension workers, however, is under way, and it was reported that an extension fund of UGX 39 billion (approximately US$10.5 million) was allocated in 2018/9, according to the Minister's speech during the symposium.

Agricultural research and development (R&D) in Uganda is led by the National Agricultural Research Organization (NARO), established in 1992. In line with decentralisation reforms, Zonal Agricultural Research and Development Institutes (ZARDI) were established in various agro-ecological zones to address area-based needs; their expenditure rate, amounting to 1% of agricultural GDP in 2014, was the highest among the EAC countries (World Bank, 2018). NARO's budget depends heavily on development partners' support (two-thirds of total expenditure), which makes its budget unstable. NARO released a total of 198 technologies, innovations and management practices (TIMPS) through the Agricultural Technology and Agribusiness Advisory Services (ATAAS) project funded by the World Bank in 2013-2017 (Ibid.).

With regard to academia, the higher education institutes that offer agricultural programmes are four public universities, four private universities, two colleges and one training institute. Uganda's development partners have renewed their interest in agricultural development since the food crisis in 2008. The ODA commitments for Uganda's agricultural sector from OECD countries have doubled or even tripled to nearly US$200m per year since 2009 (World Bank, 2018). The UN agencies, such as FAO, WFP, UNDP and UNICEF, also support smallholder farmers in various agriculture, food and nutrition security projects. In addition, a number of national and international NGOs and faith-based organisations, such as Sasakawa Global 2000, CARE, and World Vision, form an important part of the innovation system. The large-scale commercial farms with foreign investors from India, South Africa and China are newly emerging partners in the support systems, in addition to the existing commercial farms producing sugarcane, tea, sunflower, tobacco, oil palm, coffee and rice.

Finally, there are a number of farmers' groups and cooperatives in Uganda who play an important role in coordinating access to input and output markets in the innovation systems. There are approximately 16,000 farmers' groups in Uganda, of which only 1% of all the farmers in Uganda are members (the Uganda's Second National Extension Symposium 2019). District Farmers' Associations (DFAs) operate in all districts, under the authority of the Uganda National Farmers' Federation (UNFF), but they are not seen as effective representatives of smallholder farmers, according to the World Bank (2018). Currently, 10,000 cooperatives are registered, some of which are active and represented by the Uganda Cooperative Alliance (UCA), despite the challenges of having been politicized and side-lined since the 1990s. Furthermore, there were 1,992 agro-input dealers in 2008, and a total of 1,300 dealers are registered with the Uganda National Agro-Input Dealers' Association (UNADA), which provides agricultural advice regarding agricultural inputs such as fertilisers, pesticides and seeds (Ibid.). The seed traders are also organised as the Uganda Seed Trade Association (USTA), aiming to ensure the quality of traded seeds and other inputs.

Table 4-1: Matrix of sector players and their roles

Institutions	Responsibilities
MAAIF	a) Act as the lead agency in the implementation of the ASSP. b) Policy formulation, regulation and quality control; c) Establish the structure for coordinating, monitoring and evaluating ASSP; d) Develop and disseminate guidelines to operationalise the ASSP; e) Build the capacity and collaborate with other stakeholders to ensure mainstreaming of ASSP interventions in their respective programmes and plans; f) Strengthen collaboration and networking with the stakeholders to promote mutual appreciation/ understanding, guidance, involvement and community support for ASSP interventions; g) Develop the ASSP operational plans; h) Review and strengthen linkages between MAAIF HQ, Agencies, ATIs and DLG production departments; i) Periodically review and restructure MAAIF to ensure adequate alignment with the implementation requirements of the ASSP; j) Provide for the establishment of requisite approved structures and employment of personnel and ensure their effectiveness by equipping them as required.
Sector Agencies	a) Strengthen the structures of the sector Agencies to enable them to carry out their mandate to extend services in line with increasing agricultural production and commercialisation.
Sector Ministries	a) Translate the ASSP into sector-specific strategies and activities; b) Collaborate with the MAAIF on mainstreaming ASSP priority concerns in their respective sector interventions.
Local Governments (Production Departments)	a) Ensure that the local government development programmes are in line with objectives of increasing production and commercialisation of agriculture; b) Strengthen the structures of the LGs to enable them to effectively execute a country-wide mandate to extend quality service delivery in the agricultural sector; c) Deliverf field-level agricultural services to the population; d) Monitor mainstreaming of ASSP interventions in local governments to ensure

	services benefit them; e) Collaborate with MAAIF on increasing production and commercialisation of agriculture.
Development Partners	a) Support the implementation of the ASSP; b) Ensure consideration and alignment of ASSP priorities in development of cooperation partnerships; c) Establish appropriate institutional/ donor coordination mechanisms for ensuring responsiveness of development cooperation towards the achievement of the ASSP objectives.
Civil Society and private sector	a) Participate in Sector Working Groups and local government planning and budgeting processes to advance farm productivity; b) Develop and implement programmes that address key ASSP intervention areas; c) Farm production, agro-processing and marketing of agricultural output; d) Collaborate with MAAIF and other appropriate institutions on mainstreaming increased production and commercialisation of agriculture; e) Complement Government in delivering agricultural services to farmers; f) Strengthen good agricultural practices (GAPs), agribusiness and market development services and governance; g) Establish PPP initiatives aimed at increasing production and commercialisation of agriculture.
Academia	a) Establish collaborative partnerships with MAAIF, agencies and LGs; b) Contribute to agricultural research; c) Review curricula to respond to labour market needs; d) Provide high quality relevant practical training.
Private Sector	a) Jointly form PPPs; b) Provide complementary interventions for ASSP implementation
Farmers	a) Form farmers' groups and other institutions; b) Implement production and productivity enhancing interventions; c) Define and articulate needs

Source: MAAIF (2016a)

4.3.3 Gaps between Policies and Practices

Despite well-written agricultural policies "on paper", a wide gap has been identified between policy formulation and actual implementation (World Bank Group, 2015, World Bank, 2018). The main reason is defined as the lack of coordination among respective institutions as summarised in 4.3.2. MAAIF is designated as the central institution in coordinating the agricultural sector, but many agricultural stakeholders such as NARO, regulatory bodies for coffee, cotton, and dairy, and commodity platforms for seeds, maize and oilseeds are under the guidance of the Presidency (World Bank, 2018). More especially, the budget allocation decisions are made by the Presidency, and as a result, the Ministry has limited authority to prepare budgets and to engage in sectoral policies (Ibid.). Weak coordination with other ministries, such as water and environment, public works, and trade and cooperatives, and with local governments also causes difficulties in harmonisation among actors who are responsible. As mentioned earlier, understaffing at national and local level represents the limited institutional capacity for implementation. Another major challenge is the agricultural sector's limited budget: in FY 2016/17, 3.6% (US$227 million) of the national budget was allocated to MAAIF and National Agricultural Advisory Services (NAADS). However, the development partner funds account for 80% of public allocations to the agricultural sector, which is not reflected in the national budget (Ibid.). This makes planning and implementation difficult and uncoordinated. It is also reported that the actual expenditure is often well below the budgeted amount.

4.4 Agricultural Extension System in Uganda

4.4.1 History of Agricultural Extension in Uganda

Until 1987, when Uganda finally initiated its Structural Adjustment Program after the end of the civil war, research and extension approaches had been centred on projects with a great degree of duplication, where different ministries and NGOs separately implemented various projects (Rwakakamba and Lukwago, 2014, Mockshell and Birner, 2015, Semana, n.d.).

However, the new coordination with a "unified extension approach" and the "training & visit (T&V) system" began with the initiation of the World Bank-funded Agricultural Extension Program (AEP) in the early 1990s (Musemakweri, 2007). The unification included a merger of the MAAIF, a single chain of command, frontline extension workers being responsible for teaching and advising farmers, programme planning with researchers and farmers, bimonthly training workshops and supervised visits using the T&V approach. The adoption of this approach was encouraged by multimedia promotions, including radio cassettes, videos, field days, shows and tours (Semana, n.d.).

In the late 1990s, in accordance with contemporary radical reforms including decentralisation, liberalization, privatization, restructuring and retrenchment, the public extension was heavily criticised by the World Bank and the T&V approach died out. The extension staff lost morale and farmers' access to extension services was considerably reduced (Semana, n.d.).

Pluralism and privatisation started to take the key position in extension. Bilateral projects increasingly supported the delivery of advisory services by pluralistic agents such as NGOs and farmers' organisations. The NARO introduced outreach programmes to encourage engagement in extension.(Musemakweri, 2007).

4.4.2 Uganda's Experiences with Privatised Demand-driven Extension

Following a global trend of privatisation based on neoliberalist ideology and objections to the costly public extension system, Uganda's public extension system was replaced by NAADS Programme, a decentralised farmer-owned and privatised contract extension system, after the NAADS Act was passed by parliament in 2001 (Mangheni and Mubangizi, 2007). NAADS was the first national programme in SSA to operationalise the private sector contracted and demand-driven extension, and therefore it received much international attention (Parkinson, 2009). This took place within the policy framework of the Plan for Modernisation of Agriculture (PMA) which adopts a multi-sectoral approach to agricultural development, agricultural research, and advisory services. In the first phase between 2001 and 2007/8, donors including the World Bank, IFAD, EU, DFID and others contributed 80 percent of the total NAADS budget, USD 108 million, while the Government of Uganda gave 8 percent, local governments 10 percent and farmers 2 percent.

The NAADS programme was structured in parallel to the existing decentralised local government structures of districts and sub-counties, as far as most of its planning and funding activities were concerned (Mangheni and Mubangizi, 2007, Parkinson, 2009). While the effectiveness of decentralisation in practice has been questioned, the NAADS programme controversially took the challenge of decentralisation further by facilitating the delegation of responsibility from districts to sub-counties and broadening the role of producers in governance (Farrington et al., 2002).

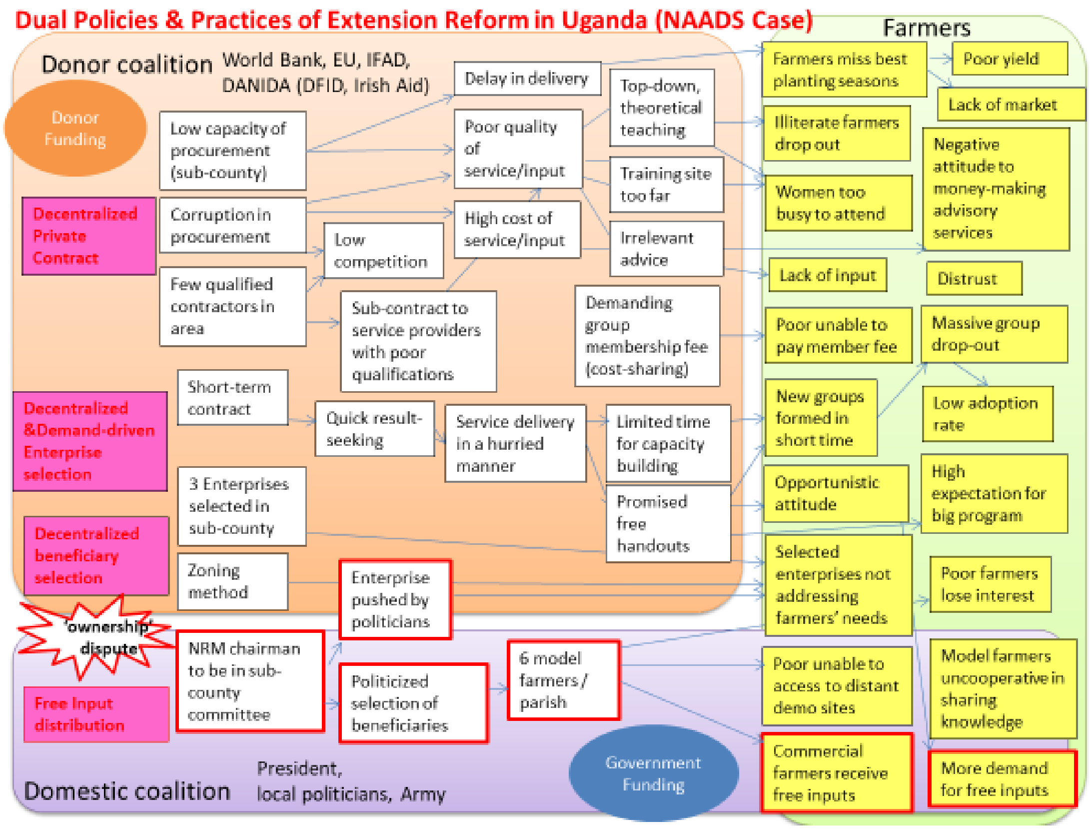
Farmers enrolled in NAADS by forming and registering groups. Two representatives from each group sat on the sub-county farmers' forum, which formulated the demands forming the basis for making contracts with private service providers and monitored their performance to ensure the delivery of the agreed services. The sub-county technical committee supported the farmers' forum in implementation, quality control and auditing. For farmers' institutional development, service providers who were mainly NGOs and CBOs were engaged in training and supporting farmers' groups to develop their capacity to implement the programme. This included the formation of farmers' groups and the selection of three priority enterprises per group by scoring and ranking the enterprises based on constraints and opportunities. The list of enterprises was aggregated at sub-county level, forming the basis for private service-provider recruitment. Thus, private extension service providers, which might be firms or individuals, were contracted by sub-county farmers to deliver enterprise-specific advice (ranging from agronomic practices to marketing) to the selected farmers' groups for 3-6 months (Mangheni and Mubangizi, 2007).

Nevertheless, the programme attracted much hostile criticism, both internally and internationally. Factors that aroused objections at policy level included a lack of national ownership in the formulation phase, a low level of population coverage against unrealistically high expectations, the excessively rigid procedures that one would expect to see in yet another top-down system, poor understanding of capacity building in a "demand-driven" system, poor coordination with other components of the PMA, and political interference, corruption and mismanagement (Farrington et al., 2002, Mangheni and Mubangizi, 2007, Parkinson, 2009, Rwamigisa et al., 2011, Kjær and Joughin, 2012, Mutimba, 2014, Rwakakamba and Lukwago, 2014, UFAAS, 2014, Mockshell and Birner, 2015, World Bank Group, 2015). The programme formulation process was reported to be heavily donor-driven. The ownership of domestic policy makers and the existing public extension services were overlooked by international donor communities in the reform process (Mockshell and Birner, 2015), resulting in tensions between the existing public system and outsourced institutions (Rwamigisa et al., 2011). The political interference also created a gap between "nominal" policy and "real" practices, whereby governments adopted a policy reform as a precondition to access donor funds, but such reforms were then only partially implemented, or reversed under internal political pressure (Kjær and Joughin, 2012, Mockshell and Birner, 2015). Thus, a weak 'demand-driven' system later became an easy target for politicians to misuse for their political gains.

The divergence from “demand-driven” and “private contract” approaches at field level is revealed through numerous case studies (Musemakweri, 2007, Parkinson, 2009, Rwakakamba and Lukwago, 2014). The criticisms include beneficiary selection favouring commercial or progressive farmers rather than poor farmers, top-down learning methods and limitation of enterprises, “private contracts” not functioning in the areas where private service providers were few or non-existent, the weak contracting capacity of decentralised structure resulting in poor service, high costs and corruption, and short-term “contracts” which jeopardised a need for long-term capacity building on demand articulation at local level and only promoted an opportunistic attitude among farmers (see Figure 4-1).

The lessons to be drawn from Uganda’s experiences are that a successful privatised contract extension system requires essential pre-conditions such as a sound policy environment for agricultural development, sufficient capacity for farmers to articulate their demands and service-quality requirements (Garforth, 2004), sufficient private service-provision capacity to satisfy these demands, efficient and effective mechanisms for ensuring adherence to minimum service quality standards, adequate and sustainable funding, and conditions conducive to profitable private-service provision, as summarised by Mangheni and Mubangizi (2007).

Figure 4-1: Dual policies and practices of extension reform in Uganda

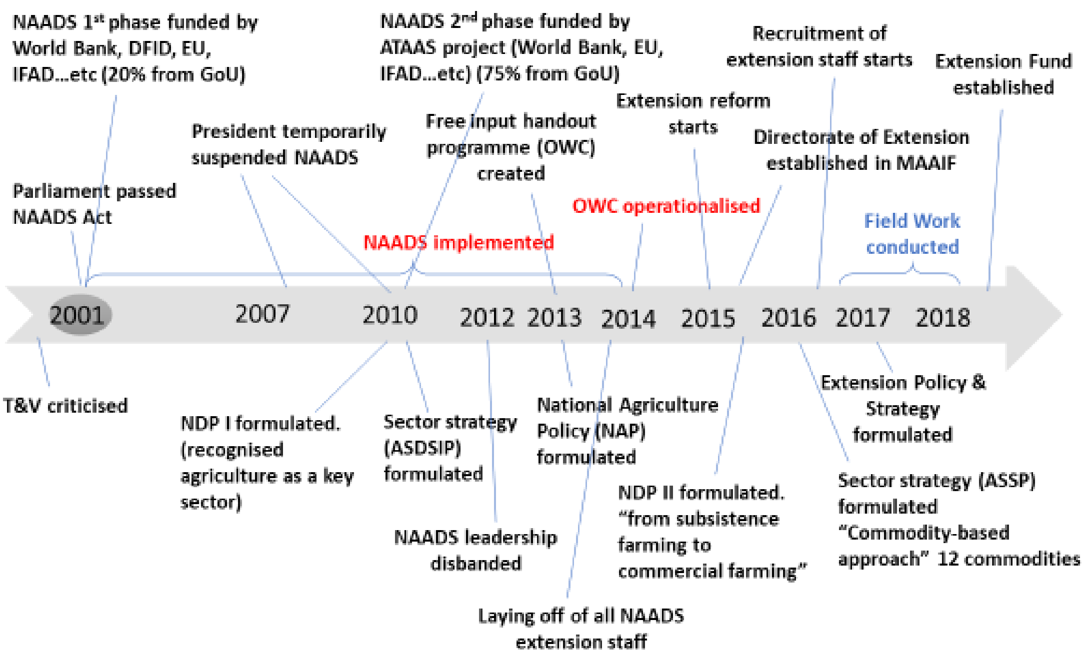


Source: Author

4.4.3 Current New Extension Reform

Clearly, Uganda's extension system is now at the crossroads. As a result of 13 years' of experiments with a private outsourced extension system, the country scrapped the NAADS programme in 2014 (in an actual sense, only the procurement component of the programme remained) and dismissed all the programme's personnel, including extension staff, due to the alleged corruption and the programme's poor performance. Since 2015, the Government of Uganda (GoU) has been raising extension reform as the first priority in agricultural sector and has been in the process of establishing the "Single-Spine Extension System (SSES)", which includes merging the NAADS programme into the District Production Departments and removing parallel structures so that agricultural production and extension activities are harmonised across all local governments, re-establishing the Directorate of Agricultural Extension Service (DAES) within MAAIF to coordinate extension service delivery in both public and private sectors, and establishing an independent input supply and distribution system by deploying the army (MAAIF, 2014, MAAIF, 2015, MAAIF, 2016a, MAAIF, 2016b). The Government has drafted a National Agricultural Extension Policy (NAEP) and National Agricultural Extension Strategy (NAES), in line with ASSP 2015/16-2019/20, with a strong emphasis on the SSES (MAAIF, 2016a, MAAIF, 2016b).

Figure 4-2: Timeline of NAADS and extension reform in Uganda



Source: Author

Despite the government's effort in recruiting extension staff at sub-county level, there are still far fewer field extension staff compared to the days of NAADS. It is reported that there are a number of sub-counties where extension staff are practically absent. Incomplete assessment of the old system, including a bureaucratic non-result-oriented public service work culture within MAAIF, was pointed out (UFAAS, 2014). "Pluralistic extension" is still a centre of the Ministry's approach, but it will still take time to be operationalised.

On the other hand, during the aftermath of NAADS' demolition (of the extension component) in 2014, Operation Wealth Creation (OWC), operated by Army, has been quickly operationalised: it distributes free agricultural inputs such as seedlings, improved seeds, and animals to farmers. This is widely criticised, due to the lack of accompanying training or of consideration for markets, the poor quality and timing of supply, the unclear procedure of beneficiary identification, the tendency of free inputs to create a dependency syndrome among farmers, undermining farmers' empowerment and entrepreneurship, and the involvement of army without expertise in agriculture (Rwakakamba and Lukwago, 2014, UFAAS, 2014, World Bank, 2018). Moreover, a high level of waste of resources and misallocation of distributed inputs is reported (World Bank, 2018). This is serious, especially when the budget for OWC was nearly half of the total agricultural budget. Importantly, it is reported that this programme has crowded out the private sector, particularly private seed companies which seek to produce quality seeds. The centrally purchased seeds and seedlings are well above market price, which increases the burden on Ugandan taxpayers (Ibid.).

In the latest policy documents such as NDP II 2015/16-2019/20 and ASSP 2015/16-2019/20, it is pronounced that Government has adopted a commodity value-chain approach to help ensure agricultural production at the smallholder level. The focus is placed on investing in the 12 agricultural enterprises along the value chain: Cotton, Coffee, Tea, Maize, Rice, Cassava, Beans, Fish, Beef, Milk, Citrus and Bananas (MoFPED, 2014, GoU, 2015, MAAIF, 2016a). National Agricultural Policy (MAAIF, 2013) aims "A Competitive, Profitable and Sustainable Agriculture Sector" and states 6 key principles which lay emphasis on strengthening the private sector, implementing the 2004 zoning strategy, and developing the value chain of selected strategic commodities. The zoning strategy refers to the commodities that are considered best suited for each zone, which will receive extra public sector support. In line with this approach, the World Bank has injected US$150 million for the five-year Agriculture Cluster Development Project (ACDP), aimed at raising agricultural productivity and marketed production for selected commodities, namely maize, beans, rice, cassava and coffee, in 12 selected high-potential agricultural areas in Uganda, termed "clusters" (World Bank, 2015). As some literature argues, the selection of enterprises to be supported by extension should not be based on the zoning approach or profitability alone. Rwakakamba and Lukwago (2014) suggest that efforts should be made to assess their impact on food and nutrition security, youth involvement, gender such as women's time use, its cost, and priority.

4.5 Study Site Profiles -Four Contrasting Contexts

This study selected four locations representing contrasting economic, social and agroclimatic environments in Uganda, as explained in the previous chapter (Methodology). The brief overviews of each location are summarised in Table 4-2. The advantaged villages are located in "high agricultural potential areas" which have more favourable physio-environmental conditions in terms of soil quality and precipitation, as well as better access to market, roads, and AIS actors. Those advantaged villages have lower poverty rates than the disadvantaged villages in the same AEZs, although the Northern region (43.7%) has a higher prevalence of poverty compared to the Western region (8.7%) in 2012/13 (UBOS, 2018).

Table 4-2: Characteristics of four study locations

AEZ	**North Western Savannah Grasslands**		**South Western Farmlands**	
Village	**Nave**	**Elema**	**Ryantende**	**Rushasha**
EEIs	Advantaged	Disadvantaged	Advantaged	Disadvantaged
District	Arua district	Adjumani district	Bushenyi district	Isingiro district
Sub-County	Vurra S/C	Arinyapi S/C	Kyamfunga S/C	Rushasha S/C
Annual rainfall (district)[4]	Heavy rainfall and moderately high temperature	750mm – 1,250mm Medium rainfall but long dry spell		957mm
Elevation (district)[5]	610 – 1,388m	600 – 1,300m		Hilly terrain.
Population (district) 2014[6]	782,100	225,300	234,400	486,400
Population Density (district) 2014[7]	180	76	277	186
Ethnic group	Lugbara	Madi	Banyankore	Banyankore, Bakiga
Distance to District HQ	27km (17km tarmac + 10km marram road) Bike taxi (cheap)	40km (marram road) + 3km rural pathway	22km (tarmac road) Frequent transport	56km (marram road) Once a day up to stop 6km away & expensive
Distance to Market	4km (twice a week)	4.5km by foot or bicycle only	200m (daily)	16km (weekly)
AIS actors	S/C extension, OWC, 2 NGOs, DFA, 2 Cooperatives, NARO (Research Institutes), Universities, Bank, Microfinance (27km distant), 5 VSLA, Many traders, Cassava/Maize milling, Cassava chipping, Seed multiplication within village	S/C extension, OWC, VSLA, No SACCO, No NGOs, No traders, Milling (4.5km far)	S/C extension, OWC, 3 SACCOs (200m), VSLA, 4 Tea factories, Many traders, Agro-input dealers (200m), Milk coolant, Maize milling, Groundnut grinding, Tea processing, Tree nurseries, Fingerling supplier	S/C extension, OWC, 1 SACCO (24km distant), VSLA, 2-3 traders, Agro-input dealers (56km distant), Tree nurseries (56km distant), Maize milling
No. of HHs	116	98	135	121
Poverty likelihoods	43.09%	55.02%	22.85%	43.01%

4 TWINOMUJUNI, N. K. 2011. *Uganda Districts Information Handbook: Expanded Edition 2011-2012,* Kampala, Fountain Publishers.
5 Ditto
6 UBOS 2014. National Population and Housing Census 2014. *In:* STATISTICS, U. B. O. (ed.). Kampala.
7 Ditto

($1.90/day 2011 PPP)				
No. of HHs by wealth	Rich=20 Moderate=73 Poor=23	Rich=9 Moderate=75 Poor=14	Rich=15 Moderate=50 Poor=32	Rich=5 Moderate=34 Poor=82
Land size (acre) by wealth	Rich: 4.18 Moderate: 2.34 Poor: 2.54	Rich: 17.11 Moderate: 13.25 Poor: 6.60	Rich: 59.25 Moderate: 3.62 Poor: 1.07	Rich: 8.13 Moderate: 4.61 Poor: 0.72
Livelihoods	Crop production, Animal rearing, Agricultural casual labour, Charcoal-burning, Off-farm business (grocery shops)	Crop production, Animal rearing, Fishing, Agricultural casual labour, Charcoal-burning, Firewood collection, Grass-cutting for roofs, Milling, Ox-ploughing	Crop production, Animal rearing, Agricultural casual labour (tea-plucking, tree-potting), Milk processing, Tree nursery business, Fish-farming, Off-farm business (e.g., motorbike servicing, shops, carpentry), Brick-laying	Crop production, Animal rearing, Agricultural casual labour, Off-farm business (grocery shops, carpentry)
Crops	Cassava, beans, groundnuts, maize, millet, sesame, bananas, pigeon peas, onions, tomatoes, amaranth	Sesame, maize, cassava, sweet potatoes, groundnuts, sorghum, millet, green gram, cowpeas, pigeon peas, okra, kale, tomatoes, amaranth, eggplants	Tea, bananas, beans, maize, sweet potatoes, eggplants, cabbages	Bananas, maize, beans, potatoes, cassava, sweet potatoes, groundnuts, millet, peas, sorghum, eggplants, tomatoes, watermelon, sugarcane, coffee
Livestock	Cattle, goats, pigs, guinea pigs, chickens	Cattle, goats, chickens, pigs	Dairy cows, cattle, goats, pigs, chickens (local, layers), rabbits	Cattle, goats, sheep, pigs, chickens

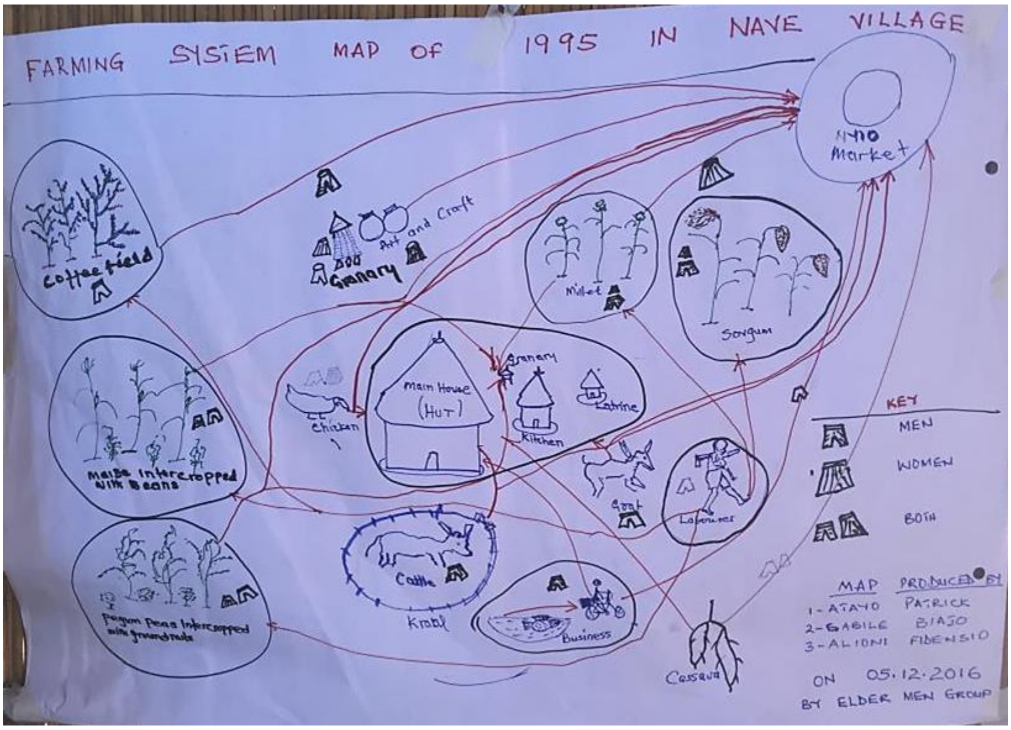
4.5.1 North Western Savannah Grasslands AEZ

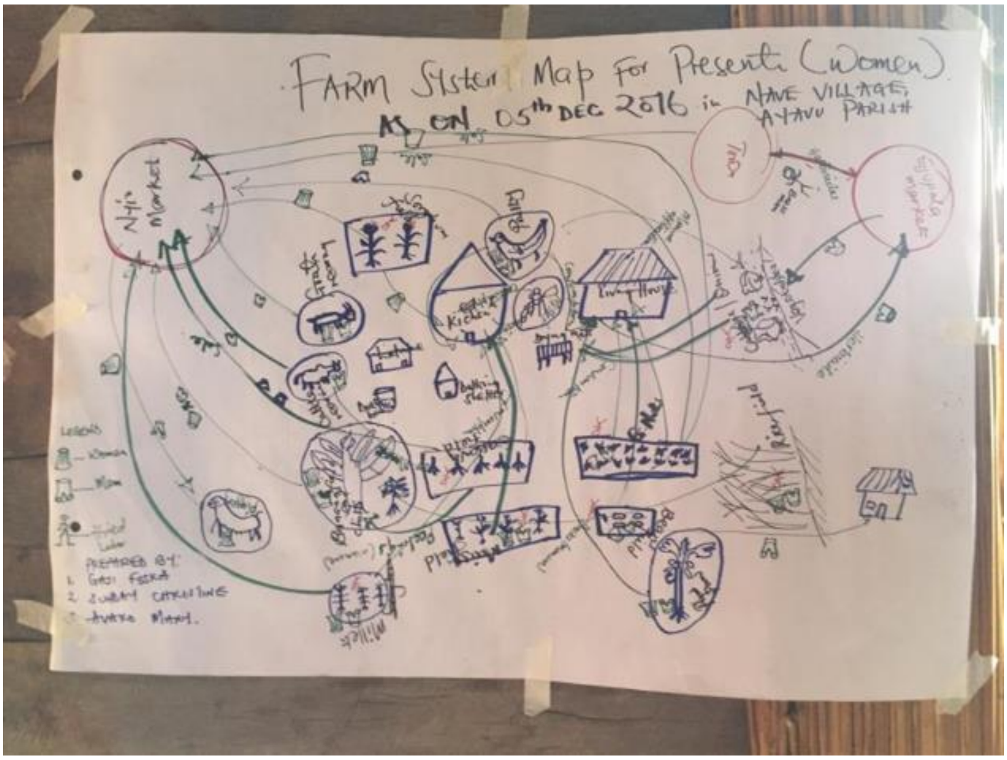
This zone has long unimodal rainfall, with a rainy season extending from April to October (Musiitwa and Komutunga, 2001). The soil types seen in this zone are heavy, grey and brown and fertile, with a high moisture storage capacity. Large areas of land are available in the Northern region, therefore the use of tractors is greater than elsewhere in Uganda. Shifting cultivation is practiced in this zone, because of land abundance. The gender division of labour is more pronounced in this zone: for example, men usually open the land and women do the rest of farming work, while communal cultivation, weeding and harvesting are commonly practiced. There is very high agricultural potential, but the hindering factors are poor marketing systems and transport infrastructure in general (Ibid.).

4.5.1.1 Nave Village (Northern Advantaged Village)

According to the village workshops where the Livelihood/Farm System Mapping exercise was conducted with KIs, it was found that the main livelihoods of this village 20 years ago were crop and livestock husbandry and non-farm activities such as art and crafts (e.g. making pottery) and casual labour at others' farms. The crops grown were food crops such as cassava, maize intercropped with beans, millet, sorghum, pigeon peas intercropped with groundnuts, and sesame, and cash crops such as coffee and cotton. The livestock included goats in large number, sheep, poultry and cattle. Men's responsibilities were craftsmanship, using their skills to make objects such as hand hoe handles and ropes from sisal and other wild fibrous materials, field slashing before burning and tillage to eliminate tall vegetation, primary tillage, weeding, particularly of cassava and horticultural crops and cash crops, marketing cash crops, and grazing animals. On the other hand, women's responsibilities were the second tillage (harrowing) of food crop fields, weeding of most of the fields, particularly food crops such as millet, harvesting food crops, transporting agricultural produce to the market, winnowing the produce such as groundnuts, beans and millet, pottery-making for commercial purposes, sale of brooms and papyrus mats, brewing from local grains such as maize, millet and sorghum and selling the drink at home or in market places. Houses and granaries are built by both men and women: while women look for the necessary materials, such as grass and reeds, in the bush, men put the materials together to build. Harvesting food crops was mostly done by women's groups paid in kind (food), while opening up land was done by hired labour, paid both in cash and in kind.

Picture 4-1: Farming system map in Nave village





Top picture: Farming system map of 20 years ago drawn by men in Nave village
Bottom picture: Present farming system map drawn by women in Nave village

The crops and animals grown and raised currently are almost the same as two decades ago, but bananas (matooke), rice, chili, cabbage, tomatoes, onions, papaya and the piggery were reported as recent enterprises. Men are in charge of buying pesticides and herbicides from market and applying them to tomatoes and onions, taking rice for threshing, taking rice, groundnuts and beans to group storage, marketing animals and cattle-rearing, while the women's current responsibilities are cooking, marketing sorghum and millet, and taking care of pigs. A variety of crops are often grown either by both men and women or by hired labour.

The major change over the last two decades identified during the workshops was the reduced landholding size from at least seven acres per family to three acres on average, due to population growth. Traditionally only boys above 15 years old could claim lands in order to earn dowry, but currently even girls can claim lands, though they have to return the land to their parents after marriage. Previously, men made all the decisions about what should be planted on the land, but nowadays women can decide what to plant on some pieces of land, as long as the original family fields have been cultivated and planting activities are completed. The land quality had significantly deteriorated, which reportedly led to lower crop yields. Other innovations have affected farming practices: these include a change from broadcasting to line-planting, which makes weeding easier and requires less seed (which led men to participate in weeding by hoes), the introduction of new crops such as upland rice and chili and of new crop varieties such as bananas, maize, cassava, beans, groundnuts (Acholi white, Shellnut 4/5, Red Beauty), onions, tomatoes and soybeans, large-scale horticultural farming, the application of pesticides and manure to horticultural crops, the abandonment of coffee due to falling prices and lack of government support, building sheds for animals instead of keeping them in the home, and the use of veterinary services (e.g. vaccination). Since the early 2000s, the use of granaries as storage facilities was phased out, due to rampant theft of produce. Tractor and ox-plough services are now available, although they are underused. Furthermore, the transportation of produce has changed: instead of carrying it on their heads or by bicycle, people use privately owned or hired motorcycles. Two markets are now available, although there was no market before. There was formerly little access to credit services, especially for women, but now the Village Saving and Loan Association (VSLA) is available to all ages and genders.

Picture 4-2: Livelihoods in Nave village

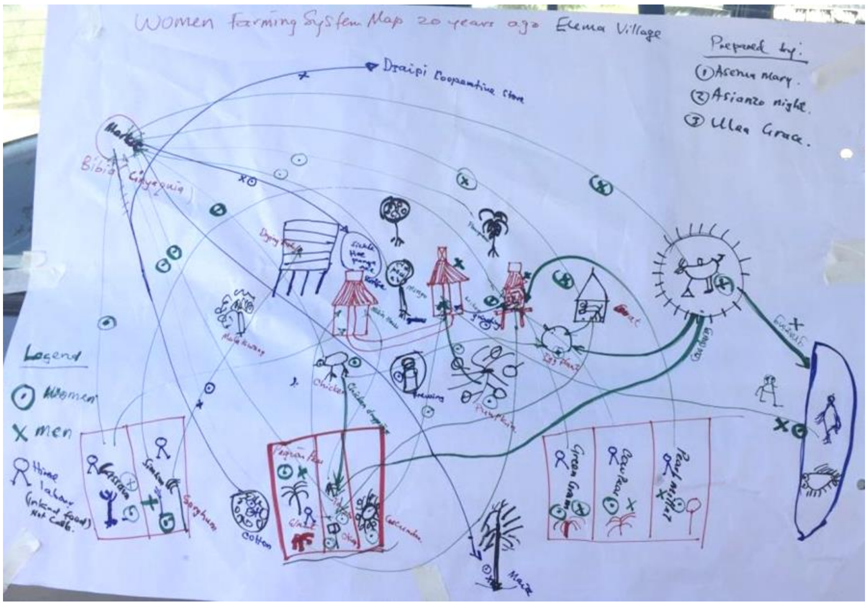
Left picture: A field of beans almost ready to harvest; Right picture: The nearest market, Nyio

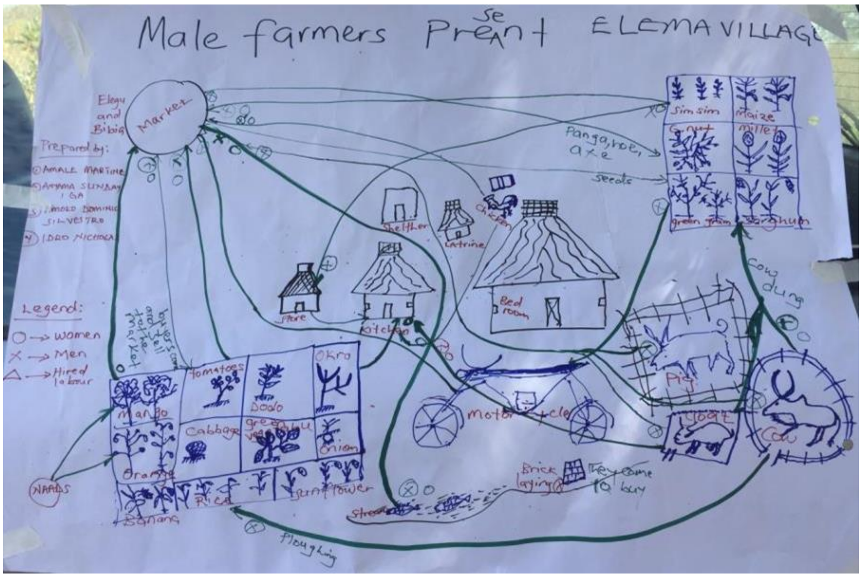
Left picture: A woman peeling cassava for drying; Right picture: Preparing brewing the local beer

4.5.1.2 Elema Village (Northern Disadvantaged Village)

The main livelihoods 20 years ago in Elema village used to be crop husbandry (cotton, sesame, sorghum, finger millet for brewing the local beer, green gram, cowpeas, sweet potatoes, cassava, pigeon peas intercropped with groundnuts, pumpkins, okra, eggplants, papaya and mangoes), and animal husbandry (chickens, cows, and goats), bee-keeping, fishing from the River Tete, and hunting. Women were engaged in rearing and selling chickens, and growing pumpkins, eggplants, green gram, tomatoes, malakwang (a leafy vegetable), and okra, brewing locally, and collecting roofing grass (aishe), while men's responsibilities used to include grazing and marketing cows and goats, bee-keeping, planting mangoes, and taking cotton to the Dzaipi Cooperative store. External labourers were often hired for various crops. Fishing used to be a responsibility of both men and women.

Picture 4-3: Farming system map in Elema village





Top picture: Farming system map of 20 years ago drawn by women in Elema village
Bottom picture: Present farming system map drawn by men in Elema village

Currently, the types of crops that they grow have not greatly changed, but the difference is the fact that there is a market for those crops nowadays. The number of markets has also increased. The barter trading system that was previously seen has now completely changed to cash. The notable most difference during the two decades is the shift from the use of communal labour for digging with hand-hoes to ox-ploughing, tractor hire, and hired labour. The labour was paid for in kind (e.g. food) 20 years ago, but now every kind of work is paid for in cash. Family labour has significantly reduced because recently children have started to go to school. Land size has reduced and the land quality deteriorated, which is allegedly partly due to wild elephants disturbing their lands. Due to the unreliable rainfall and prolonged dry spells increasingly seen nowadays, the yield has reduced, and the size of animals became smaller; some farmers have resorted to the use of irrigation systems for growing vegetables during dry seasons. Furthermore, the number of cases of pests and disease in crops and animals has increased, leading to the present need to use drugs. Hunting and fishing have been reduced, due to regulations enforced by the local authority. Women have now gained access to credit (e.g. SACCO, VSLA), while only men had access 20 years ago. However, it is claimed that women still have to consult men before taking loans. Collective work (lapi) is rare now, although the number of farmers' groups has increased.

Picture 4-4: Livelihoods in Elema village


Left picture: Children preparing a field for sweet potatoes; Right picture: Family irrigating a field of tomatoes and amaranth


Left picture: Drying sweet potatoes for food preservation; Right picture: Common homestead in Elema village

4.5.2 South Western Grasslands AEZ

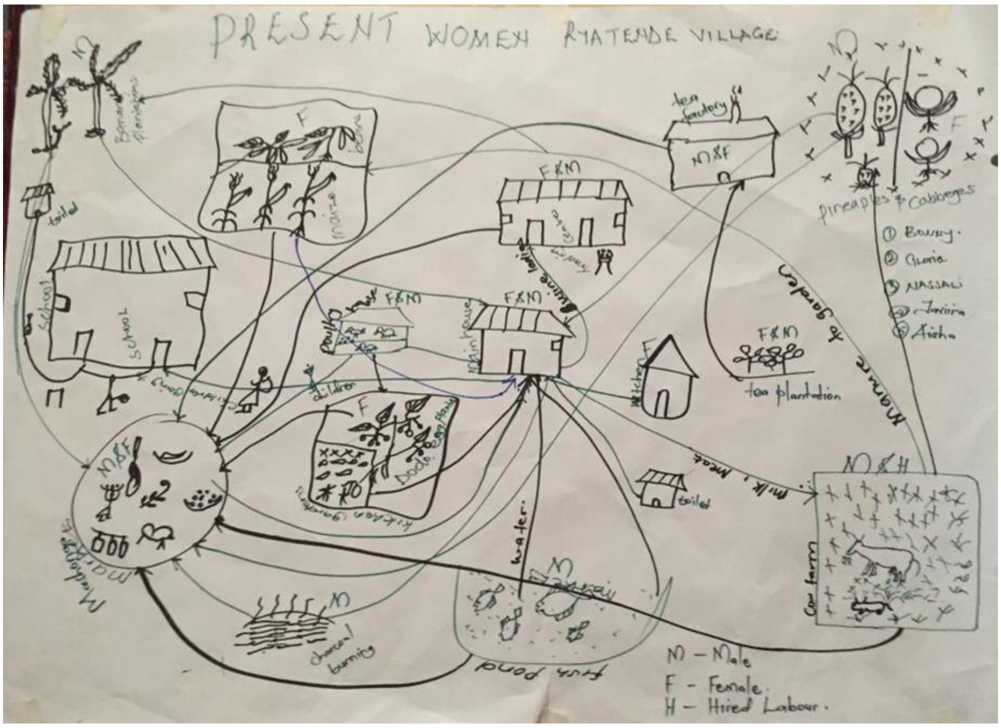
This zone has two short rain peaks in April and October/November, and is suitable for perennial crops such as sugarcane, tea, pineapple, and coffee, due to the short dry seasons. While the cultivation of bananas (matooke) is declining in the northern parts of the lake crescent, it is spreading in the south western region into the cattle corridor in the districts of Mbarara and Bushenyi (Musiitwa and Komutunga, 2001). The fertile dark grey silty clay loam soils seen between the eroded hills of the cattle corridor are now used for growing bananas in this region. Bananas are now commercially grown in this zone because of the increased urbanisation and demand in Kampala. In this zone, the Bairu Banyankole operate the banana-finger millet-cattle system, in which cash crops such as tea, pineapples and Robusta coffee are grown on the hill slopes, and bananas in the valleys (Ibid.). Labour is supplied by migrants, mostly from Kabale (the Bakiga), who work on large-scale plantations of tea and bananas, sometimes on a permanent basis. The south western pastoral system is found in the cattle corridor of this zone, where the rainfall is lower than the rest of the zone, and the soils are sandy loams with dark-grey silty clays in the valleys (Ibid.). In this system, the cattle keepers, known as Bahima Banyankole or Balaalo, graze their cattle on the hill tops and slopes, and barter their livestock products, milk and ghee, for food crops such as millet and sorghum grown by Bairu Banyankole.

4.5.2.1 Ryantende Village (Advantaged Western Village)

The main livelihoods used to be growing crops such as bananas, millet, beans, groundnuts, maize, Irish potatoes, cassava, green vegetables, tea and coffee, and rearing cows and chickens, while marketing was only for maize, beans, groundnuts and chickens. Women's responsibilities used to be taking care of banana plantations, growing and marketing Irish potatoes for commercial purposes, growing sweet potatoes, pumpkin and cowpeas for home consumption, and rearing and marketing chickens, while men were in charge of growing and marketing coffee and tea at factories. Boys used to look after cows. Growing and marketing other crops, like maize and groundnuts, were the responsibilities of both men and women.

At present, growing other types of crop, particularly horticultural crops (pineapples, cabbages, amaranth, eggplants), fish farming, carpentry, casual labour at tea plantations, factory work, tree planting, charcoal burning, and trading were added as their main livelihood options. Fish farming, charcoal burning, carpentry, banana plantations, and pineapples come under men's responsibilities, while growing vegetables in kitchen gardens to grow vegetables is a task for women. Work at tea and coffee plantations and factories is done by both.

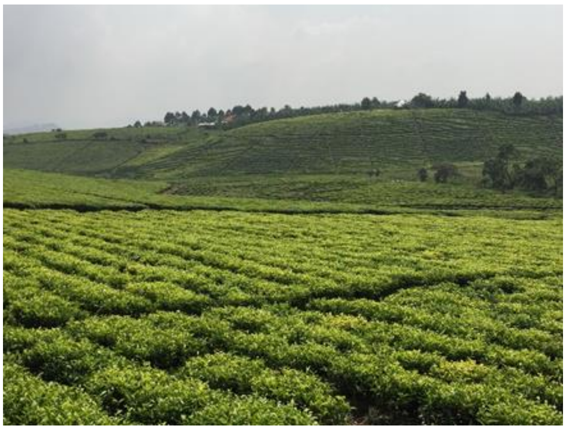
Picture 4-5: Farming system map in Ryantende village



Top picture: Farming system map of 20 years ago drawn by men in Ryantende village
Bottom picture: Present farming system map drawn by women in Ryantende village

The most pronounced changes over the last two decades were the land shortage and the deteriorating land quality in Ryantende village. The decline in quality was reportedly due to excessive use of pesticides and chemical fertiliser, as well as the rapid increase in the incidence of pests and diseases. Furthermore, the deforestation due to population growth caused more cases of drought. Many developments were reported: the availability of mobile phones, electricity obtained from solar panels, a good road infrastructure providing access to markets, improved modes of transport, such as a motorbike taxi (known as bodaboda), the establishment of many factories, and the availability of schools and hospitals nearby (despite the fact that some cannot take their children to school). The changes in farming practices include the introduction of fishponds, new varieties of animals, some of which are exotic animals (e.g. boar goats), spraying pesticides, and the commercialisation of food crops (e.g. bananas). Tea used to be grown only by a few people, but now by many. It was reported that the men and women share roles nowadays. Although the society was more economically equal society before, there are rich and poor now, reportedly due to the government's poor implementation of policy.

Picture 4-6: Livelihoods in Ryantende village



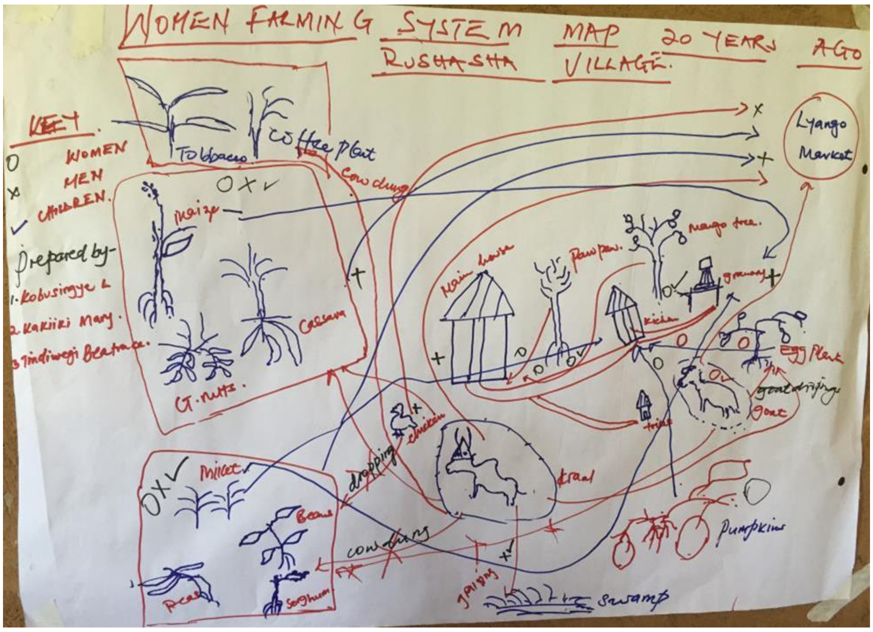
Left picture: Tea leaves collection site; Right picture: Tea plantation

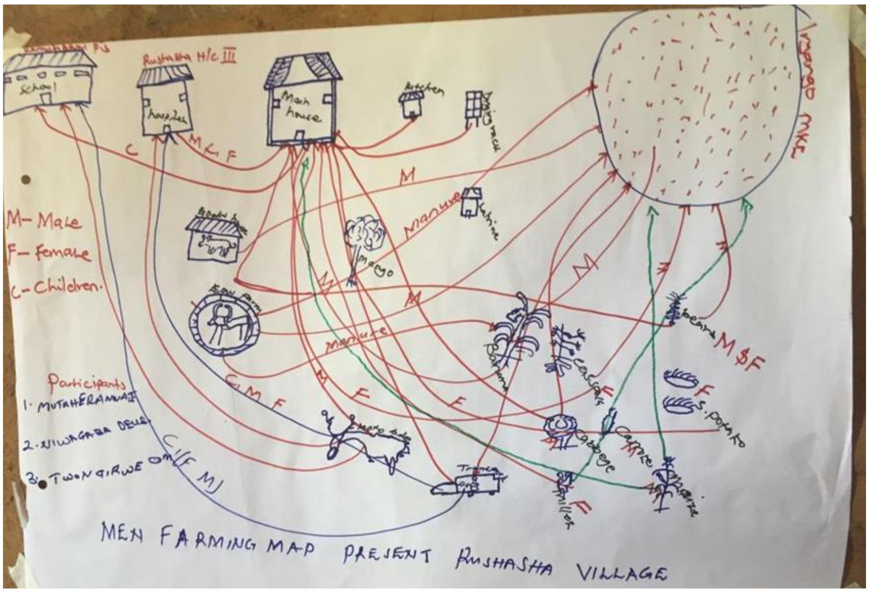
Left picture: Piggery; Right picture: Eggplants with mulch in rented swamp

4.5.2.2 Rushasha Village (Disadvantaged Western Village)

The main livelihoods of 20 years ago in Rushasha village were growing crops such as tobacco, coffee, maize, groundnuts, cassava, millet, beans, sorghum, peas, eggplants, pumpkins, papaya and mango trees, and keeping animals such as cattle, chicken, and goats. Millet used to be kept in the granary within the compound. Women used to be in charge of growing pumpkins and rearing chickens, while growing bananas, tobacco and coffee, brewing local beer, grazing cows and goats, and the marketing of all produce were men's work. Men cleared the bushes, and women dug, weeded, and harvested the crops.

Picture 4-7: Farming system map in Rushasha village





Top picture: Farming system map of 20 years ago drawn by women in Rushasha village
Bottom picture: Present farming system map drawn by men in Rushasha village

The most significant change was from larger areas of fertile communal land to smaller areas of depleted private land. This was caused by population increase, bush-burning, the use of herbicides, climate change and deforestation. It was reported that youths used to respect parents before because of their extensive land, but that respect is lost now because the land is no longer allocated to the youths. Another major change reported was the commercialisation of food crops such as cassava, vegetables and fruit. Therefore, there used to be a granary, but now they sell their produce to market immediately after harvest. Local bananas used to be grown for the purpose of brewing a local drink (tonto), but it is now common to grow the matooke variety as a staple food. Tobacco growing has stopped because of awareness of cancer, and coffee has now been uprooted due to low yield, disease and drought. Newly emerged enterprises are growing Irish potatoes and horticultural crops such as carrots and cabbages, a piggery, charcoal burning, and off-farm businesses such as bodaboda. Moreover, the housing has changed from grass-thatched huts to semi-permanent or permanent houses with iron sheets. People's diets have become less healthy, with more oily food and less green vegetables. This has caused more sickness, even though there are health centres nearby nowadays. Most children are now attending school, hence the child labour force at home is reduced.

Picture 4-8: Livelihoods in Rushasha village

Left picture: Scenery of Rushasha village; Right picture: Weeding a banana plantation

Left picture: Harvesting beans; Right picture: Banana plantation with mulch

4.6 Conclusion

The purpose of this chapter is to set the context for this thesis; based on this, the following chapters were developed in paper form. This chapter has provided an overview of the agricultural sector, policy and practices, focusing on the extension system and programme, namely NAADS and the reform processes. The latter half of the chapter developed livelihood profiles of four research sites in contrasting socioeconomic and physio-environmental conditions: Nave and Elema villages in the North Western Savannah Grasslands AEZ, and

Ryantende and Rushasha villages in the South Western Farmlands AEZ. In the Northern AEZ which is relatively land-abandant, cassava, beans, sweet potatoes and sesame are grown as their main crops, while in the Western AEZ which is land-scarce, the main crops are banana, tea, maize and beans. In both AEZs, the advantaged villages have easier access to market and government services where AIS actors are abundant, while the disadvantaged villages are remotely located and have difficulties to access market and other services where AIS actors are scarce. Thus, the characteristics of the four sites found by the field work confirmed the contrasting environments.

Chapter 5 - Inclusive Knowledge and Information Systems for Agricultural Innovations: Analysis of Farmers' Access, Use and Attitudes in Diverse Socioeconomic and Environmental Contexts

This chapter is going to be submitted to journal as:

SHIBATA, R., DORWARD, P., CARDEY, S., & STERN, D. Addressing Gaps in Farmers' Attitudes to, Access to and Use of Knowledge and Information Sources about Agricultural Innovations: Analysis of Diverse Socioeconomic and Environmental Contexts. *Agricultural Systems*.

Abstract

Putting useful knowledge and information into practice is a crucial development pathway for smallholder farmers in developing countries. However, the processes by which farmers obtain and use such information are not fully understood. Moreover, many recent studies of Agricultural Innovation Systems (AIS) attempt to capture infrastructural and static aspects of systems with a "hard systems" thinking approach, which precludes the understanding of more dynamic and diverse AISs, formed by complex interactions among actors. This study aimed to unpack different farmers' innovation systems in different agroecological and enabling environments, particularly the knowledge and information systems used in their innovations, as well as to examine how farmers' attitudes to AIS actors influenced access to and utilisation of the information. Focussing on four purposively selected locations in Uganda, representing a range of socioeconomic and environmental characteristics, the research was based on household and individual questionnaire surveys involving 531 farmers, Focus Group Discussions (FGDs) with 166 farmers, in-depth interviews with 90 randomly selected farmers, and participatory workshops. The study found the agroecological and enabling environmental differences and the differences between farmers'

characteristics, particularly wealth, gender and membership of farmers' groups, affected the information sources that the farmers accessed and used for their innovations. Importantly, access to and utilisation of information were found to be intertwined with the farmers' information-seeking behaviours and perceptions of the information sources' trustworthiness and applicability. The study found hitherto unresearched systemic gaps between farmers and government actors, other farmers and market actors. Such gaps include poor and female farmers' limited access and passive attitude to government extension services, coupled with the government's "demand-driven approach", a "social class gap" blocking information exchange with model farmers, difficulty in obtaining farmers' group membership, and a low level of trust in information from market actors leading to its underuse, despite the rapid recent increase in access to it. This study demonstrates that analysing various farmers' different perspectives on AIS actors with a "soft systems thinking" approach contributes to the better understanding of innovation. It recommends that understanding and mapping agricultural needs and opportunities should extend beyond locations to include diversity in farmers' attitudes to innovation players and systems, in agroecological zones and enabling environments, and in different types of farmer. These differences are vitally important.

5.1 Introduction

Innovation by smallholder farmers has been defined as one of the key drivers for economic development and poverty alleviation in Sub-Saharan Africa (SSA), especially where the majority of the population rely on smallholder farming for their livelihoods (World Bank, 2012, Wiggins, 2014). The role of innovation support systems is critical for farmers in their innovation processes. In 2000s, Agricultural Innovation System (AIS) thinking emerged from criticisms of a linear model of innovation, with the acknowledgement that the innovation process is driven not only by research but rather by interactions among various organisations, enterprises and individuals (Hall et al., 2006b, Klerkx et al., 2012).

Smallholder farmers are becoming increasingly heterogeneous (Waters-Bayer et al., 2009, Jayne et al., 2010, Jayne et al., 2014), and the AISs for their innovations are diverse. However, mainstream AIS studies often neglect smallholder farmers as central actors within the system and view farmers as homogeneous actors (Assefa et al., 2009, Spielman et al., 2009a, Cardey and Garforth, 2013, Chowa et al., 2013). Moreover, many AIS studies rarely consider the inclusion of such diverse smallholders in innovation systems and processes.

While there have been numerous studies of “existing” AISs at sectoral or national levels, there is limited knowledge on AISs as “perceived” by diverse socioeconomic categories of farmers at the community level. The farmers’ utilisation is closely linked with their perceptions of and interactions with various AIS actors. Therefore, this paper aims to unpack AISs by analysing the different perceptions of AIS actors by smallholder farmers in different socioeconomic categories and different agroecological and enabling environments, and ways in which farmers’ innovations have been facilitated by the different actors. Consequently, the inclusion of different types of farmer in innovation processes was investigated. This study takes Uganda as a case study because of its large farming population and its rich experiences arising from the privatisation of the national extension system, known as National Agricultural Advisory Services (NAADS), beginning in 2001 (Mangheni and Mubangizi, 2007, Parkinson, 2009, Rwamigisa et al., 2011, Kjær and Joughin, 2012, Mockshell and Birner, 2015), and the restoration of the public extension system in 2014, followed by the reform of NAADS (UFAAS, 2014, MAAIF, 2016b, MAAIF, 2016a).

5.2 Smallholder Farmers' AISs as Knowledge and Information Sources

"Knowledge" and "information" are critical parts of farmers' innovation processes, as innovation results from the exchange of knowledge (Spielman et al., 2011) in the form of information. Those two terms should be distinguished: Engel (1997) defines "knowledge" as a personal asset consisting of an implicit concept or idea, and "information" as an explicit pattern produced by social actors and often imposed on a carrier such as radio or paper. However, both knowledge and information are within the scope of this study, as they can be transformed from one to another and are thus difficult to separate.

Previously, Transfer of Technology (ToT) has been a predominant approach since the 1960s, based on Rogers' linear model of innovation, whereby ready-made knowledge or innovations developed by research are disseminated to farmers (Rogers, 2003, Leeuwis, 2004, Klerkx et al., 2012). Nevertheless, alternative frameworks such as Agricultural Knowledge and Information Systems (AKIS) and subsequently Agricultural Innovation Systems (AIS) were developed, in accordance with drastic change in the understanding of "innovation", which is now defined as "the process by which individuals or organizations master and implement the design and production of goods and services that are new to them, irrespective of whether they are new to their competitors, their country, or the world" (World Bank, 2012). The AKIS framework addresses the necessity for strengthening the capacity of research, extension and education systems and the linkages among them (Assefa et al., 2009, Rivera, 2011). AIS emerged with the acknowledgement that innovation processes are not only driven by research and extension, but involve interactions among a much broader range of actors including public and private extension agents, research institutes and researchers, market traders, and farmers, while AKIS pays insufficient attention to the role of markets, the enabling institutional environment, and complex interactions between multiple players (Hall et al., 2006b).

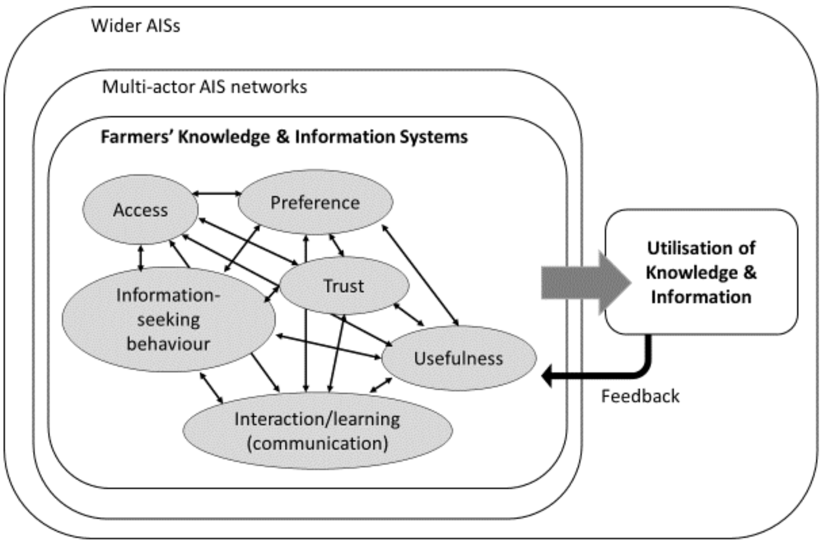
Nevertheless, recent studies reveal the limitations of the AIS approach and its application. The majority are related to the neglect of farmers, particularly smallholder farmers, as a key and central actor within the system. Much of the AIS literature presents innovation systems at project, sectoral and national levels only, based on what the system outside the smallholder farmers is or should be, leaving out the farmers' real experience and capacities (Garforth, 2013). Another criticism is that the focus of the AIS approach has been limited to commercially important high value agricultural commodities, with less emphasis on food security, natural environment and community empowerment, according to Assefa et al. (2009), who claim the AKIS perspective is more suitable for local innovation systems in SSA.

It has also been argued that the AIS approach needs to take account of the economic and social heterogeneity that is common to rural areas (Rajalahti et al., 2008, Klerkx et al., 2017), especially in SSA where much evidence suggests that the smallholder farmers have become increasingly heterogeneous in recent years (Jayne et al., 2010). The interests of poor smallholder farmers, in particular, are neglected or undermined. A number of studies indicate that innovation or technology adoption is significantly influenced by farmers' socioeconomic status, but their linear-model approach of such studies precludes identification of the AISs involved and understanding of how they are perceived and used by different farmers. Over the last two decades, "inclusive innovation", defined as "the inclusion within some aspect of innovation of groups who are currently marginalised" (Foster and Heeks, 2013), attracted scholarly attentions, due to experiences in developing countries where the economic growth and innovations arising from formal scientific and technological systems rarely addressed the needs of the poor (Santiago, 2014). Recent literature has increasingly promoted the application of the SoI (Systems of Innovation) framework to "inclusive innovation", to achieve a grounded and comprehensive understanding of innovation processes, actors and relations, and policy. However, there is still little literature applying this framework to inclusivity in the context of developing countries.

The farmers' innovation processes are profoundly influenced by knowledge and information systems, which are important components of AIS. Many studies illustrate the importance of social learning in innovation processes (Bandiera and Rasul, 2006, World Bank, 2007b, Darr and Pretzsch, 2008, Conley and Udry, 2010, Spielman et al., 2011, van Rijn et al., 2012, Maertens and Barrett, 2013, Matous et al., 2013, Ishikawa et al., 2014) with a focus on different variables, such as access to extension services, the novelty of knowledge for the community, membership of farmers' groups, and gender-related issues. However, there are fewer studies investigating farmers' cognitive perceptions and choices of knowledge and information sources. The actual use of information sources or channels is shaped by accessibility to AIS actors, but, more importantly, it is influenced by pro-activeness in farmers' information-seeking behaviour (Klerkx et al., 2017) and farmers' attitudes to and perceptions of information sources, especially their perceived reliability. A number of AIS studies with a "hard systems thinking" approach attempt to capture a static or infrastructural view of AIS as a snapshot, by using Social Network Analysis (SNA), for example Spielman et al. (2011) and Adolwa et al. (2016). This process, however, fails to provide insights on how the networks are constituted, or comprehension of "co-evolutionary processes" (Klerkx et al., 2012) such as the dynamics of users' preferences, the quality of interactions, differences between formal and informal institutions, and more especially the complexity of inclusivity.

Therefore, as conceptualised in Figure 5-1, actual utilisation of knowledge and information is affected by farmers' AISs as shaped by their access, preferences, trust, perceptions of usefulness, information-seeking behaviour and interaction or communication with the AIS actors. This is an iterative process whereby feedback of farmers' opinions after using the information is fed into the various components of the farmers' AISs.

Figure 5-1: Farmers' knowledge and information systems



Source: Author

Thus, this study aims to understand farmers' AISs as dynamic knowledge and information sources for different socioeconomic groups of farmers, focusing on the innovations identified as important by individual farmers, rather than predefined enterprises or technologies. In this study, innovations are defined as any new changes in farming practices for individual farmers, regardless of how novel the innovations are for other actors or in other locations. The guiding research questions for this research are as follows.

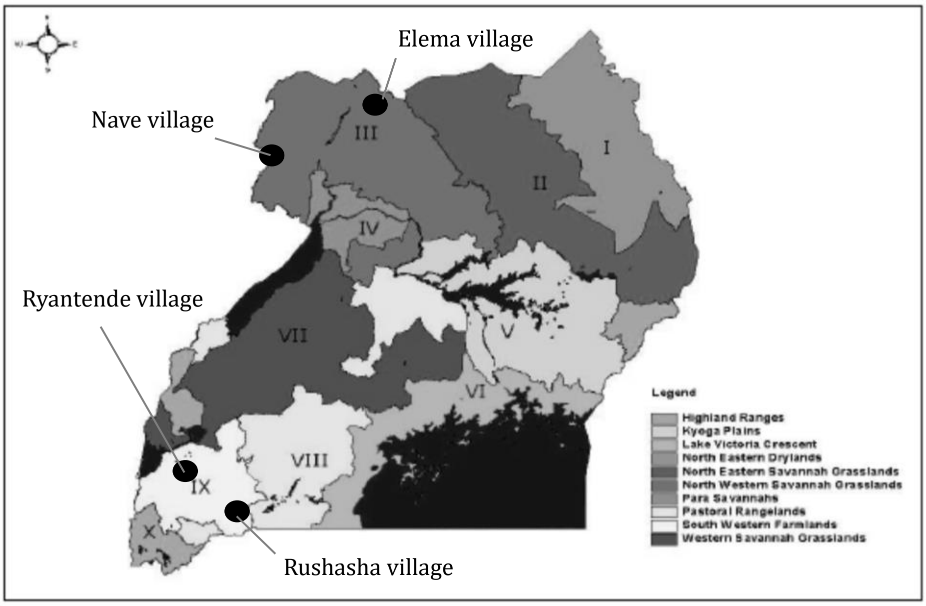
1. What kinds of AIS actors are being accessed and used by farmers with different socioeconomic characteristics and operating in contrasting enabling environments to make innovations?
2. How do the farmers' attitudes towards AIS actors affect their access to and actual utilisation of knowledge and information?

5.3 Methods

The study used mixed methods with an exploratory stage-by-stage reflexive approach, targeting four villages in Northern and Western regions in Uganda between November 2016 and February 2018. Using a set of criteria purposively chosen from the data from the Agriculture Census 2008/9 (UBOS, 2010), two districts, the most advantaged and disadvantaged districts in terms of favourability of innovation environments including abundance of various agricultural services, road conditions, market access, and agricultural potential, were selected from each of two different Agro-Ecological Zones (AEZ) in Uganda: the Arua and Adjumani districts in the North Western Savannah Grasslands AEZ (Northern

AEZ in short), and the Bushenyi and Isingiro districts in the South Western Farmlands AEZ (Western AEZ in short). Then field scoping visits were conducted in July 2016 to identify the most advantaged and disadvantaged villages from each district, by interviewing district agricultural officers, District Farmers' Associations (DFAs), sub-county extension officers and village chairpersons. Two villages, with the most advantaged and disadvantaged innovation environments, were eventually chosen from each AEZ, making four villages in total (see Table 5-1). This was to investigate the diversity of the farmers' knowledge and information systems in contrasting agroecologies and enabling environments.

Map 5-1: Research sites in agricultural production zones of Uganda



Source: MAAIF (2016a)

First, 12 key informants were chosen from each village, 6 male and 6 female. Each group was separately asked to create system maps of their farms for 20 years previously and for the present using flipcharts, and to compare the two maps in order to understand the changes that had occurred in the main livelihoods and farming activities. All the initially listed 470 farming households in the four villages were stratified in terms of wealth and gender. Wealth Ranking (WR) was used to stratify the households into three wealth categories, rich, moderate and poor, whereby key informants initially clarified a common understanding of wealth factors and categorised all the households into three wealth groups in each village. The ranking was triangulated by having three different pairs to categorise separately. The gender groups were divided into three categories: male household heads, their wives (including women in polygamous relationships), and single female household heads (widow, separated or divorced). As a result, nine socio-economic categories were identified.

In order to understand innovation processes in different AEZs and enabling environments and for different categories of farmers, 49 FGDs were conducted, attended by 166 participants in total who were selected randomly from the nine stratified socioeconomic categories in each village. The FGDs involved participants being asked about and discussing individual experiences of innovation processes regarding innovations introduced in the previous 10 years, subjective evaluation of the innovations introduced, changes in innovation types and processes, agricultural extension services received, livelihood portfolios, and crop and livestock types. The results were analysed using a matrix for the purpose of comparison among the different categories of farmers in different locations. The responses from the FGDs were used to formulate questions and answer options for structured questionnaires in the following phase.

Table 5-1: Research sites and characteristics

AEZ	North Western Savannah Grasslands (Northern AEZ)		South Western Farmlands (Western AEZ)	
District	Arua	Adjumani	Bushenyi	Isingiro
Village	Nave	Elema	Ryantende	Rushasha
Enabling Environment	Advantaged	Disadvantaged	Advantaged	Disadvantaged
Distance to District HQ, Market	Near	Distant	Near	Distant
AIS actors	Many actors nearby	Few actors distant	Many actors nearby	Few actors distant
No. of HHs (HHs interviewed)	116 Rich=20 Moderate=73 Poor=23	98 Rich=9 Moderate=75 Poor=14	135[8] Rich=16 Moderate=63 Poor=56	121 Rich=5 Moderate=34 Poor=82
Poverty likelihoods ($1.90/day 2011 PPP)	43.09%	55.02%	22.85%	43.01%
Land size (acre) of interviewed HHs by WR* wealth	Rich: 4.18 Moderate: 2.34 Poor: 2.54	Rich: 17.11 Moderate: 13.25 Poor: 6.60	Rich: 59.25 Moderate: 3.62 Poor: 1.07	Rich: 8.13 Moderate: 4.61 Poor: 0.72
Crops	Cassava, beans, groundnuts, maize, millet, sesame, bananas, pigeon peas, onions, tomatoes, amaranth	Sesame, maize, cassava, sweet potatoes, groundnuts, sorghum, millet, green gram, cowpeas, pigeon peas, okra, tomatoes, amaranth, eggplants	Tea, bananas, beans, maize, sweet potatoes, eggplants, cabbages	Bananas, maize, beans, potatoes, cassava, sweet potatoes, groundnuts, millet, peas, sorghum, eggplants, tomatoes, watermelon, sugarcane, coffee
Livestock	Cattle, goats, pigs, guinea pigs, chickens	Cattle, goats, chickens, pigs	Dairy cows, cattle, goats, pigs, chickens, rabbits	Cattle, goats, sheep, pigs, chickens
Ethnic group	Lugbara	Madi	Banyankore, Bakiga	Banyankore, Bakiga
No. of HH and farmers interviewed	108 HH 151 farmers	75 HH 103 farmers	68 HH 102 farmers	107 HH 175 farmers
No. of key innovations (max.3 per farmer)	191	124	210	328

Targeting all the household heads and their spouses engaged in farming and available during the survey period, a questionnaire survey was conducted by pre-trained

[8] The number of farming households in Ryantende village is 97.

enumerators who verbally asked questions in local languages and entered data onto smartphones using KoBo Toolbox[9]. As a result, 531 individual farmers from 358 households were interviewed. The collected data included access to information from various AIS actors both 10 years previously and at the time of the survey; attitudes (activeness in information-seeking, trust, and perceptions of usefulness) towards each AIS actor; and their key innovations introduced in the previous 10 years (each farmer was asked to identify up to three innovations) and their main information sources (multiple choices) for each innovation. With regards to the attitudes, Likert scales were used for measuring trust and usefulness (1-5; 1=not at all, 5=very much), as well as activeness in information-seeking (1=Not actively, 2= Sometimes actively, 3= Always actively). The questions on attitudes were asked only regarding AIS actors to which the respondent reportedly had access. Concerning the information sources for key innovations, 853 innovation cases were collected from 446 individual farmers out of the 531 farmers interviewed (see Table 5-1), while the rest of farmers had not made any innovations. Furthermore, the Poverty Probability Index (PPI)[10] extracted from basic household data was later used as an absolute wealth indicator to categorise farmers into three groups; PPI poor (probability under a poverty line[11] 68.3-96.7%), PPI moderate (29.7-54.5%), and PPI rich (0.0-26.0%).

Given the sampling methodology of the sites and villages for the study population, the hypothesis testing is to be interpreted as indicating relative importance rather than demonstrating generalisability. Using IBM SPSS software version 22, the results were analysed for the different socioeconomic categories of farmers in different locations, by

[9] https://www.kobotoolbox.org/
[10] https://www.povertyindex.org/
[11] $1.90 per day (2011 PPP)

running binary logistic regression tests, Chi-square tests for categorical data, and ANOVA pair-wise Mann-Whitney U-tests for ordinal data in order to compare different groups of farmers with different socioeconomic characteristics in different locations.

This was followed by the in-depth individual interviews of 90 farmers randomly selected from each of the nine socioeconomic categories by wealth and gender. These explored in more detail the AIS actors that farmers usually have access to, frequency and type of interactions, changes that had occurred in the previous 10 years, information seeking behaviour, preferences for AIS actors and reasons for these. The interviews were audio-recorded and fully transcribed before being coded and analysed.

5.4 Results

5.4.1 Smallholder Farmers' Innovations

The innovations identified through the questionnaire survey (853 innovation cases) are highly diverse, ranging from soil management practices, introduction of new crops or animals and new varieties of crops or animals, to land preparation and planting methods, depending on the different AEZs, enabling environments, and socioeconomic characteristics of the farmers. For example, in the Northern AEZ, more farmers had engaged in the innovations related to land preparation and planting methods (e.g. line-planting, inter-cropping, spacing) (N-Adv.-29.7%, N-Disadv-28.8%) and to the expansion of planted areas (e.g. large-scale farming) (N-Adv.-25.2%, N-Disadv.-23.8%), compared to the Western AEZ (land preparation: W-Adv.-14.7%, W-Disadv.-17.5%, $p=0.013$; expansion: W-Adv.-5.3%, W-Disadv.-10.0%, $p<0.001$). On the other hand, fewer farmers in the Northern AEZ (N-Adv.-

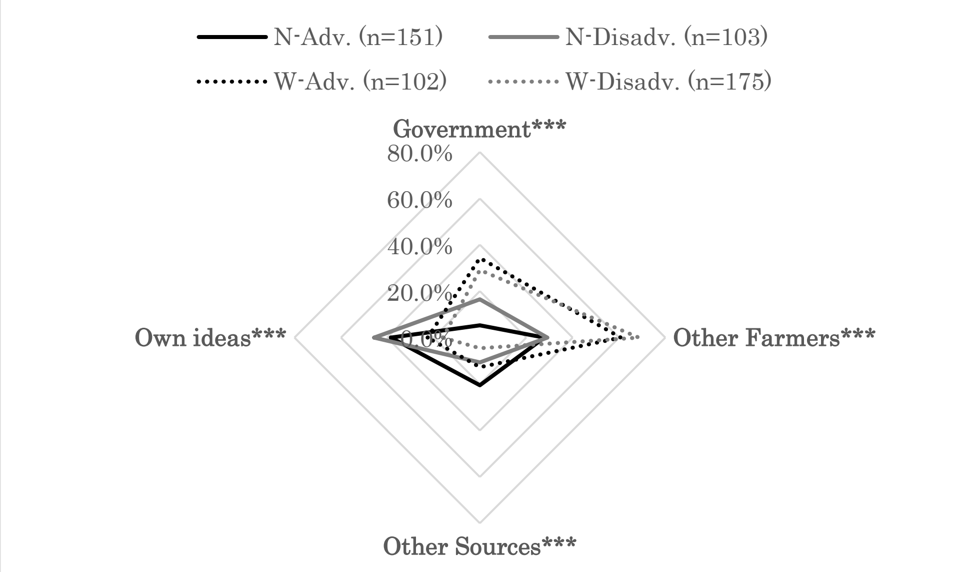
8.1%, N-Disadv.-0.0%) made innovations related to soil management (e.g. manure, mulching, compost, trenches), compared to the farmers in the Western AEZ (W-Adv.-49.5%, W-Disadv.-35.0%, $p<0.001$). This could be the reflection of the differences in biophysical characteristics between those two AEZs: for example, land abundance in Northern AEZ and land scarcity in Western AEZ; different priorities and practices would be the consequence. Regarding the differences in enabling environments, more farmers in advantaged environments made innovations related to pests and diseases affecting crops (e.g. pesticide application) (N-Adv.-11.7%, W-Adv.-22.1%) and livestock (N-Adv.-24.3%, W-Adv.-36.8%), compared to farmers in disadvantaged enabling environment (pests: N-Disadv.-2.5%, W-Disadv.-6.3%, $p<0.001$; livestock: N-Disadv.-8.8%, W-Disadv.-8.8%, $p<0.001$). Regarding the wealth differences (using PPI as an indicator to compare across all the areas), the rich farmers (24.1%) made more livestock-related innovations, compared to the moderate (17.0%) and poor farmers (13.0%, $p=0.056$). The richer farmers made capital-intensive innovations, such as the use of irrigation, ox-ploughs, grinding mills, fertilisers and pesticides. Clearly, wealthier farmers make more innovations motivated by commercialisation, such as using irrigation pumps to adjust crops' planting seasons, in order to achieve better market prices. In the disadvantaged village of the Western region, innovations concerning Irish potatoes and beans were found to be common among poor farmers, because they are short-term annual crops which can be grown on seasonally rented land and are consequently suitable for an area of land shortage. Thus, innovations were found to be profoundly affected by the AEZs and enabling environments, as well as farmers' socio-economic status.

5.4.2 Knowledge and Information Sources Actually Utilised in Key Innovations

The study investigated which AIS actors' information was actually used by the farmers. For all the 853 key innovation cases, the farmers were asked which information sources they had mainly used. Almost half of the respondents (47.8%) reported that at least one of their innovations was sourced from other farmers (both within and outside the village and family), 20.9% of them reported having used information from the government (district, sub-county, NAADS, research institutes, and government projects) and 11.9% of them used other sources (NGO, DFA, agro-input shop, market, factory, school, local leaders, farmer groups and mass media). 29.4% of farmers counted on their own ideas (i.e. without using specific external information sources).

The study then investigated the differences between the information sources for different locations (agroecology and enabling environments) and farmers with different socioeconomic characteristics. Large differences were found, especially between different AEZs, which were even larger than the enabling environmental differences (Figure 5-2). The farmers in the Northern AEZ counted on "own ideas" more than the Western AEZ (N-41.3%, W-18.4%, $p<0.001$), while the Western AEZ counted on "government information" and "other farmers' information" more than the Northern AEZ (government: N-9.8%, W-31.0%; other farmers: N-28.3%, W-65.7%, $p<0.001$ for both). Regarding the information from "other sources", the enabling environment seems to be a significant factor: a higher proportion of farmers in the advantaged locations (17.4%) had used the information, compared to the disadvantaged locations (6.8%, $p<0.001$).

Figure 5-2: Information sources for farmers' innovations in different locations



-*p<0.1, **p<0.05, ***p<0.01 for Chi-square tests comparing four villages
-N-Adv.=Northern advantaged village, N-Disadv.=Northern disadvantaged village, W-Adv.=Western advantaged village, W-Disadv.=Western disadvantaged village
"Government" includes district, sub-county, NAADS, research institute, and government projects. "Other farmers" include farmers out of village, farmers within village, and family. "Other sources" include NGO, DFA, agro-input shops, traders, market, factory, school, local leaders, farmers' group, and mass media.

Then, a binary logistic regression analysis was run to identify associations between the farmers' attributes and information sources, as well as the AEZ and enabling environment[12]. As Table 5-2 shows, farmers' utilisation of "government information" is positively related to the wealth of the farmers (measured by PPI[13]) and if they are in the Western AEZ, at statistically significant levels. The village-disaggregated data also supports the agroecological differences[14]. Regarding utilisation of "other farmers' information", a positive association is seen only for the Western AEZ, while no significant association was found for

[12] It must be noted that due to the nature of this study, which has been designed to compare the four contrasting locations, the purpose of this analysis is not to generalise the findings by applying them to wider areas, but to explore the overall trends across the locations and then compare the differences between the locations.
[13] PPI was used here, instead of WR, in order to compare across all villages.
[14] The association with PPI wealth was not necessarily supported by the village-based data, despite the existence of a pattern (this will be further analysed with WR below). Additionally, the village-based data revealed that in the Northern advantaged village total education years and land size are significant factors for using "government information".

farmers' characteristics [15]. The utilisation of "other sources" is positively related to membership of farmers' groups: this is mostly supported by the village-based data from all agroecological and enabling locations[16]. Furthermore, farmers' reliance on their "own ideas" for their major innovations increases if they are in the Northern AEZ[17]. The agroecological differences could occur because extensification does not require external information in the land abundant Northern AEZ.

These regression results clearly highlight the AEZ as the most influential factor except use of "other sources' information", but the farmers' characteristics are also major factors influencing the utilisation of the information sources: in particular, wealth influences the utilisation of "government information", and farmers' group membership the use of "other sources". Nonetheless, the binary logistic analysis unexpectedly did not find any statistically significant associations between other variables (e.g. gender, age, literacy, household size) and information sources.

Table 5-2: Binary logistic regression analysis on whether information sources were utilised

	Government			Other Farmers			Other Sources			Own Ideas		
	B	S.E.	exp(b)	B	S.E.	exp(b)	b	S.E.	exp(b)	B	S.E.	exp(b)
AEZ (Western)	**1.38**	**0.32*** **	**3.98**	**1.43**	**0.24*** **	**4.19**	-0.76	0.41*	0.47	**-1.13**	**0.26*** **	**0.32**
EE (Disadv.)	0.45	0.28	1.57	0.27	0.23	1.31	-0.69	0.39*	0.50	-0.10	0.24	0.91
PPI Poor												
PPI Moderate	0.76	0.36**	2.14	-0.06	0.26	0.94	0.18	0.44	1.20	0.28	0.27	1.33
PPI Rich	1.02	0.42**	2.77	0.09	0.31	1.10	0.85	0.48*	2.33	0.32	0.33	1.37
Single Men												
Married Men	-0.01	0.59	0.99	0.27	0.48	1.31	0.72	0.86	2.05	0.02	0.47	1.02
Single Women	0.31	0.61	1.36	0.13	0.50	1.14	0.06	0.94	1.06	0.11	0.50	1.12
Married Women	-0.46	0.61	0.63	0.35	0.49	1.41	0.06	0.93	1.06	-0.13	0.50	0.88

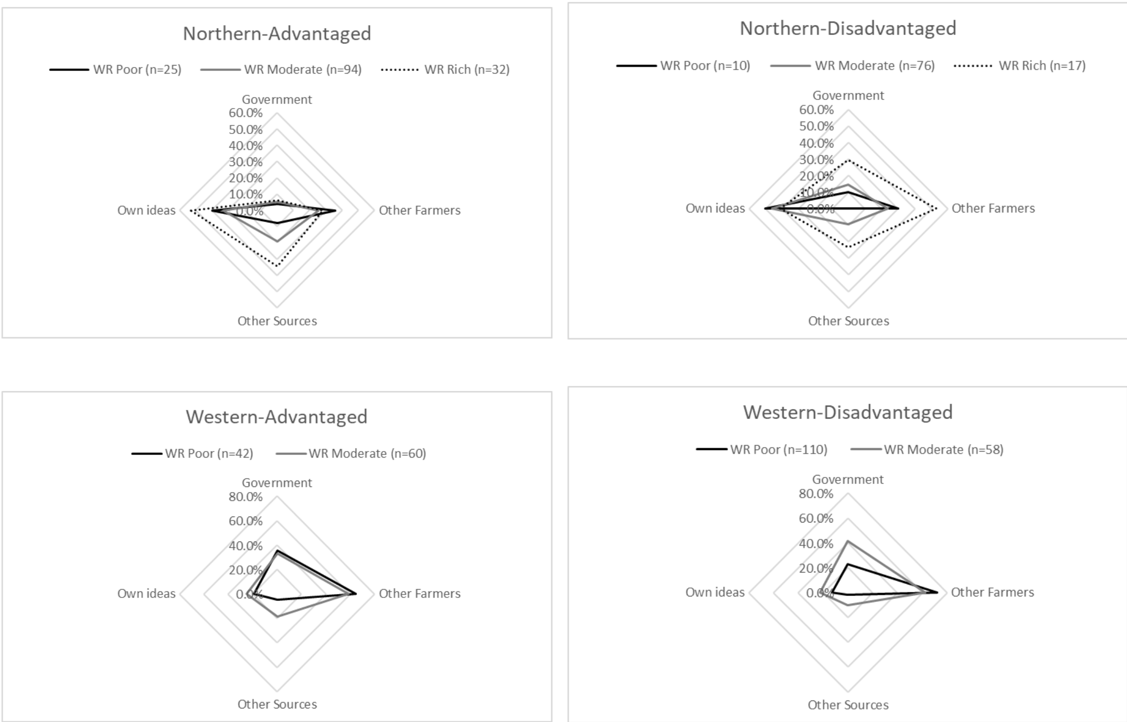
[15] Noteworthily, the village-based data suggests other significant factors: wealth and migrant status in the Northern disadvantaged village, and household size in the Western disadvantaged village.
[16] Village-disaggregated data supported migrant status only for the Western advantaged village, and wealth and literacy were found to be significant in the Western disadvantaged village.
[17] The agroecological differences were confirmed by the village-based data, although the association with land area was not supported.

Age	0.02	0.02	1.02	-0.01	0.02	0.99	0.03	0.02	1.03	-0.02	0.02	0.98
Education Years	0.03	0.05	1.03	-0.05	0.04	0.95	0.05	0.06	1.05	-0.01	0.04	0.99
Literacy	-0.09	0.36	0.92	0.41	0.29	1.51	0.10	0.47	1.10	0.15	0.31	1.16
Farming Years	-0.01	0.02	0.99	0.00	0.02	1.00	-0.02	0.02	0.98	0.02	0.02	1.02
FG membership	0.32	0.36	1.38	-0.05	0.28	0.95	**1.69**	**0.34*****	**5.41**	-0.32	0.28	0.73
Non-migrant	0.07	0.27	1.07	-0.13	0.23	0.87	-0.83	0.42**	0.44	0.08	0.25	1.08
HH size	0.08	0.06	1.08	0.01	0.05	1.01	0.12	0.08	1.13	0.08	0.05	1.09
Land size	0.02	0.01*	1.02	0.00	0.01	1.00	0.00	0.01	1.00	0.02	0.01**	1.02
Constant	-4.54	0.92	0.01	-1.13	0.70	0.32	-3.97	1.28	0.02	-0.61	0.72	0.54
-2 Log likelihood	477.37			652.68			311.64			595.86		
Cox and Snell R2	0.12			0.14			0.13			0.09		
Nagelkerke R2	0.19			0.19			0.26			0.12		

-*p<0.1, **p<0.05, ***p<0.01
-EE= Enabling Environment
-"Other Sources" include "farmers' groups", which could be predicted as the reason that "FG membership" increases the chance of using "other sources". Therefore, another analysis was run for the other sources excluding farmers' groups. As a result, it was found that FG membership still showed the same trend with a p-value of 0.000.

Next, the relationship between utilisation of information sources and wealth was further investigated in each village (Figure 5-3), by using WR which is a more accurate indicator than PPI when comparing the wealth within the particular village. As a result, it was found that in disadvantaged villages, richer farmers have a higher usage of "government information" than poorer farmers (N-Disadv.: Poor-10.0%, Moderate-14.5%, Rich 29.4%, no significance; W-Disadv.: Poor-22.7%, Moderate-41.4%, Rich 28.6%, p=0.041), which is supported by a village-based binary logistic regression analysis, at least for the Western disadvantaged village. In addition, it is a common feature for all the four villages that richer farmers have higher usage of "other sources" (N-Adv.-poor-8.0%, moderate-19.1%, rich-34.4%, p=0.043; N-Disadv.-0.0%, 63.6%, 36.4%, p=0.043; W-Adv.-4.8%, 18.3%, p=0.043; W-Disadv.-1.8%, 10.3%, 0.0%, p=0.035), which is also mostly supported by the village-based regression analysis.

Figure 5-3: Information sources for farmers' innovations by different wealth levels in different villages



In the Western-advantaged village, there is no data obtained from WR Rich farmers. In the Western-disadvantaged village, the sample size is too small for the WR Rich (p=7), hence the removal of the data from the figure.

5.4.3 Access to Knowledge and Information Sources

5.4.3.1 Trends in Access

The individual farmers were asked whether they had access to information from various AIS actors 10 years previously and at the time of the survey (Yes=1, No=0), no matter whether they used the information for their innovations. Regarding the means of access at the time of the survey, neighbours, mass media, and local leaders were accessed by the farmers at the highest rates, while research institutes, schools and NGOs at the lowest rates (Table 5-3). Comparison between 10 years previously and the present reveals a trend for all categories of farmers to gain more access to most of the AIS actors. The most prominent rate of increase appears for DFA and market actors such as traders, agro-input dealers and markets, although the access rates remain lower than for other AIS actors. This result might be a reflection of the recent commercialisation of food crops to respond to the growing urban demands, as reported during the in-depth interviews.

Table 5-3: Farmers who have access to various AIS actors' information

	Access (2008) (n=531)	Access (2017) (n=531)	Increase Rate
DFA	5.1%	10.2%	100.0%
Traders	11.1%	19.4%	74.6%
Agro-input Shops	9.0%	14.9%	64.6%
Market	18.1%	26.9%	49.0%
Farmers' Group	9.8%	13.6%	38.5%
Neighbours	39.2%	52.2%	33.2%
Model Farmers	12.1%	15.6%	29.7%
District	9.0%	11.1%	22.9%
Private Extension	5.5%	6.6%	20.7%
Local Leaders	26.0%	31.1%	19.6%
Mass media	36.5%	42.6%	16.5%
Sub-county	18.3%	19.4%	6.2%
NGO	4.3%	2.8%	-34.8%
Research Institute	2.8%	1.5%	-46.7%
School	5.1%	2.4%	-51.9%

The binary logistic regression analysis (Table 5-4) suggests that both environmental factors (AEZ and enabling environment) and farmers' attributes are related to the accessibility of different information sources. Access to "government information" increases if the farmers are in Northern AEZ and disadvantaged locations (N-Adv.-21.2%, N-Disadv.-42.7%, W-Adv.-16.7%, W-Disadv.-20.6%), and decreases if they are women and migrant[18]. The access to "other farmers" increases if the farmers are in the Western AEZ, are not migrant, and have a

[18] The village-disaggregated data did not confirm the associations with age and household size, while the gender and migrant status had some validity. Men have higher access to "government information" than women in three of the four villages. Non-migrants had a higher percentage of access to "government information" in all four villages, although the statistical significance was confirmed for only one of the villages. In addition, the village-based regression analysis suggests that, in both advantaged villages, farmers' group membership increases access to government information, and in the Northern advantaged village, larger land size also matters.

larger land area[19]. With regard to access to "other sources", there is no significant association with locations, but it increases with total education years, farmers' group membership, and the farmer's household size[20].

Table 5-4: Binary logistic regression analysis predicting whether farmers have access to information sources

	Government			Other farmers			Other sources		
	b	S.E.	exp(b)	b	S.E.	exp(b)	b	S.E.	exp(b)
AEZ Western	**-0.76**	**0.28***	**0.47**	**1.35**	**0.25***	**3.87**	0.39	0.26	1.48
EE Disadv.	**1.09**	**0.27***	**2.97**	0.23	0.23	1.26	-0.06	0.24	0.94
PPI Poor									
PPI Moderate	0.34	0.31	1.41	-0.68	0.26***	0.51	0.23	0.27	1.26
PPI Rich	0.70	0.36*	2.02	-0.21	0.31	0.81	0.42	0.33	1.52
Single Men									
Married Men	**-1.10**	**0.48****	**0.33**	-0.21	0.44	0.81	0.36	0.45	1.43
Single Women	**-0.95**	**0.52***	**0.39**	0.13	0.47	1.14	0.27	0.47	1.30
Married Women	**-0.95**	**0.50***	**0.39**	0.22	0.46	1.25	-0.14	0.47	0.87
Age	0.04	0.02**	1.04	-0.01	0.02	0.99	-0.02	0.02	0.98
Education Years	0.08	0.05*	1.09	0.03	0.04	1.03	**0.10**	**0.05****	**1.10**
Literacy	-0.09	0.34	0.92	0.15	0.29	1.16	-0.42	0.31	0.66
Farming Years	-0.03	0.02*	0.97	0.01	0.02	1.01	0.01	0.02	1.01
FG membership	0.39	0.29	1.47	0.27	0.27	1.31	**0.74**	**0.32****	**2.10**
Non-migrant	**0.61**	**0.26****	**1.84**	**0.46**	**0.23****	**1.59**	0.09	0.24	1.10
HH size	0.13	0.06**	1.13	0.05	0.05	1.05	**0.15**	**0.05***	**1.16**
Land size	0.01	0.01	1.01	**0.03**	**0.01****	**1.03**	0.01	0.01	1.01
Constant	-3.06	0.78	0.05	-1.03	0.67	0.36	-0.35	0.69	0.71
-2 Log likelihood	525.6			658.94			606.69		
Cox and Snell R2	0.11			0.11			0.07		
Nagelkerke R2	0.17			0.15			0.09		

-*p<0.1, **p<0.05, ***p<0.01

-EE= Enabling Environment

-"Government" includes district, sub-county and research institute. "Other farmers" include model farmers and neighbours. "Other sources" include private extension, agro-input shops, markets, traders, school, DFA, local leaders, NGOs, farmers' groups, and mass media.

[19] The village-disaggregated data confirmed the agroecological differences (N-Adv.-38.4%, N-Disadv.-57.3%, W-Adv.-72.5%, W-Disadv.-58.2%, p<0.001), and non-migrant status and land size with recognisable patterns (of no statistical significance), but wealth differences were not consistent. The village-based regression analysis implies that gender, literacy, and non-migrant status in the Northern advantaged village, and literacy in the Western advantaged village, are important for those who seek to gain information from other farmers.

[20] The village-based data supported the importance of farmers' group membership for having higher access to "other sources' information" in all the four villages, even though only one village produced statistically significant results. Also, the patterns associating more total education years and larger household size with more access to "other sources' information" were found to be valid for all the four villages. In addition, land area was found to be significant for the Northern advantaged village, and gender for the Northern disadvantaged village.

5.4.3.2 Relationships between Access to and Actual Utilisation of Information

Access to information is obviously a crucial pre-condition to the actual utilisation of the knowledge, as confirmed by the binary logistic regression analysis.[21] However, access to information does not automatically lead to its utilisation. As seen in Figure 5-4, there are gaps between access and use, notably for “other sources”. Moreover, the summary of the results of the regression analysis (Table 5-5) shows the gaps in the factors which are found to be significantly associated with utilisation (Table 5-2) and access (Table 5-4), which are then confirmed by the village-disaggregated data. This shows that the farmers in the Northern AEZ and in the disadvantaged enabling environment have higher access to the “government information”, but those in the Western AEZ used the “government information” more frequently. Moreover, various farmers’ characteristics (e.g. gender, migrant status) increase the access to the “government information”, but only wealth is found to be a significant factor in utilisation. Nonetheless, regarding the information from “other farmers”, the farmers in the Western AEZ have both higher access and utilisation, compared to the Northern AEZ. For this type of information source, access increases with non-migrant status and land area, but such characteristics do not affect utilisation. For “other sources”, farmers’ group membership was found to be a commonly crucial factor for both access and utilisation, but education years and household size strongly affect access to the information source, and wealth is important for utilisation of the other sources’ information. As the gap between access and use is particularly huge at this point, wealth must be the important factor.

[21]It has to be noted that the information was utilised between 2008 and 2017, and the access reported was gained e in 2008 and 2017. This ambiguity is the reason why data from both years is considered here.

Figure 5-4: Percentages of farmers who have/had access to and used information sources

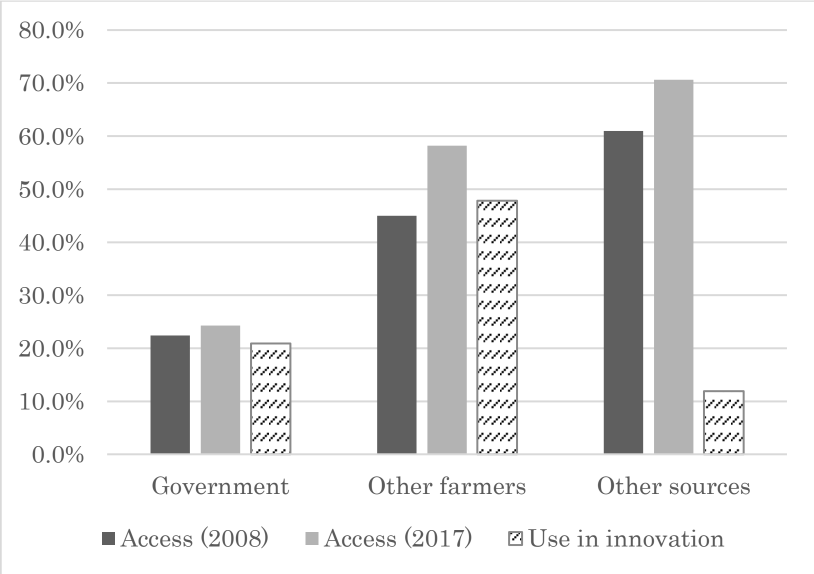


Table 5-5: Comparison of the results of binary regression analysis (utilisation and access)

Information Source	Utilisation (from Table 5-2)	Access (2017) (from Table 5-4)	Access (2008)
Government	WR Richer+ (in disadv.)	Single men>Married men** Migrant**-	FG membership***+ WR Richer+
	Western AEZ***+	Northern AEZ***+ EE disadvantage***+	N/A
Other farmers	N/A	Migrant**- Land size**+	FG membership***+ HH size**+
	Western AEZ***+	Western AEZ***+	Western AEZ***+
Other sources	FG membership***+ WR Richer+	FG membership**+ Education year**+ HH size***+	WR Rich+ Farming year***+ HH size***+

5.4.4 Farmers' Attitudes and Preferences concerning AIS Actors

The previous section highlighted the importance of access to information sources in order for the information to be utilised. Nevertheless, it must be noted that farmers are selective, hence the farmers' attitudes and preferences to AIS actors affect access and utilisation. As Table 5-6 shows, farmers most actively seek for information from research institutes and model farmers, while they are passive in relation to sub-county, district and NGO sources. The farmers trust information from NGOs, research institutes and model farmers the most, and are least trustful of traders, market actors and mass media. The actors who provide the most useful information, from the farmers' perspectives, are agro-input shops and farmers' groups, while the least useful information is provided by research institutes. The following sections will explore the farmers' attitudes to each type of actor, focusing on the farmers' various characteristics and environmental circumstances.

Table 5-6: Farmers' attitudes towards AIS actor's information

		n	Activeness (0-2)	Trust (1-5)	Usefulness (1-5)
Government	District	59	0.93	4.14	3.59
	Sub-county	103	0.80	4.21	3.89
	Research Institute	8	1.38	4.63	3.38
Other farmers	Model farmers	83	1.35	4.48	3.83
	Neighbours	277	1.11	4.04	3.81
Other sources	Private Extension	35	0.97	4.31	3.80
	Agro-input shop	79	1.09	4.41	4.06
	Market	143	1.05	3.80	3.52
	Traders	103	0.99	3.75	3.71
	School	13	1.23	3.92	3.54
	DFA	54	1.00	4.46	3.87
	Local leaders	165	1.08	4.00	3.75
	NGO	15	0.93	4.67	3.60
	Farmer group	72	1.17	4.43	3.96
	Mass-media (Radio)	226	0.99	3.98	3.58

-Only those who reported having access to each actor gave further information about their attitudes (pro-activeness, trust, and usefulness).
-This analysis used Likert scales as a continuous variable instead of a categorical variable, following the examples of other studies (Knudsen and Roman, 2015, Lalani et al., 2016).

5.4.4.1 Government Information

Government actors (mainly, the NAADS Programme) contribute to farmers' major innovations as their information sources (20.9% of farmers), as mentioned above. Government information (district, sub-county) is fairly well trusted by farmers in comparison with private actors (Table 5-6). Farmers learned about a broad range of innovations from this programme, including new varieties of cassava, beans, maize, and fruit trees, the introduction of new crops and animals, and control of pests and diseases such as Banana Bacteria Wilt (BBW), through community gatherings, group demonstrations and regular field-based training. According to the in-depth interviews, some farmers value government sources because the extension staff are the most educated: they are trained in agriculture and provide information about pests and diseases which farmers cannot acquire just by observing other farmers. Some rich farmers even pay for their technical consultation. The farmers appreciate the fact that the government extension officers also play a linking role in connecting farmers to other AIS actors.

Interestingly, pro-activeness in information-seeking, especially from sub-county extension staff, scored the lowest (0.80) among all AIS actors (Table 5-6). In-depth interviews with farmers equally revealed that the farmers do not normally seek information from the government. The reasons frequently mentioned include lack of time to visit them due to the need to do casual labour (for poor male farmers) and overwhelming work at their own farms (for female household heads), as well as the distance to the office and unavailability of the officers. Furthermore, farmers perceived that officers had no time for poor smallholder farmers, but only for rich large-scale farmers who grew cash crops such as tea. Farmers wait for government extension staff, due to their perception that extension staff are not meant to be visited but to visit the farmers, and even that only when projects are running, while the staff believe in a demand-driven approach whereby farmers should come to ask for their advice.

The wealth disaggregated data suggests that the poorer the farmers are, the less active they are in information-seeking (district: poor-0.71, moderate-1.00, rich-1.00; sub-county: 0.76, 0.80, 0.80), and the less they trust government information (district: 3.86, 4.21, 4.24; sub-county: 4.05, 4.17, 4.34), despite the lack of statistical significance. Furthermore, the poor and moderate farmers do not share the rich farmer's high opinion of the utility of government information. This finding could explain the lower utilisation of government information by the poorer farmers, as shown in Table 5-2. The in-depth interviews also support the poor farmers' passiveness. The poorer farmers in the Western advantaged village laid stress on their belief that they could not seek for advice from the government extension staff, since they did not have enough land for demonstrations, and they believed that government officers were not interested in subsistence farmers, who did not grow export crops.

The gender difference in attitudes towards government information is consistent with the gender pattern of access to their information, according to the binary regression analysis (Table 5-4) and the result of a chi-square test for the rate of those who have access to it (Single Men-45.2%, Married Men-28.2%, Single Women-19.1%, Married Women-20.2%, p=0.007). Resonating with the low rate of married women's innovations which actually used government information (SM-16.1%, MM-26.1%, SW-24.7%, MW-15.7%), women, particularly married women, appear to be less proactive in information-seeking than men (district: 1.10, 1.04, 0.75, 0.71; sub-county: 0.90, 0.91, 0.75, 0.65), and women trust government information less strongly than men (district: 4.40, 4.26, 3.88, 3.86). The pair-wise Mann-Whitney U-tests revealed that married women (3.59) consider sub-county information less useful compared to married men (4.02, p=0.042) and single women (4.42, p=0.011). Findings from the in-depth interviews hinted that married women fear moving out of the community to seek advice from the outside world. Women expressed their lack of confidence in communicating with government extension officers, who are predominantly male. It is also evident from in-depth interviews that women consider belonging to farmers' groups is the way to access external actors such as the government and NGOs (e.g. N14), but many poor female farmers said they found it difficult to participate in group activities, due to lack of time and money for membership fees.

'Since I have not joined any farmers' group, I fear to go to the sub-county. It's because no one is leading women to the government or the sub-county. Yes, majority of them are men. I first want to join a farmers' group, then later I will try to go.' (N14/Moderate married woman in advantaged village, Northern AEZ)

Regarding the differences in locations, the farmers (those who already have access) in the advantaged enabling environment have stronger "trust" in government information (district: N-Adv. 4.50, N-Disadv. 3.88, W-Adv. 4.33, W-Disadv. 3.67, p=0.001; sub-county: N-Adv. 4.27, N-Disadv. 3.97, W-Adv. 4.53, W-Disadv. 4.32), but they have less access to it and utilise it less than farmers living in disadvantaged areas. This signifies that the farmers in the advantaged locations are not necessarily benefitted by the enabling environment (e.g. closer to the district HQ). Furthermore, the farmers in the Northern AEZ utilise government information less than those in the Western AEZ (Northern-9.8%, Western-31.0%, p<0.001), despite having higher access to it (Northern-29.9%, Western-19.1%, p=0.004). This could be explained by the low level of "usefulness", at least for the Northern advantaged village (district: N-Adv. 3.13, N-Disadv. 3.96, W-Adv. 4.33, W-Disadv. 3.50, p=0.094; sub-county: 3.07, 4.00, 4.33, 3.94; p=0.001). On the other hand, the farmers in the Western AEZ use government information more than those in the Northern AEZ, despite the lower access. This may be attributed to the social learning effect, which may be stronger in the more populated Western AEZ.

5.4.4.2 Other Farmers' Information

Information from other farmers plays the most significant roles in the key innovations reported by farmers. As mentioned above, 47.8% of farmers sourced information from other farmers (farmers out of village, farmers within village, and family) for their major innovations. The pro-activeness in information-seeking from model farmers is one of the highest among all AIS actors, as well as the trust level (Table 5-6).

The in-depth interviews revealed that farmers select particular model farmers (often used to mean commercial farmers) after careful observation. This is reflected in the differences in attitude indicators between model farmers and neighbours (Table 5-6). The criteria used by farmers to select particular farmers for innovation information include observed performance (yield, best plantations), geographical closeness, access to networks (whether the person received training from other organisations), frequency of information-sharing, follow-up and personal traits (openness, willingness to give out information, availability) (e.g. E20). Many farmers said that they valued advice from particular farmers whose personalities they had already assessed and come to trust. Moreover, poor farmers learn when working as casual labourers for model farmers.

'Whenever I go to them, they are always open to me and share knowledge freely. … If Mr. A identifies you as a serious farmer, during his free time he also comes and advises me on farming.' (E20/Rich married woman in disadvantaged village, Northern AEZ)

Regarding the wealth disaggregated data, there was no explicit difference in wealth in terms of farmers' attitude towards other farmers' information, although the wealthier farmers have less access to the other farmers' information (Table 5-4). In the in-depth interview, the rich farmers declared that they did not have much to learn from their neighbours, as they themselves were more advanced.

Consistently with the finding that married women have the highest level of use of information from other farmers (51.6% compared to SM-32.3%, MM-48.4%, SW-42.7%, no statistical significance), married female farmers (4.12) have the highest trust level towards neighbours among gender categories (compare with SM-3.75, MM-4.03, SW-3.91, no statistical significance). Innovations are sometimes found to be transferred through daily reciprocal food and seed exchanges within the community, which are mostly conducted by women (e.g. Ru11). This may explain the women's strong inclination to receive innovation information from neighbours.

'Yes fellow women, for planting Irish potatoes, sweet potatoes and cassava. Here the majority of men don't know how to plant these crops and these crops are taken for women's crops. I can move around their gardens and I ask them about sweet potato vines they have planted… We freely share as women.' (Ru11/Poor married woman in disadvantaged village, Western AEZ)

According to the findings from stratified FGDs and in-depth interviews, the innovations made by women often relied on information from family members such as parents and husbands, in contrast to innovations made by men. Female farmers learn from parents when helping them in their gardens. The women, mainly poor female farmers, who regard their parents as the best advisors in farming practices also noted that they are close to them and that they provide psychological encouragement (e.g. Ru21).

'I was working with them (parents) in gardens (when learning about mulching for bananas), I could participate…They are very close to me and I can freely consult them in my frequent visits to them.' (Ru21/Poor female household-head in disadvantaged village, Western AEZ)

In regard to the locational differences, the farmers' activeness in information-seeking and trust of both model farmers (activeness: adv.-1.49, disadv.-1.04; trust: adv.-4.68, disadv.-4.04, $p<0.001$ for both) and neighbours (activeness: adv.-1.23, disadv.-1.04; trust: adv.-4.36, disadv.-3.84, $p<0.001$ for both) in the advantaged areas are higher than those in the disadvantaged areas. Regarding model farmers, the higher level of trust and information-seeking seems to be consistent with the higher access to their information in the advantaged villages (adv.-22.5%, disadv.-9.4%, $p<0.001$). This could be because there are more model farmers available in the advantageous enabling environment. For agroecological zonal differences, the Western AEZ has higher access and use of other farmers' information than the Northern AEZ, despite lower activeness (model farmers: N-1.50, W-1.00; neighbours: N-1.23, W-1.05) and trust (model farmers: N-4.69, W-4.00; neighbours: N-4.19, W-3.96).

While the results clearly show the importance of other farmers in facilitating innovation processes, there are, however, some factors that block social learning within communities. One of the hindering factors is the "social class gap" that was strongly pronounced in the advantaged Western village which is characterised by a high level of socioeconomic heterogeneity. Poor and moderate farmers are afraid to seek information from rich model farmers in the village, even by observation (e.g. Ry15). No poor farmer in the advantaged Western village (0.0%) reported having access to model farmers, whilst in contrast poor farmers in other villages have much higher levels of access (40.0% in the advantaged Northern village, 20.0% in the disadvantaged Northern village, and 7.3% in the disadvantaged Western village). This is also consistent with the poor farmers' lower activeness in information-seeking from model farmers (poor-1.23) than other wealth categories of farmers (moderate-1.45, rich-1.36). In addition, it was reported that practices learned from model farmers can hardly be implemented due to lack of resources (e.g. Ry13).

'Model farmers do not allow you to go to their gardens. If Mr. T finds you observing his garden, he will arrest you as a thief.' (Ry15/Poor female household-head in advantaged village, Western AEZ)

'Even if I learnt knowledge from them (model farmers), nowhere to plant them, because I have no land.' (Ry13/Poor female household-head in advantaged village, Western AEZ)

5.4.4.3 Private Actors' Information

Despite relatively moderate levels of access to private sector actors (agro-input shops-14.9%, market-26.9%, traders-19.4%, mass media-42.6%), the actual utilisation of major innovations derived from those sources is extremely low (agro-input shops-0.8%, market-0.6%, traders-0.2%, mass media-3.0%). This is consistent with the results on the respondents' trust of these actors compared with other AIS actors (Table 5-6). In-depth interviews revealed that farmers carefully interpret the information given by traders who might give them false information, although they value them for giving them loans that can be paid back with produce.

'I heard that masava (new variety of beans) has high prices in the market, but I wanted to confirm it myself….. Someone may give you false information but when you take them there you find things are different.' (Ru6/Moderate married man in disadvantaged village, Western region)

Concerning wealth differences, ANOVA tests did not find statistically significant differences, but pair-wise Mann-Whitney U-tests found that for market vendors, the rich farmers (1.18) are more active information-seekers than the poor (1.00) and the moderate (1.00, no statistical significance), while for traders, the poor (1.17) are more active than the moderate (0.92, $p=0.014$) and the rich (0.97, $p=0.033$). This suggests that poor farmers are more active in seeking information from and trust "traders", while rich farmers value the "market" more than other wealth groups. This finding reflects the reality that the poor have more frequent contact with traders to sell their smaller quantity of produce, while the rich mostly market their produce directly to the market without traders being involved. Regarding the locational differences in attitudes, the farmers in the disadvantaged villages are mostly less active in seeking information from private actors (agro-input shops: adv.-1.15, disadv.-0.96, $p=0.070$; market vendors: adv.-1.29, disadv.-0.90, $p<0.001$) and feel less trust (agro-input shops: adv.-4.57, disadv.-4.04, $p=0.004$; market vendors: adv.-4.23, disadv.-3.53, $p<0.001$; traders: adv.-4.03, disadv.-3.61, $p=0.002$), compared to the advantaged villages.

Interestingly, the contribution of radio to the innovations was found to be very limited. However, during the previous 10 years the poor farmers had gained greater access to radio (from 24.1% to 42.6%) unlike moderate farmers (from 41.0% to 42.7%) and rich farmers (from 55.4% to 50.0%), although the poor farmers (0.94) are more passive information-seekers than the moderate farmers (1.03, $p=0.025$), according to the pair-wise Mann-Whitney U-tests. In-depth interviews revealed, however, that despite getting easy access to knowledge through the radio, the farmers experienced difficulties in putting the information into practice without field demonstrations. On the other hand, some farmers, mainly in the

Northern disadvantaged village, regarded radio as the best information provider, because it was readily accessible, and listening to it did not require farmers' time and effort; they also perceived it as reliable. This is consistent with the higher percentage of farmers in the village who reported that they had applied information from the radio to their innovations (N-disadv.-6.8%, Average-3.0%, p=0.023) and with the highest rate of "usefulness" among villages (N-disadv.-3.94 compared to N-adv.-3.18, W-adv.-3.70, W-disadv.-3.57, p=0.003). In fact, the radio programme popular among farmers in the Northern disadvantaged village is run by an NGO which provides useful information based on the thorough field-based assessments and feedback from farmers calling in. This suggests the radio has potential, particularly in more disadvantaged villages, if both the information and communication approaches meet the demands of the people in the area.

5.5 Discussion

This study attempted to unpack smallholder farmers' knowledge and information systems; i) by analysing the types of AIS actors being accessed and used by farmers with different socioeconomic characteristics in contrasting enabling environments and different agroecological zones; and ii) by exploring the farmers' attitudes towards AIS actors which may influence the access to and the actual utilisation of the knowledge and information.

5.5.1 Knowledge and Information Systems for Agricultural Innovations

For the first research question, this study empirically found the knowledge and information systems (a major subsystem of AIS) of smallholder farmers are profoundly influenced by the differential socioeconomic and environmental conditions which shape the utilisation of and access to AIS actors differently. “Other farmers” are found to have played the most significant role as a source of information for smallholder farmers, as nearly half of the farmers interviewed (47.8% of 531 farmers) used this information source in their innovations. The probability that this source was used increases with residence in the Western AEZ, no matter what the farmers’ characteristics were. Regarding access to information from other farmers, 58.2% of the farmers claimed to have access, and the probability of having access increases with residence in the Western AEZ, larger land size and non-migrant status.

The second most influential contributor is “the government”. Their information contributed to 20.9% of the innovations made by smallholder farmers in the research sites. The higher the farmers’ wealth level is and the greater the likelihood that they live in the Western AEZ, the higher are the chances that they utilised the government’s information in their innovations. In the disadvantaged villages, the richer farmers utilised the government’s information more than the poorer. In terms of access, 24.3% of the farmers have access to the government’s information, and the probability of having access increases with residence in the Northern AEZ and the disadvantaged enabling environment, and if the farmers are male and non-migrant.

Moreover, 11.9% of the farmers used the information from “other sources” (e.g. NGOs, agro-input dealers, radio), a tendency increasing with farmers’ group membership. In all the four research sites, the usage of other sources significantly increases with wealth level. On the other hand, this utilisation level is extremely low compared to their access to information from other sources (70.6% of farmers). The probability of having access increases with farmers’ group membership, total years in education, and household size, no matter which agroecological zone or enabling environment they inhabit.

Furthermore, over a quarter of the farmers (29.4%) counted on their "own ideas" or knowledge to implement the new practices: the probability that they used their own ideas increased with residence in the Northern AEZ. It is evident that farmers are innovating even without external knowledge inputs. This study suggests that knowledge is stored, possibly combined with multiple known or unknown information sources, and waits for the right moment to be put into practice. Reij et al. (2001) report that a similar percentage of East African farmers (29.7%) relied on their own ideas when making innovations, and claim that it is not unusual for farmers to believe that their innovations came from themselves. It is also noteworthy that farmers, especially in the land abundant Northern AEZ, did not invariably need external knowledge of extensification.

It is important to note that comparison of factors affecting all information sources reveals that wealth is commonly associated with utilisation of information obtained both from "government" and "other sources", while there no characteristic significantly affects the utilisation of "other farmers' information". This signifies that external information sources are biased in favour of the wealthier farmers. Furthermore, being non-migrant is important for accessing "government'" and "other farmers' information", while it does not affect access to "other sources of information". This means that migrants have less exposure to "the government" and "other farmers' information".

5.5.2 Gaps between Access to and Actual Utilisation of Information

This study found huge gaps between access to and actual utilisation of information, particularly for “other sources’ information”. The finding that higher “utilisation” of the information from AIS actors is associated with better “access” to their information is statistically significant: this signifies the importance of access as a precondition of knowledge usage. However, better “access” to AIS actors does not necessarily facilitate the “utilisation” of the information. For example, the radio, the market vendors and local leaders were found to be relatively well “accessed” by farmers, yet their information is rarely “utilised” in innovation. This is reflected in the wide gap between the farmers with access to (70.6%) and those who used (11.9%) the information from “other sources”. Looking at the farmers’ socioeconomic and biophysical characteristics, most importantly, the factors associated with utilisation are not necessarily the same as those associated with access. For example, access to government information increases with residence in the Northern AEZ, while utilisation decreases. This could be due to the government information in the Northern AEZ being less useful. On the other hand, the common factors affecting both “access” to and “utilisation” of other farmers’ information are residence in the Western AEZ and farmers’ group membership. Thus, both different and common factors influence both access and utilisation.

5.5.3 Farmers’ Attitudes in Knowledge and Information Systems

The representations of utilisation and access demonstrated above are important, but the reasons behind these results must be understood. Therefore, in the quest for an answer to the second research question, this study explored the farmers’ attitudes towards the information sources, since these may have affected the access and use of the information. Whether farmers access the information and put it into practice depends heavily on farmers’ attitudes (pro-activeness in information-seeking, trust, and perception of usefulness) to the information sources. Moreover, such attitudes are different for different socioeconomic categories of farmers in different locations. This study has identified three types of gap perceived by farmers in their relationship with various actors: government actors (i.e. male-rich biased “demand-driven” extension practices), other farmers (i.e. the “social class gap”), and market actors (i.e. lack of trust), as discussed below.

The government actors played an important role in smallholder farmers’ innovations. However, government information was not accessed and utilised to an equal extent by all socioeconomic categories of farmers in all locations. Although a number of studies have reported the rich-biased (Hoang et al., 2006, Matous et al., 2013) and male-biased (Katungi et al., 2008, World Bank, 2008) government rural innovation support practices, few of them explored the cognitive reasons behind this. This study, however, has revealed the wide range of various farmers’ attitudes towards information from government actors. The Likert scales revealed that poor and female farmers (particularly married women) are relatively passive in information-seeking, are less trustful and perceive the government information as less useful, compared to other categories of farmers. Noteworthily, the in-depth interviews revealed that married women lacked confidence in communicating with male-dominant extension offices, which is why some women try to belong farmers’ groups to overcome this communication barrier. Moreover, the poor in the land scarce Western village confessed that they did not have land to spare for demonstrations, and did not grow export crops, which is why they did not seek advice from the government extension. The richer seek information from the government more actively than the poor, as they can possibly pay for the services. In fact, another huge cognitive gap was identified between the farmers’ extremely passive information-seeking behaviours (as confirmed by both Likert scales and in-depth interviews) and the government extension's withdrawal from field visits. Such passive practices on the part of the government are based on the "demand-driven approach" combined with a sudden drastic reform of the national extension programme since 2014, which is characterised by a shortage of extension staff and a reduced operational budget. Moreover, the location-related gap identified by this study is that being in an advantageous enabling environment (e.g. closer to the district HQ) does not necessarily increase access to government information. Also, the farmers in the Northern AEZ have higher levels of access to the government information than those in the Western AEZ, but they use the information at much lower rate than the Western AEZ. This signals that the information shared by the government actors are less relevant or inapplicable for the farmers in the Northern AEZ. These findings unveil the perception-related gaps between differential farmers and the government actors beyond mere accessibility.

Other farmers' information was the most accessed and utilised among AIS actors. Although there are a number of studies reporting that peer farmers are the most used and preferred information source (Solano et al., 2003, Bandiera and Rasul, 2006, Dolinska and d'Aquino, 2016), as with other aspects of this subject, little attention has been paid to variations in experience, or farmers' perceptions. The in-depth interviews revealed that farmers carefully observed other farmers' yields and personal characters, and then chose specific farmers from whom to learn. Poor farmers tended to learn from model farmers when working as their casual labourers. Despite the lack of statistically significant association, the trust towards neighbours measured by the Likert scales was found the highest for married women among gender categories. Through in-depth interviews, it became clear that female farmers learned innovations through seed and food exchange with their neighbours and relatives. In addition, poor female farmers declared that their most preferred information source was their parents, because of their constant mentorship in "hard-working". This corresponds with Lamontagne-Godwin et al. (2018), which showed that women valued informal interpersonal communication. Thus, farmer-to-farmer extension is crucial for innovations, though some findings imply that this social learning effect diminishes as heterogeneity among the community increases due to "the social class gap" (echoed in the advantaged Western village) which creates a mental gap in communication, because one farmer's innovations become irrelevant to the other due to an insuperable difference in resource endowment. This study found that living in the Western AEZ is a significant factor associated with higher access to and utilisation of other farmers' information, probably attributed to its dense population, and a social structure that enables numerous casual labourers to acquire knowledge from the model farmers who employ them, and spread it among other members of the community. However, the farmers in the Western AEZ are less active and trust the other farmers' information less than those in the Northern AEZ, which may be caused by "the social class gap". Therefore, this analysis shows the importance of the other farmers' information to farmers' innovations, as well as the risks of diminished social learning due to a social class gap.

The market is often a critical driver for innovation generation and uptake. However, the study found that information from private actors (e.g. traders, market, agro-input shops, mass media) had almost never been utilised for the farmers' innovations in the previous 10 years, despite the fact that the access was not necessarily low and had rapidly increased over the previous 10 years (see Table 5-3). The limited linkages between private actors and smallholder farmers are frequently reported by other studies, among which Spielman et al.

(2011) conducted the social network analysis, from which private sector actors were found to be peripheral to smallholder innovation networks. Nevertheless, many of them placed less emphasis on the farmers' attitudes towards the private actors. On the other hand, this study revealed that the private actors were the least trusted among AIS actors, which may explain the low level of utilisation of their information. Proactiveness in seeking information from market vendors and traders was found to be lower in the disadvantaged areas, as was trust in them. Moreover, poor farmers were found to be less active in information seeking from market vendors than from traders, even though they trusted the market vendors' information more than the traders' information. This shows that efforts should be made to address this attitude gap particularly for the poor farmers in the disadvantaged areas, if market linkage is to be promoted.

Regarding information from the radio, there is a wide gap between access and actual utilisation, as with other private actors. This study's finding of Information Communication Technologies (ICTs) not being reported as an information source is somewhat contradictory to many studies (Aker, 2011) which emphasize the roles of ICTs on agricultural innovations in SSA, although some recent studies (Lamontagne-Godwin et al., 2018) report the limited utilisation of the ICTs by farmers. As implied by the example of the popular radio programme presented by an international NGO based on farmers' needs in the Northern disadvantaged village, the relevance and reliability of information may be more important than a mere transmission technology. This corresponds to the study of Zanello and Srinivasan (2014), which found that radio and mobile phones have a larger impact on the quantity of information, but, in Ghana at least, the reliability of the information's source is crucially important when establishing the market price.

In summary, this study has demonstrated that exploring farmers' attitudes and behaviours (information-seeking activeness, trust, and usefulness) towards AIS actors contributed to the better understanding of the availability and utilisation of information. This study has shown both quantitative and qualitative features of the inner logic underlying farmers' choices of information sources. As claimed by other authors (Solano et al., 2003, Sseguya et al., 2012, Zanello and Srinivasan, 2014), this study confirms that farmers' decisions on whether or not to put their knowledge about innovations into practice depend heavily on the perceived reliability of the sources of their information. Whilst there has been a growing number of articles that go beyond knowledge use and indicate the importance of the nature of interaction among actors and social learning (Bandiera and Rasul, 2006, Conley and Udry, 2010, Spielman et al., 2011, Maertens and Barrett, 2013), few of them have explored the diversity of farmers' cognitive processes, except a few studies of Klerkx et al. (2017) and Jansen et al. (2010) which examined the different preferences of information sources according to different categories of farmers. This study has clearly demonstrated more comprehensive and holistic understanding of the diverse farmers' attitudes towards different information sources in contrasting agroecological and enabling environments. Such understanding further contributes to identifying how "inclusive" their innovation systems are and could become.

5.5.4 Reflection on Systems Approaches to Agricultural Innovations

This study clearly exhibited the evidence that the smallholder farmers' AISs are diverse, non-static and subjective. Many AIS approaches tend to apply 'hard systems thinking' as if the system has a common goal and a clear boundary (Leeuwis, 2004, Hall et al., 2006a), as opposed to ‘soft systems thinking’ which interprets a system which can be different for different actors. ‘Hard systems thinking’ pays little attention to the diverging and conflictive interests of interdependent actors (Klerkx et al., 2012). As noted in the introduction, while traditional AIS studies often overlook the diversity of smallholder farmers (Spielman et al., 2009b, Chowa et al., 2013, Garforth, 2013), the result of this study has demonstrated that socioeconomically and environmentally heterogeneous farmers often have different AISs for making a wide range of types of innovations, as other literature (Rajalahti et al., 2008, Klerkx et al., 2017) also reported. Thus, unpacking farmers’ AISs requires investigating AISs with a farmer-centred approach, not an innovation-oriented approach; consequently, this study focused on AISs that the farmers actually used, rather than conventional technology adoption studies which focus on pre-selected innovations. Moreover, to capture the diversity of these AISs, the study aimed to address different locations with different agroecological and enabling environments as well as different types of farmers in each location, as they have different AISs.

A further contribution of this study is that it has shown that innovation systems thinking beyond AKIS is needed. Although some recent studies claim that AKIS and AIS are to an extent merged as Agricultural Knowledge and Innovation Systems (Klerkx et al., 2012, Adolwa et al., 2016), the main difference between AKIS and AIS is that the former comprises public-sector research, extension, educational institutes and farmers, and the latter framework emphasizes relevant organisations beyond them, including market actors. This study shows the empirical evidence of farmers’ AISs which clearly stretch beyond the farmers-extension-research linkages, as “other sources” (e.g. radio, agro-input shops, traders, NGOs) were found to be the crucial information sources for their innovations.

However, the study also found the huge gap between access (70.6%) and actual use (11.9%) of the other sources' information, which has to be addressed for potential improvement, especially when market actors are rapidly emerging actors in AISs as seen in Table 5-3. For example, bananas traditionally grown purely for home consumption met a rapid growth of market demands, which stimulated farmers to introduce new varieties of banana for commercialisation, managerial practices such as forking and staking, and soil management practices such as mulching and manure application for this crop, as well as expanding banana plantations. As implied in this example, market influence is easily overlooked if investigating information sources at innovation level only, but dynamic analysis of farm system maps, alongside the use of FGDs and in-depth interviews, disclosed the roles that the market plays as one of the key drivers for a range of innovations. Hence, this study recommends that the combination of various research methods should be used for understanding the wider AISs beyond the farm and their influence on innovation processes.

Furthermore, AKIS pays little attention to the multi-functionality of innovation actors beyond information sharing. The knowledge they impart is often accompanied by inputs such as new seeds or cuttings, as shown above in the examples of innovation dissemination through women's exchange of beans and cassava as seed and food; moreover, some poorer women farmers rely on their parents for both information and moral support. These examples suggest that farmers' information sources are often multi-functional, providing not only novel information but also material and psychological support. Consequently, a systems approach should address holistic innovation systems.

Finally, another important reflection on the systems approach is that the focus of the framework should address the real challenges in SSA, where most of the farming population are subsistence farmers whose livelihoods must be protected. Since the scope of the AIS framework is value-chains, involving multi-actor learning and partnership (Hall et al., 2006a), many AIS studies tend to focus on a certain commodity and aim to intensify its commercialisation, as pointed out by Assefa et al. (2009). This approach risks limiting the focus to commercial farmers, excluding the majority. Learning from the AKIS framework, whose scope is farmers' livelihoods, systems studies should focus on how systems work for the majority of poor farmers. In this way, this study was able to identify the systemic gaps for those who lack accesses to AIS actors which can possibly address "inclusive" innovation systems.

5.6 Conclusion

This study examined ways in which the AIS actors were perceived, accessed and used by farmers in different socioeconomic categories in the two contrasting enabling environments in two different AEZs of Uganda that were used as case studies. This study found that various farmers' attributes (e.g. wealth, gender), advantageous or disadvantageous enabling environments (e.g. access to services, markets), and AEZs shape the farmers' AISs in a complex manner. Furthermore, cognitive analysis disclosed that the access to and utilisation of AIS actors' information were profoundly influenced by the farmers' preference, based on their own selection criteria.

First, the "government information" was accessed by 24.3% of the farmers and used by 20.9%. The farmers in the Northern AEZ have greater access to government information, yet there is a big gap as a small portion of farmers used the information source for their innovations, compared to the Western AEZ. In addition, the study found that residence in the favourable enabling environments does not necessarily improve the situation, as seen in the lower access to and utilisation of government information in the advantaged locations. This is why the low level of perceived "usefulness" was observed in the Northern advantaged village. This suggests that an effort should be made to offer more relevant information in the Northern advantaged area. Moreover, the study disclosed that women had less access to government information. As other literature (Katungi et al., 2008, World Bank, 2008) also suggests, more gender-balanced recruitment of extension staff should be considered, as female farmers feel underrepresented and hesitant to access male-dominated government extension services. Furthermore, the lower degree of proactiveness displayed by the poorer farmers in this study, alongside their relative lack of trust in government sources and their low perceptions of their usefulness, could explain their lower utilisation of government information, particularly in disadvantaged locations. In fact, the government extension services were found to be rich, male-biased and becoming more passive in the name of "the demand-driven approach", which has widened the gap between them and the smallholder farmers (particularly poor and female) who are passive in seeking information from the government. These findings strongly question the government's narrowly defined "demand-driven approach" and suggests the necessity for a more proactive policy, which should continuously support the articulation of farmers' diverse and dynamic demands in the field and seek the best fit between extension demand and supply (Parkinson, 2009, Kilelu et al., 2014).

Secondly, the "other farmers' information" was accessed by 58.2% of the farmers and used by 47.8% of the farmers. The study found that agroecological differences dictated both access to and utilisation of other farmers' information, with the Western AEZ higher than the Northern AEZ. Nevertheless, the lower level of proactiveness and trust regarding the other farmers' information in the Western AEZ is a concern. In fact, in the Western advantaged village, "a social class gap" within communities bars a knowledge exchange between model farmers (i.e. commercial or progressive farmers) and poorer farmers. The casual labourers working for the model farmers can facilitate the knowledge exchange, but the relevance of the knowledge becomes questionable in highly heterogeneous societies. Therefore, it is important for innovation interventions to facilitate farmer-to-farmer extension with a fuller comprehension of the dynamism of farmers' perceptions, and better communication strategies for reaching out to diverse categories of farmers, without assuming any automatic innovation transfer from their contact farmers to the rest of the community.

Thirdly, with regard to the "other sources' information", 70.6% of farmers have access, but only 11.9% of the farmers used the sources: the chance that this will happen increases with farmers' group membership, and with wealth (based on WR), no matter what their agroecological and enabling environments are. Many farmers strive to become members of farmers' groups in order to get access to external actors such as NGOs and government extension services, but this is difficult for poor female farmers due to their overwhelming commitment to domestic work, combined with their limited labour capacity. Importantly, the main reason for the huge gap between the access to and utilisation of "other sources' information" (as seen in Figure 5-4) can be explained by the fact that the farmers trust information from private actors, such as market vendors and traders, less than that from any of the other AIS actors. This applies particularly to the poorer farmers and those living in the disadvantaged areas. The study also found that the poorer are less active in seeking information from market vendors, compared to the richer, while they are more active in seeking it from traders. The poorer farmers often take loans from traders and later accept lower market prices as a repayment for the loans. However, if the poor can overcome their reluctance to seek information from the market vendors, they may benefit from selling their produce directly to the markets at higher prices. Additionally, radio is widely accessed in all the research sites, yet utilisation of the information remains at an extremely low level. The relevance and reliability of the information should be improved, so that the potential of this transmission technology can be fully utilised.

In summary, the farmers' AISs are diverse, with differences arising from their socioeconomic and environmental characteristics and perceptions. Analysing the farmers' different perspectives of AIS actors with a 'soft systems thinking' approach, this study found the main gaps within the systems, as highlighted above. Those three perception-related gaps in linkages with other farmers, government, and private actors need to be further addressed so that AIS can function in a more inclusive way. Thus, the findings suggest that the utilisation of knowledge and information would not be achieved by just simply improving "infrastructural" accessibility to the AIS actors, but by understanding and addressing farmers' perceptions of them. With a better understanding of the various AISs, policy and practice can possibly influence them and their operation not just by mapping agricultural needs and opportunities in specific locations, but by undertaking more detailed examination of the existing innovation players and systems from farmers' perspectives, for different enabling environments and for different types of farmers. It is critical to improve not only farmers' access to information sources, but, more importantly, the quality of their interactions as well as the relevance of the information to their socioeconomic and environmental circumstances. Thus, the findings provide crucial implication to "inclusive" AISs. All the practitioners should bear in mind that no innovation is socioeconomically and agroecologically neutral and universal, hence the necessity of farmer-centred and context-specific approaches in any innovation support.

Chapter 6 - Gendered Intra-Household Decision-making Dynamics in Agricultural Innovation Processes in Uganda: Assets, Norms, and Bargaining Power

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Abstract

This article explores intra-household decision making in smallholder farmers' innovation uptake and use of outputs within a bargaining framework. Research was conducted in selected locations representing contrasting economic, social and agroclimatic environments in Uganda using a combination of qualitative and quantitative methods (including a survey of 531 farmers). Decision making in innovation processes were highly gendered and shaped by intra-household allocation of production assets as well as social norms. The findings highlight the male capture of decision making regarding innovation uptake and use of outputs, especially for income-generating crops, and that this can both reflect and reinforce gender inequality of asset ownership.

6.1 Introduction

Innovations or changes in farming practices are increasingly important for tackling development challenges, including poverty, food and nutrition insecurity, climate change, degraded natural resources, and population pressure on scarce lands (World Bank, 2007a, Spielman et al., 2009b, World Bank, 2012, Wiggins, 2014). Nevertheless, the fact that innovation processes and outputs are highly gendered is often neglected in AIS literature and innovation support interventions and this results in a low uptake of innovations (Reij et al., 2001, Cardey and Garforth, 2013, Kingiri, 2013).

Men and women make innovations and benefit from them differently. On the one hand, traditionally defined gender division of labour is a key factor which shapes characteristics of innovations that farmers adopt. Women are more likely to be engaged in subsistence farming, while men are involved with cash crops (Moser, 2012). This explains the higher uptake rate for food crop-related changes for women, while more men welcome cash crop-related changes, as highlighted in various case studies (Miiro et al., 2001, World Bank, 2007b, Mazur and Onzere, 2009).

Gender difference in innovation uptake is attributed to the unequal access to resources which result from gendered roles and responsibilities. The Future Agricultures Consortium found that those households with more land, assets, and resources took advantage of opportunities, often leaving out female farmers with fewer resources (Wiggins, 2014). Further empirical evidence suggests that women are more likely to be engaged in subsistence farming and less likely to cultivate cash crops because of gender inequality in terms of limited access to fertile soil, to the tenured security of plots, or to credit (Doss and Morris, 2001, World Bank, 2007b, Mazur and Onzere, 2009, Fisher and Carr, 2015).

This study investigates how such gender inequalities are embedded in the local innovation processes at farmers' level, focusing particularly on intra-household decisions. Uganda ranks 14th highest in the world with the rate of its male and female population employed in agriculture (70.4 per cent of total employment; 65.5 per cent of male employment and 75.8 per cent of female employment) in 2016, according to ILOSTAT database. As the majority of them (96.3 per cent) are subsistence farmers (UBOS, 2014), the sector holds great importance for poverty alleviation. However, it is reported that women's agricultural productivity is lower than men's by a great degree, as a result of the gender inequality in access to the factors of production (MAAIF, 2016a, World Bank, 2016).

6.2 Intra-household Decision Making and Bargaining Power in Innovation Processes

Innovation is a process which constitutes a series of intra-household decisions which are strongly affected by existing decision-making patterns on production and consumption and perceived institutions, such as social norms and culture. Earlier studies of 'New Home Economics', founded by Becker (1965), applied a unitary model which assumes a household is a single production or consumption unit, thus failing to understand intra-household dynamics (Wolf, 1990, Agarwal, 1997, Moghadam et al., 2011). However, the bargaining framework emerged to claim that the outcomes of households' decisions are affected by the allocation of resources and the power relationship within the household, as opposed to the unitary model's predictions (Doss, 2001, Browning et al., 2010, Meinzen-Dick et al., 2011, Doss, 2013, Anderson et al., 2017).

Agarwal (1997) and Doss (2013) further categorise the bargaining framework into cooperative bargaining models, collective models, and non-cooperative bargaining models, whereby the former two presume the Pareto efficiency in household outcome in which no one could be better off without making someone else worse off, while the latter models reject this. The cooperative bargaining and collective models argue that individual household members bargain over how to allocate both the pooled resources and the household expenditure, hence there are different outcomes due to different preferences among household individuals. On the other hand, non-cooperative bargaining models assume that household individuals make separate decisions about their own resources, i.e., resources are not pooled, but rather spent individually (Doss, 2001). However, Malapit (2012) claims that cooperative models and non-cooperative models are not mutually exclusive. Much of the literature supports the non-cooperative models, or a combination of the three, as the best explanation of intra-household decision making in developing country contexts (Udry, 1996, McPeak and Doss, 2006, Browning et al., 2010, Njuki et al., 2011, Kebede et al., 2014). This could be true in SSA where resources are not often pooled, but are typically controlled by men (Njuki et al., 2011), and where decisions about gender roles and responsibilities are seemingly governed by strong social norms or institutions, not necessarily with the aim of maximising household productivity, with daily negotiations among household individuals. In other words, in any model, gender inequalities in decision-making authorities are apparent; in cooperative and collective bargaining models, the production and consumption decisions are affected by the gender inequalities in bargaining power which are often led by unequal asset endowment and control. In parallel, in non-cooperative bargaining models, gender inequalities in asset endowment limit the share of decisions which come under women's control.

Intra-household bargaining or dynamics influences the uptake of new agricultural technologies, but it is seldom examined by adoption studies literature. Many empirical studies reveal that women farmers have relatively low rates of adoption of agricultural technologies associated with higher productivity, however, they do not consider the intra-household context and the bargaining framework which may affect the technology adoption (Doss, 2001, Doss, 2013, Haider et al., 2018). Some of the first contributions to the analysis of technology adoption in intra-household contexts were those of Von Braun (1988) and Jones (1983) who investigated how the allocation of labour changed when irrigated rice was introduced in West Africa. Those studies demonstrate that women's insufficient bargaining power allows the benefits of the new technologies to be captured by men, as predicted earlier by Boserup (1970). More recently, Fisher and Carr (2015), in their adoption study on Drought-Tolerant (DT) maize in eastern Uganda, found that women farmers have much lower adoption rates of DT maize compared to men farmers due to differences in resource access. Also, Haider et al. (2018) analysed fertiliser adoption in Burkina Faso and demonstrated that technology adoption status differs among household members depending on whether their plots are collectively- or individually-managed. Thus, based on a set of gender and socio-cultural dynamics relating to resources and labour (re)allocations associated with innovations, it is clear that intra-household bargaining influences adoption. It is also noteworthy that gendered division of labour by crop and by task is not static, rather it changes in accordance with new economic opportunities (Doss, 2001). This implies that change in the economic value of a certain crop may change gender power relations in intra-household resource allocation and in who benefits from the crop.

Moreover, there is again scarce literature on the intra-household decision making which concerns the output of innovations. Women and men in SSA may not pool household incomes, but they may negotiate and choose to spend the money under their control differently (Meinzen-Dick et al., 2011, Njuki et al., 2011, Doss, 2013). Some studies have shown that women's bargaining power affects the household budget share spent on food, education, health, private goods, or other goods. However, the practical difficulty of distinguishing between goods for the entire family and those purchased purely for individual members makes it difficult to assess the bargaining power of household individuals. Doss (2013) also suggests that consumption patterns may be strongly related to measures of bargaining powers, particularly income and asset ownership.

As the determinants of bargaining power, a variety of studies identify the following: income and employment; ownership and control over assets, such as land, livestock, and agricultural equipment; social networks; access to credit; institutionally determined and individual perceptions of social norms of gender roles and responsibilities; women's education, age, health, and their participation in the market; spousal contributions to households; and, fall-back position (Agarwal, 1997, Meinzen-Dick et al., 2011, Doss, 2013, Fisher and Carr, 2015, Mishra and Sam, 2016, Anderson et al., 2017). The ownership and the types of such assets are gendered, conditioned, and perpetuated by sociocultural context and intra-household allocation rules (Quisumbing et al., 2015, Johnson et al., 2016, Doss et al., 2018). Those studies which investigate determinants of bargaining power can provide significant insights for understanding decision-making patterns in innovation contexts.

Thus, many studies suggest that innovations or technological adoptions are influenced by gendered resource allocations, such as land, labour, credit, agricultural inputs, and extension, as well as gender norms. However, few studies have attempted to reveal such influence in an intra-household context. Moreover, many adoption studies typically focus only on a specific crop or technology, thereby failing to capture holistic views of innovation processes or of farmers' subjective reasoning behind their decision-making patterns (Leeuwis, 2004). Therefore, taking an intra-household bargaining perspective, this article aims to analyse how men and women farmers within the household make decisions about their agricultural innovations and what determines the decision-making authority over the innovation processes. The study was guided by the following research questions:

- How do men and women within the same households make decisions regarding the uptake of innovations and the use of products from them?
- What influences decision-making authority by men and women within the household?

6.3 Methods

The study was conducted in Uganda between November 2016 and February 2018 and applied an exploratory and inductive approach. In order to examine a wide range of innovation process scenarios, two villages, the most advantaged and most disadvantaged in terms of enabling environment for innovations[22], were chosen for each of two Agro-Ecological Zones (AEZs) in Uganda, namely North Western Savannah Grasslands (NWSG) and South Western Farmlands (SWF). Thus, four villages in total were focused on (see Figure 6-1). An innovation here is defined as a change that is made to farming activities or practices by a household member(s). It may not be new to the area or location but is to that particular farm (Hall et al., 2006b, World Bank, 2012).

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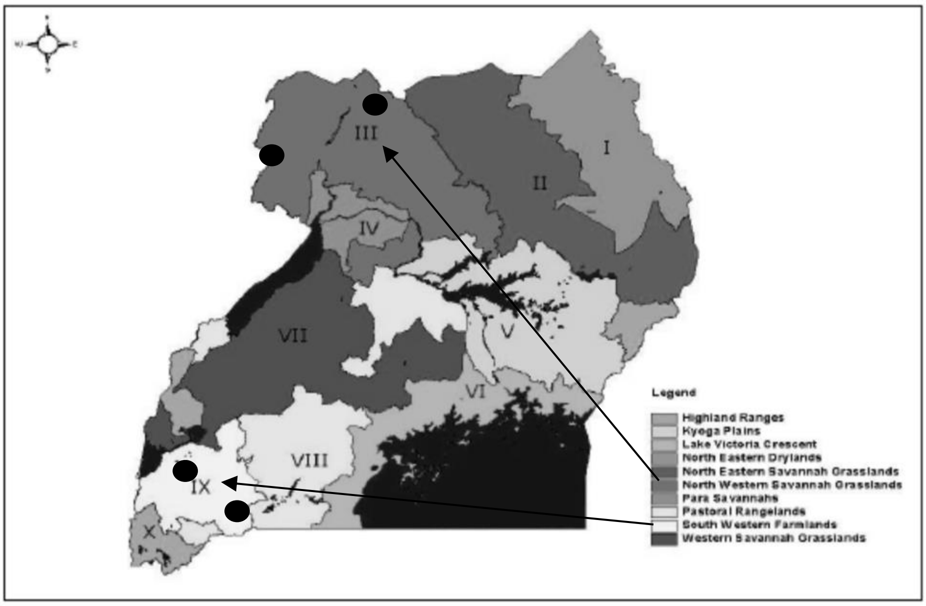
[22] The indicator of Enabling Environment for Innovations (EEI) was created by the author, based on a set of criteria purposively chosen from the readily-available data from the Agriculture Census 2008/9 (UBOS, 2010) and interviews with the local government production department.

Figure 6-1. Research sites in Agricultural production zones of Uganda



Source: MAAIF (2016a)

Table 6-1. Research process

Data collection tools	Sessions	Female	Male	Total
Livelihood/Farm system mapping (changes between present & 20 years ago)	8	24	24	48
Wealth Ranking	4	12	12	24
FGDs	49	94	72	166
Household Questionnaire Survey	358	207	151	358
Individual Questionnaire Survey	531	312	219	531
In-depth individual interviews	90	56	34	90
Participatory Budgeting and Effects Diagrams	83	44	39	83

The field research process is summarised in Table 6-1. For 'Wealth Ranking', all the farming households in each village were categorised into three wealth groups: poor; moderate; and rich. Furthermore, Focus Group Discussions (FGDs) were organized for various gender and wealth categories of farmers; this provided the basis on which structured questionnaires were formulated. Regarding the household and individual surveys, all the household heads and their spouses (if any) available during the survey period were interviewed face-to-face, using the structured questionnaire, whereby the enumerators input the data using smartphones with Open Data Kit (ODK). The individual farmers were interviewed about their experiences of key innovations (up to maximum three) introduced in the last 10 years (2008-2017). Specifically, the respondents were asked who the first person was to know about innovations within the household, and who decided to introduce the key innovations. Table 6-2 shows the number of respondents and innovation cases collected in total. During the visit to each household, either the household head or the spouse was interviewed (based on alternating selection) and asked about household characteristics, their three main crops, and their main livestock. In this way data were generated on the gender role divisions for each farming activity and the control of profits and outputs from each enterprise.

Table 6-2. Number of questionnaire respondents and innovations introduced[23]

Gender category	Poor		Moderate		Rich		Total	
	Farmer	Innov.	Farmer	Innov.	Farmer	Innov.	Farmer	Innov.
Single men	18	23	12	13	1	0	31	36
Married men	58	108	104	178	25	44	187	330
Single women	39	64	48	73	2	5	89	142
Married women	72	123	124	182	28	40	224	345
Total	187	318	288	446	56	89	531	853

In-depth interviews were conducted with farmers randomly selected from each stratified category of gender and wealth; questions asked covered: whether the respondent must seek permission from his or her partner to introduce innovations and give reasons for its implementation; if there are any enterprises or activities that the respondent is allowed to do without permission from his or her partner; and, who controls the profit from

[23] Respondents were divided into four categories: single men; married men; single women; and married women. ‘Married’ signifies ‘with partner/s’ rather than official marital status, while ‘single’ means either widowed, separated, or divorced.

innovations. All the interviews were audio-recorded and transcribed for content analysis. Moreover, regarding the most frequently mentioned innovations, usually two to three per village, 84 farmers randomly selected from the stratified categories of farmers who responded that they had introduced the selected innovations worked on two participatory activities, namely Participatory Budgeting and an Effects Diagram. The former activity investigated cash and in-kind inputs and outputs, comparing gross margins with and without innovations. During the latter activity, the farmers were asked about intra-household decision making on innovation outputs in terms of expenditure of innovation profits i.e. what the benefits (specific amounts of cash or food produce gained from the innovation) were used for, who made the decisions about their use, and what the knock on effects of their use were.

6.4 Results

6.4.1 Innovation Overview

Importantly, there are statistically significant differences between men and women in terms of innovation types (x^2=23.833, df=14, p=0.048) (Table 6-3). For example, the proportion of livestock-related innovations is larger for men (14.8 per cent) than women (10.1 per cent), with a statistically significant difference (x^2=3.533, df=1, p=0.060).

Table 6-3. Innovation types by gender

		Married men		Married women		Total	
Innovation Types		Count	%	Count	%	Count	%
Crop*	Soil management*	63	19.1%	49	14.2%	112	16.6%
	New crop	48	14.5%	66	19.1%	114	16.9%
	Land preparation and planting method	38	11.5%	52	15.1%	90	13.3%

	Expansion in area planted	33	10.0%	33	9.6%	66	9.8%
	New variety	30	9.1%	42	12.2%	72	10.7%
	Managerial practices (pruning, de-suckering, staking)	25	7.6%	19	5.5%	44	6.5%
	Pest and disease control*	14	4.2%	25	7.2%	39	5.8%
	Improved farming tools	13	3.9%	5	1.4%	18	2.7%
	Change in planting timing	8	2.4%	4	1.2%	12	1.8%
	Weeding method	3	0.9%	8	2.3%	11	1.6%
	Harvesting/Post-harvesting method (storage, processing, marketing)	2	0.6%	2	0.6%	4	0.6%
	Irrigation/ water-harvesting	2	0.6%	2	0.6%	4	0.6%
	Reduction in area planted	1	0.3%	3	0.9%	4	0.6%
	Other	1	0.3%	0	0.0%	1	0.1%
Livestock*	New animal	23	7.0%	16	4.6%	39	5.8%
	Animal disease control	15	4.5%	13	3.8%	28	4.1%
	Expansion in no. of animals	5	1.5%	6	1.7%	11	1.6%
	New breed	3	0.9%	0	0.0%	3	0.4%
	Reduction in no. of animals	2	0.6%	0	0.0%	2	0.3%
	Other	1	0.3%	0	0.0%	1	0.1%
TOTAL		330	100.0%	345	n.a.	675	100.0%

-Respondents were asked to name up to a maximum of three innovations that they had made in the last 10 years and that they were directly involved in.
-*p<0.1, **p<0.05, ***p<0.01 (Chi-square tests were run for only innovations which have more than 10 samples for both numbers of men's and women's innovations.)

6.4.2 Intra-household Decision Making on Uptake of Innovations

The study investigated gender differences in intra-household decision-making authority for their main innovations (Table 6-4). Consequently, the study found that a higher percentage of self-decision is seen for men's innovations (69.7 per cent), compared to that for married women (50.7 per cent). The chi-square test found that there are statistically significant differences between men's and women's innovations regarding who decided to introduce the innovation (x^2=53.458, df=3, p<0.000).

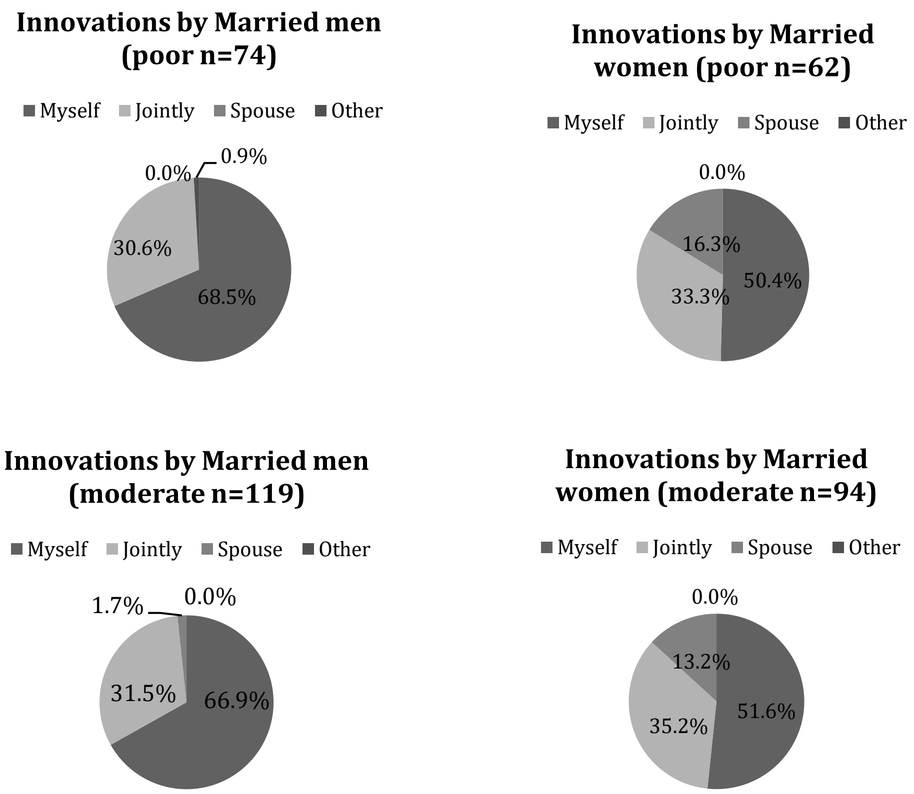
Table 6-4. Intra-household decision making on innovation uptake

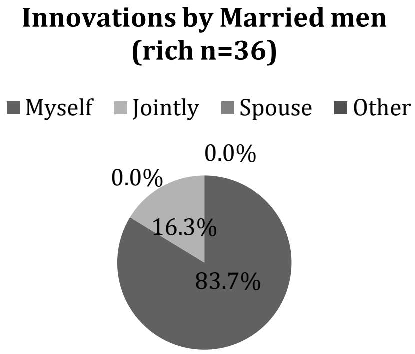
Gender			Who decided to introduce innovation?				Total
			myself	jointly	spouse	other	
Married	men's	N	230	96	3	1	330

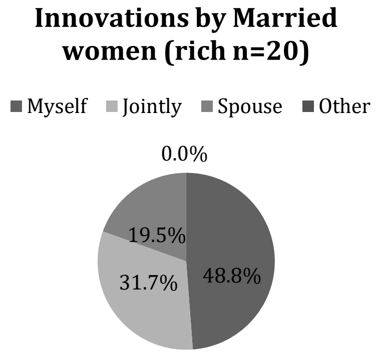
innovations	%	69.7%	29.1%	0.9%	0.3%	100.0%
Married women's	N	175	118	52	0	345
innovations	%	50.7%	34.2%	15.1%	0.0%	100.0%

Regarding the wealth difference in gendered patterns of decision making on innovation uptake (Figure 6-2), stronger male dominance is seen in the richer households. The innovations made by rich married women were dominated to a greater degree by their husbands (19.5 per cent), compared to the innovations made by poor (16.3 per cent) and moderate (13.2 per cent) married women. On the other hand, the large part of the innovations made by rich married men (83.7 per cent) tends to be decided by themselves, compared to the innovations made by those poor (68.5 per cent) and moderate (66.9 per cent) married men.

Figure 6-2. Intra-household decision making on introducing innovations by wealth







Poor: x^2=22.043, df=3, p<0.000; Moderate: x^2=19.759, df=2, p<0.000; Rich: x^2=14.332, df=2, p=0.001

The results of the in-depth interviews provide further insights into the above-mentioned gender patterns which concern decision making on innovation uptake. Husbands mostly do not need to seek agreement from their wives, whilst wives must seek permission from their husbands to introduce any new innovations. Typically, married women are only allowed to plant vegetables and other food crops for the purpose of home consumption without first asking permission from their husbands.

The reasons raised by men for why they make decisions without discussing them with their wives are that men are family heads, that they are the owners of land, and that the particular crops being grown (typically banana in SWF AEZ) are men's crops. Reasons related to land ownership were more strongly pronounced among the rich men. However, poor and moderate male farmers reported that they share innovation ideas with their wives in advance because the work requires their wives' efforts, especially their labour. Unlike the poor and moderate males, rich women have no bargaining tools because rich men can hire labour and, therefore, are not dependent on their wife's labour to support their innovations. This finding resonates with the results seen in Figure 6-2 which demonstrates that the rich men have more decision-making authority regarding their innovations than poor and moderate males. Furthermore, husbands indicated that their wives could possibly introduce new ideas if the husbands are not around, as long as the wives report them later.

'I own land, it is mine and to open up any enterprise, no one should first authorize me. I'm in control and I'm the manager…Of course my wife and sons have to seek for approval (from me).' (Ru8/Rich married man in disadvantaged village, SWF AEZ)

'I do not need to ask permission from her, but I shared the idea with her, because she is a concerned party. Because when I am not around, she has to take care of animals.' (Ry3/Poor married man in advantaged village, SWF AEZ)

The reasons given by women for seeking approval from men are that: men are their bosses and women are their subordinates; the innovations require capital from their husbands to buy seeds and materials and to pay for casual labour; such innovations require labour from the husbands (e.g., spraying pesticides); and, that the women do not know the boundary of their land (E17). Some moderate-income married women claim that they do not ask permission from their husbands because the resources, such as land rent and seeds, are paid by women themselves, as seen in the statement from a female farmer (Ru15). Women's decision-making power for innovations appears therefore to be stronger where land is rented by women, or jointly purchased, especially in the land-scarce SWF AEZ compared to the land-abundant NWSG AEZ and where large areas are customary land. Furthermore, a rich married woman (N15) expressed her fear of divorce if she does not follow what her husband tells her to do regarding innovations. This again is consistent with results in Figure 6-2 and indicates that rich women's innovations are more strongly controlled by their husbands. Furthermore, men claim that women should seek approval from them for reasons similar to those raised by the women above.

'For expansion of groundnuts and sesame, I have to first share with him, because land opening is difficult. It is my husband to decide where to plant or expand the land, because he knows our land boundary with neighbours.' (E17/Moderate married woman in disadvantaged village, NWSG AEZ)

'Why seek permission? It was my own money I used to buy the Irish potatoes from selling millet. I planted where I wanted. In case he stops me from using it, I would go out and rent in. He does not ask permission from me either, because he is growing his own crops'. (Ru15/Moderate married woman in disadvantaged village, SWF AEZ)

'If I don't follow his advice, he will divorce me. I have to ask permission from my husband when introducing new practices. When he introduces, he will just say he is going to do this, not necessarily getting an approval.' (N15/Rich married woman in advantaged village, NWSG AEZ)

6.4.3 Intra-household Decision Making on Innovation Outputs

In a similar way to the production process discussed above, men hold stronger decision-making power over innovation outputs than women. The decisions on how to spend cash income from innovations are typically made by husbands, while wives decide on how much harvest is to be kept for home consumption and distributed to neighbours and relatives, as revealed by the Participatory Budgeting and Effects Diagrams. Buying land and animals and paying school fees are often suggested or decided by men, while buying clothes and domestic basic necessities such as soap, salt, and cooking oil are often decided by women (Table 6-5). The reasons why the women give part of the harvest to their neighbours is said to be mainly in expectation of their help in return in case of sickness and/or food shortage, which is consistent with female responsibility in domestic food and welfare provision, although the reciprocity culture differs between NWSG and SWF AEZs. Table 6-5 depicts that men have more authority over outputs for assets, investment where off-farm investment seems stronger than on-farm investment, and social expenditure such as education and medical treatment, while women tend to control home consumption and produce distribution to helpers or others.

Table 6-5. Intra-household decision making on innovation outputs

Innovation	Mainly Husband	Jointly	Mainly Wife
Expansion of sesame	Maize, Goats, Chicken, Medical treatment, School fee, In-kind contribution to helpers, Capital for brick-laying business, Hiring ox-plough	Seeds for next season, Home consumption, Funeral donation	Home consumption, Soap, Cooking oil, Salt, In-kind contribution to helpers, Clothes, Seeds for next season
Irrigation for tomato	Hiring ox-plough, Hiring casual labour for maize, School fee, Cows, Motorbike,	Home consumption, Donation to neighbours, Building materials for permanent house, Land, Ox-plough, Goats, Hiring casual labour for maize	None
Line-planting for beans	Goats, Home consumption, Seed exchange, Seeds for next season, Hiring casual labour for next season, Medical treatment	Saving for permanent house, Home consumption	Home consumption, In-kind contribution to neighbours
Mulching/Manure for banana	School fees, Uniforms, Books, Land purchase, Land hire (for Irish potato, beans, sweet potato), Irish potato and beans seeds, Saving for emergency, Group saving for cow, Clothes, Goats, Pigs, Medical treatment, Treatment for cows, Hiring casual labour for banana expansion, Soap, Salt, Cooking oil, Home consumption	In-kind contribution to neighbours, Pigs, Soap, Salt, Medication, Tea plantation, School fees, Hiring casual labour for banana, Medical treatment, Meat, Clothes business for wife, Mulches, Goats, Chickens	Home consumption, In-kind contribution to mother, Pigs, Uniform, Scholastic materials, Food, fish, meat, soap, salt
Introduction of Irish potato	School fees, Land purchase, Land hire, Saving for emergency, Home expenses (salt, soap), Seeds, Shop items for his business, Medical	Seeds for next season, School fee, Uniform, Land hire, Saving for emergency, Cows, Hiring casual labour, Clothes, Medical treatment, Saving group, Home	Home consumption, Seeds for next season, Uniform, Seed exchange with neighbours, Construction of house

	treatment, Home consumption	expenses (salt, soap), Home consumption, In-kind payment for casual labour	

The findings from in-depth interviews suggest that the decision making on outputs is strongly influenced by the type of crops that are being grown, more especially whether it is a cash crop or a food crop, as claimed by some respondents (E7 and Ru18). Men typically control profit from men's crops, such as banana, while women are relatively free to use the petty cash gained from selling the surplus food crops, such as beans, maize, millet, groundnuts, and soybeans. However, the profit that women can use is limited to the purchase of family necessities like soaps and salt, as described by Ru14.

'She can sell and use money from vegetables at small scale, as long as she meets the basic family needs. Yes, we always sit and budget this money together as a family. But I have more say on money, because I am the head of the family.' (E7/Moderate married man in disadvantaged village, NWSG AEZ)

'I'm only allowed to sell sweet banana, and I can use that money for my personal use, like sanitary pads, knickers and skirts. For groundnuts and soybeans, I grow mostly for food but the surplus I can sell and use the money for my personal purpose.' (Ru18/Rich married woman in disadvantaged village, SWG AEZ)

'Man has control over the benefits (from innovation). For example, it is when deciding to buy land, which banana to eat or sell while I'm only allowed to decide for petty issues like buying salt and soap.' (Ru14/Moderate married woman in disadvantaged village, SWF AEZ)

The cultural beliefs and norms of gender roles and responsibilities seem to be dictating the decision-making authority over innovation outputs, according to the in-depth interviews. For example, women are believed to be responsible for home food provision, as the examples above show. In addition, the intra-household allocation of resources, such as land, labour, and farm inputs, influence the decision making on innovation outputs, similar to the case of innovation uptake decision making. This comes from the belief that the production outputs which used men's assets belong to men. On the contrary, wives can decide on outputs if they use their own land as Ru12 insists. When the innovation requires the wife's labour participation, the profit tends to be more jointly decided, while the profit from off-farm labour is typically kept and controlled by the one who did the work (Ry17).

'It is me who decide how much to give him after selling Irish, beans, and banana. It is me, because the plantation is on my own land. He (husband) spends his money on waragi (local brewery). Wife is in charge of food.' (Ru12/Poor married woman in disadvantaged village, SWG AEZ)

'It is me who decides (earning from s/potato) and also I decide on the money I earn from tea plucking. And my husband also decides on what he also earns from spraying.' (Ry17/Moderate married woman in advantaged village, SWG AEZ)

6.4.4 Empirical Evidence of Gendered Enterprises and Decision-making Power

As discussed above, the intra-household decision making which concerns innovation implementation and outputs is strongly related to the type of crops and livestock which are gendered by the perceived social norms and household rules. This section attempts to verify the farmers' claims on men's and women's crops or animals in relation to decision-making authority, and to further unpack the decision-making patterns based on the different levels of the enterprise's contribution to household income. With regard to crops, the results of the household survey on intra-household decision making about crop management and control over the resultant profit (Table 6-6) reveal that the decision-making authority differs depending on the crop type. This is consistent with the findings of the in-depth interviews which disclosed that women are relatively free to make innovations for food crops, such as sweet potatoes, millet, beans, maize, groundnuts, and vegetables for home consumption (Ru18 in 6.4.3 and E21 below), while they are often not allowed to make innovations which concern men's crops, such as banana, tobacco, and onion (Ru9).

Table 6-6. Intra-household decision making on management and profit control by crop type

	Who decides to grow and how to grow the crop?			Which person within your household manages the profit from this crop?		
NWSG AEZ						
	Mainly Husband	Jointly	Mainly Wife	Mainly Husband	Jointly	Mainly Wife
Beans	36.2%	36.2%	27.7%	37.8%	35.6%	26.7%
Cassava	35.5%	50.0%	14.5%	39.7%	35.6%	24.7%
Maize	34.0%	50.9%	15.1%	44.2%	30.2%	25.6%
Groundnuts	27.6%	52.9%	19.5%	35.7%	44.0%	20.2%
Sesame	24.3%	67.6%	8.1%	31.4%	54.3%	14.3%
SWF AEZ						
	Mainly Husband	Jointly	Mainly Wife	Mainly Husband	Jointly	Mainly Wife
Coffee	66.7%	33.3%	0.0%	16.7%	66.7%	16.7%
Banana	58.7%	35.9%	5.4%	49.3%	42.0%	8.7%
Tea	57.1%	42.9%	0.0%	42.9%	57.1%	0.0%
Irish potato	54.8%	32.3%	12.9%	60.0%	30.0%	10.0%
Maize	46.3%	42.6%	11.1%	53.2%	40.4%	6.4%
Cassava	33.3%	28.6%	38.1%	41.7%	41.7%	16.7%
Beans	32.2%	48.3%	19.5%	52.9%	32.9%	14.3%
Sweet potato	30.0%	46.7%	23.3%	33.3%	55.6%	11.1%

*Only major crops are listed in the table. The original data contain 683 and 577 crop cases for production decision and output decision, respectively.

'Without seeking for approval (from my husband), I can plant eggplant, osubi, sukuma and okra. Where to plant sesame, my husband decides, because he is the head of the family.' (E21/Rich married woman in disadvantaged village, NWSG AEZ)

'She can grow beans, millet and maize, but not banana.' (Ru9/Rich married man in disadvantaged village, SWG AEZ)

The livestock management analysis reveals greater male dominance in decision making regarding livestock compared to crop management (Table 6-7). This is also evident in the farmer's statement below (E17). Women have either no or little authority to decide whether and when to sell or consume the animals, except chickens. The control over the livestock profits is similarly male dominant.

Table 6-7. Intra-household decision making on management and profit control by livestock type

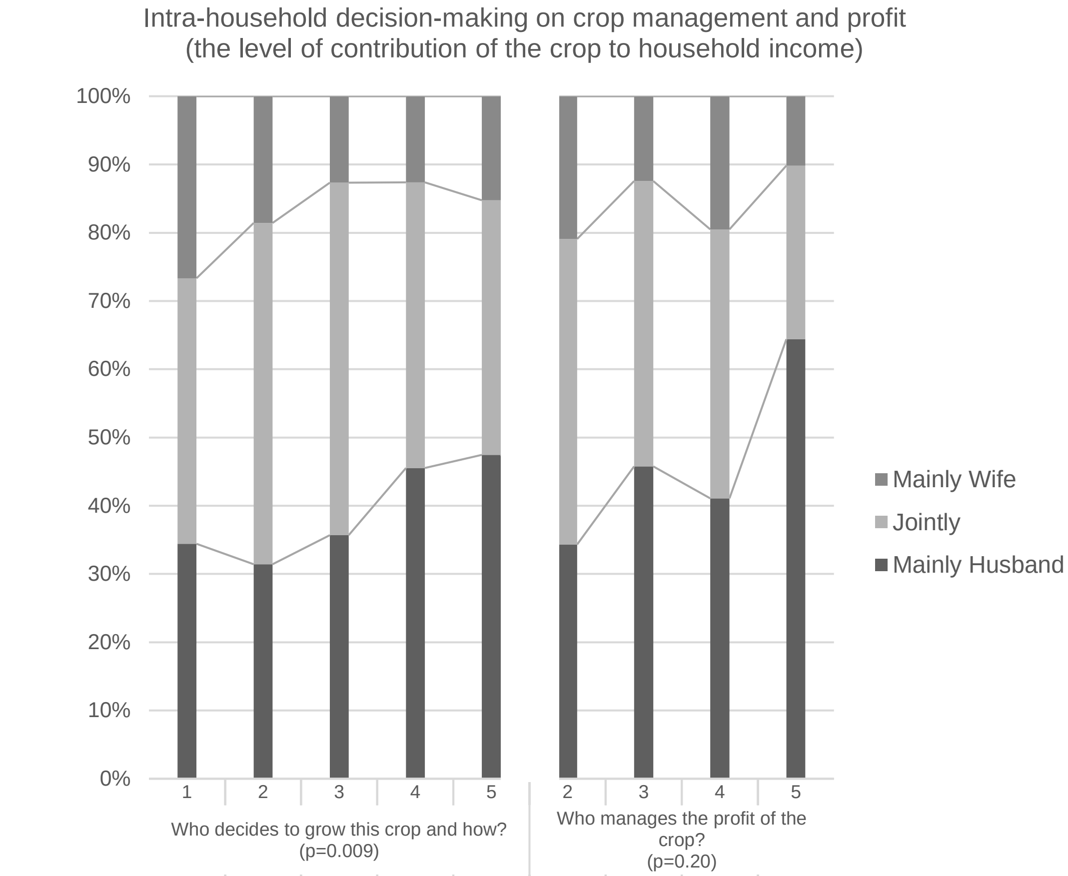
	Who decides whether and when to sell or consume the animals?				Which person within your household manages the profit from this animal?			
NWSG AEZ								
	Mainly Husband	Jointly	Mainly Wife	Other	Mainly Husband	Jointly	Mainly Wife	Other
Pigs	60.0%	30.0%	10.0%	0.0%	75.0%	12.5%	12.5%	0.0%
Cows	53.8%	42.3%	0.0%	3.8%	53.3%	46.7%	0.0%	0.0%
Goats	51.5%	40.9%	7.6%	0.0%	50.0%	37.0%	13.0%	0.0%
Chickens	40.7%	42.6%	16.7%	0.0%	40.0%	45.0%	15.0%	0.0%
SWF AEZ								
	Mainly Husband	Jointly	Mainly Wife	Other	Mainly Husband	Jointly	Mainly Wife	Other
Cows	63.6%	36.4%	0.0%	0.0%	61.9%	33.3%	4.8%	0.0%
Goats	58.1%	35.5%	6.5%	0.0%	57.4%	31.1%	11.5%	0.0%
Pigs	55.6%	44.4%	0.0%	0.0%	50.0%	37.5%	12.5%	0.0%
Chickens	52.4%	28.6%	14.3%	4.8%	60.0%	22.9%	17.1%	0.0%

*Only major crops are listed in the table. The original data contain 304 and 251 livestock cases for production decision and output decision, respectively.

'What I cannot do without seeking for approval (from my husband) may be introduction of animal. I need his approval for goats, because animal is an asset, and my husband is the head of family, so for such thing to enter in our home, it needs his consensus.' (E17/Moderate married woman in disadvantaged village, NWSG AEZ)

The difference in crops alone, particularly cash or food crops, does not fully capture the decision-making reality. Since 'traditional' food crops are increasingly commercialised due to rapid urbanisation, such crops are no longer ‘women’s’ crops. Therefore, the gender patterns of decision making over crops are not static. Hence, the crops were categorised into their different degrees of importance to household income, rated by each household using a five band Likert-scale (where 1= of little importance; 2= less important; 3= moderately important; 4= important; and 5= very important) in the household survey on crop management. Consequently, the level of authority was found to differ in accordance with the importance of the crop for household income (Figure 6-3). More specifically, the results demonstrate that the husbands’ decision-making powers increase in accordance with the level of importance to household income. Binary logistic regression analysis (Table 6-8) supports at statistically significant level the hypothesis that men’s decision-making power (on both crop management and profit) increases with the level of importance of the crop to household income, while women’s decision-making power declines (on crop management). Also, the analysis shows some statistical evidence that joint decision making (on both crop management and profit) decreases in accordance with the level of importance of the crop.

Figure 6-3. Intra-household decision making on crop management and profit in order of the level of contribution to household income



	1	2	3	4	5	2	3	4	5
Mainly Wife	26.7%	18.6%	12.7%	12.6%	15.3%	20.9%	12.4%	19.5%	10.2%
Jointly	38.9%	50.0%	51.6%	41.9%	37.3%	44.8%	41.8%	39.4%	25.4%
Mainly Husband	34.4%	31.4%	35.7%	45.5%	47.5%	34.3%	45.8%	41.1%	64.4%

-The importance of crop for household income (level 1) from "who manages the profit of the crop?" is removed, because there is no case for this category (which means that there is no profit at all from the crop.).
-This analysis used Likert-scales as a continuous variable as other studies (Knudsen and Roman, 2015, Lalani et al., 2016).

Table 6-8. Binary logistic regression analysis predicting whether decision makings (on crop management and profit) are related to importance of the crop for household income

	Who decides this crop and how?								
	Mainly husband			Jointly			Mainly wife		
	b	S.E.	exp(b)	b	S.E.	exp(b)	b	S.E.	exp(b)
Importance for HH income (1-5)	0.19	0.07***	1.20	-0.04	0.07*	0.96	-0.25	0.09***	0.78
-2 Log likelihood	903.67			932.69			573.8		
Cox and Snell R^2	0.01			0.00			0.01		
Nagelkerke R^2	0.01			0.00			0.02		

	Who manages the profit of the crop?								
	Mainly husband			Jointly			Mainly wife		
	b	S.E.	exp(b)	b	S.E.	exp(b)	b	S.E.	exp(b)
Importance for HH income (1-5)	0.21	0.10**	1.24	-0.20	0.10*	0.82	-0.03	0.14	0.97
-2 Log likelihood	784.14			765.77			508.51		
Cox and Snell R^2	0.01			0.01			0.00		
Nagelkerke R^2	0.01			0.01			0.00		

*p<0.1, **p<0.05, ***p<0.01

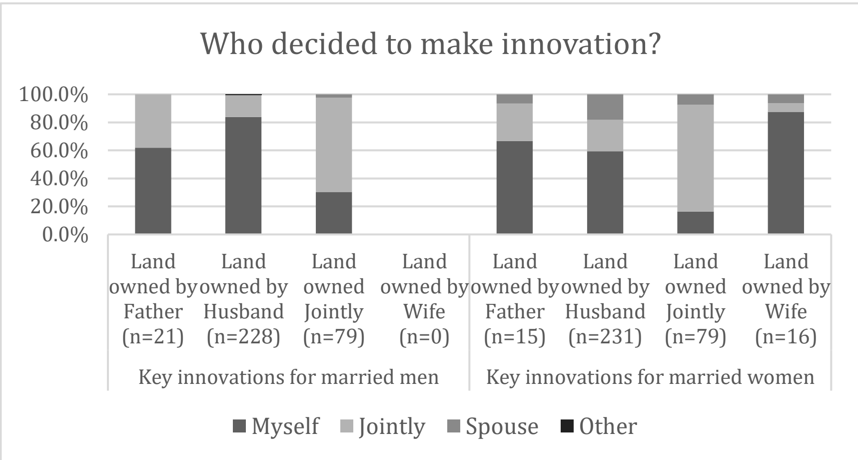
6.4.5 Empirical Evidence of Gendered Production Assets and Decision-making Power

6.4.5.1 Land

Decisions over innovation processes are determined by the gendered endowment and allocation of production assets, as indicated in the in-depth interviews discussed previously. Many of the interviewees claimed that land ownership is one of the most crucial factors to affect the decision-making power which concerns the innovations. Land ownership is clearly male dominant at the research sites. The household survey found that 73.1 per cent of 238 households with spouses stated that their land belongs to the husband, 5.9 per cent claim it belongs to the husband's father, while only 15.5 per cent of the households said the land belong to both husband and wife, and 4.2 per cent to the wife alone. However, the in-depth interviews suggest that women have more decision-making power over innovations implemented on the jointly owned land or on the land rented by women. The trend of land ownership has not changed drastically compared to the data of 10 years ago. Nonetheless, the proportion of households with spouses who rent land increased from 26.8 per cent to 45.0 per cent over the last 10 years, although it is not clear who rented the land, the wife or the husband.

Despite the gender inequality in land ownership, the noteworthy finding is that decision-making authority about innovations is affected by land ownership (Figure 6-4). Due to the lack of more precise data on whose land each of the innovations is made, the land ownership analysed here is the ownership of the household's land in general. Despite this data shortage, Figure 6-4 clearly unveils the empirical evidence to show joint decision making on innovations is associated with the jointly owned land, as also supported by some respondents (e.g. Ru13). Furthermore, the wife's autonomy in decision making over her innovations is seen for the household's land owned by the wife (e.g. Ru 15 in 6.4.2), while it is predominantly the husband who decides on his innovations if the household's land belongs to him (e.g. Ru 8 in 6.4.2).

Figure 6-4. Relationship between Intra-household decision making over innovations and Land ownership



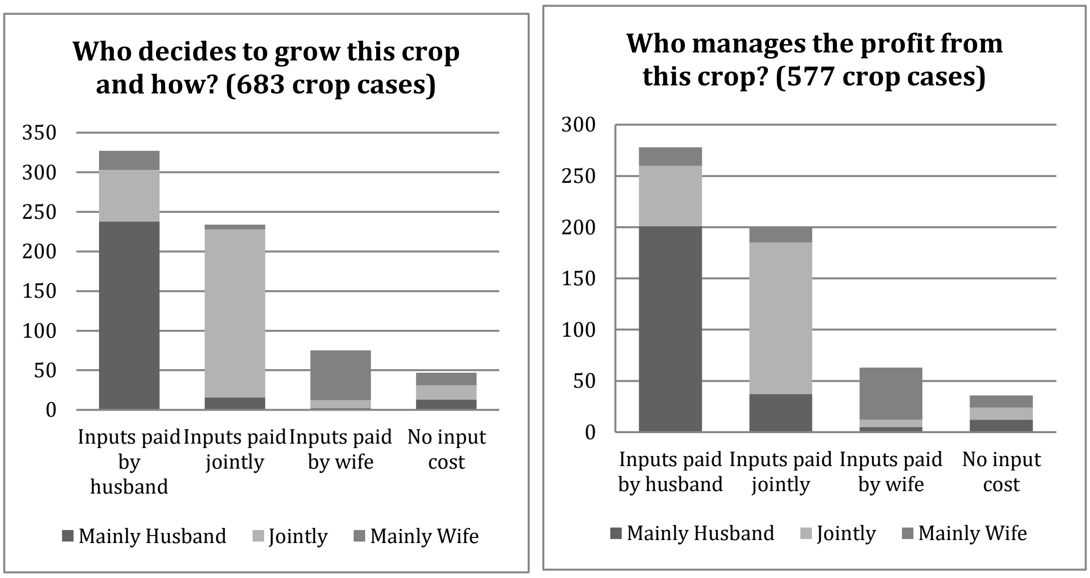
'I do not ask permission from my husband (for my innovation), because we hire land.' (Ru13/Moderate married woman in disadvantaged village, SWG AEZ)

6.4.5.2 Capital Inputs

The source of inputs strongly influences who makes the decisions on the innovations and their outputs, as noted by both male and female in-depth interview respondents, as shown in Ry10. Figure 6-5 which is based on the household survey shows that the party who paid for the inputs to grow the crops has a greater voice over the management of the crop and the profit generated.

'I share (an idea of new practice) with him because I have no money to buy inputs.' (Ry10/Moderate married woman in advantaged village, SWG AEZ)

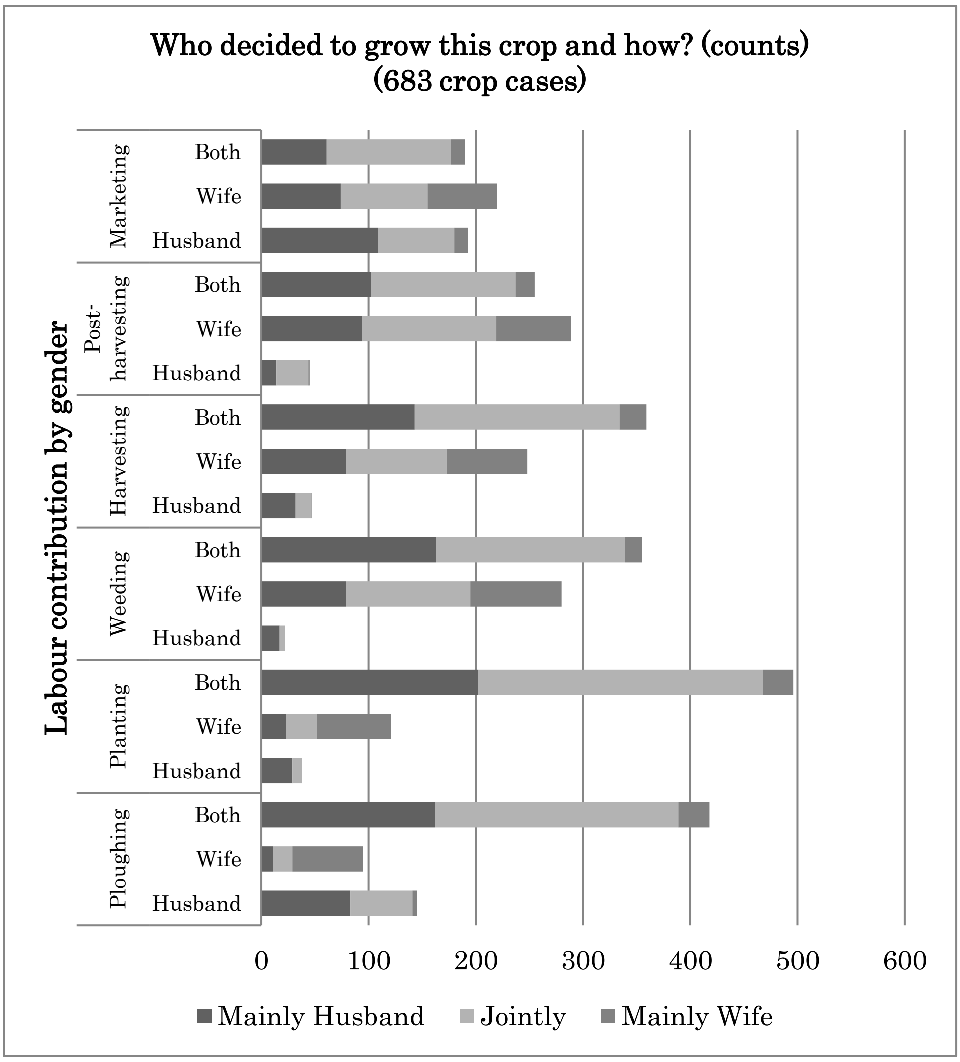
Figure 6-5. Intra-household decision making on crop management and profit control and who paid for inputs



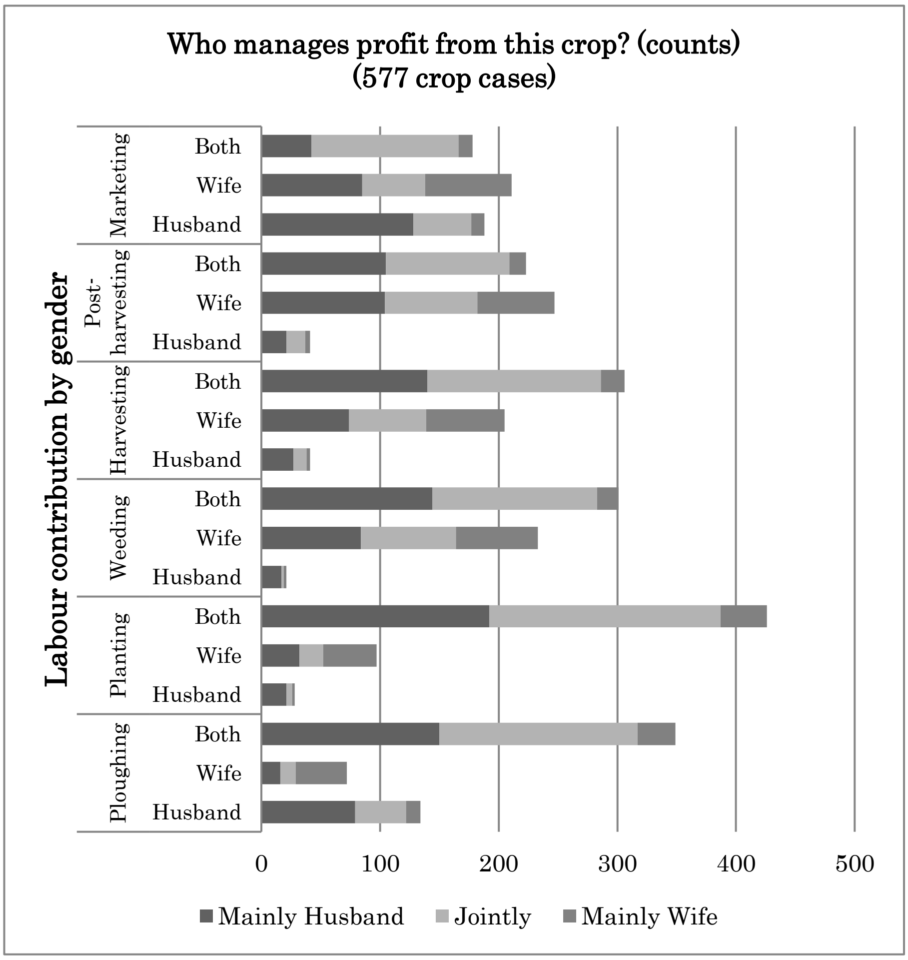
6.4.5.3 Labour

A gendered division of labour is related to decision-making power over crop and profit management. Figure 6-6 demonstrates the relationships between intra-household labour contribution (work done by mainly men, women, or jointly) and decision-making pattern on the management (decided by mainly men, women, or jointly). It shows that each farming activity has its own tendencies for labour allocation between men and women. For instance, ploughing and planting are often done by both, while weeding, harvesting, and post-harvesting activity (e.g. peeling and drying) are done either by women alone or by both. Spraying pesticides is typically done by men. These gendered divisions of labour clearly shown in Figure 6 were consistently reported by the farmers during in-depth interviews. Nevertheless, most importantly, who provides the labour at each stage of crop production and marketing is associated with the decision-making power over management and profit, although the causality is uncertain. Figure 6-6 supports the claims made in the in-depth interviewees that the party who contributed his or her own labour has more say on innovation processes and outputs. It is noteworthy, however, that the women's labour contribution seems greater than the men's, despite their lower decision-making power. The data seems to imply that women who mainly decide how to grow the crop and control the profit are mostly working on the crop alone, which is also evident in the statement of E20 below. The data displayed in Figure 6-6 also captured the high rate of each farming activity jointly performed, although it is clear that husbands have greater authority on decision making, even for the crops for which the work is done jointly.

Figure 6-6. Gender role division and Intra-household decision making on crop management and profit control



*Other answer options (children, no one does the work) are excluded from the bar chart above.



*Other answer options (children, no one does the work) are excluded from the bar chart above.

'When I had such idea (expansion of groundnuts, green grams and sesame), I shared it with my husband and we made decision together because of labour. (Even if my husband wants to make a similar innovation), still we have to share and decide together because I am the one who cooks during the farm work for workers. For introducing okra, osubi, dodo and pumpkins, I do not seek an approval (from my husband), because it's on small scale and requires little labour.'
(E20/Rich married woman in disadvantaged village, NWSG AEZ)

6.5 Discussion

This study identified and explored the patterns of intra-household decision making and the factors which influence the decision-making authority which concern innovation uptake and outputs. It used a mixed method guided by the reasons farmers perceived as influencing who has decision-making authority. The study found the gender disparity in decision making over both innovation uptake and benefits. On the one hand, married women themselves decide whether or not to adopt approximately half of the innovations with which they are directly involved, while the rest of their innovations are decided either jointly or by their husbands. On the other hand, married men decide on the majority of their innovation uptakes by themselves, while some of their innovations are decided jointly. Moreover, the richer the households are, the more male dominant decision making is seen to be. The gendered enterprises (either food or cash crops, and the importance of the crop to household income) for which the innovations are adopted, and the assets (land ownership, labour participation, and cash input contribution) used for those innovations, are found to be the major factors influencing decision-making authority. Hence, the intra-household decision making about innovations is greatly gendered due to the norms which stipulate gendered roles and responsibilities, and to the gender inequalities associated with asset endowment and control.

This study found that the intra-household decision-making patterns on innovation uptake are attributed to complex, intertwined reasons with various influencing factors. This tells us that men and women have different levels of autonomy in deciding whether to adopt innovations and that this depends on the power relationship between husband and wife. This, in turn, is determined by whether the required resources or assets can be mobilised to make the innovations. Men make decisions without consulting women because they are the family heads and the crops are grown on their own land, while women have to seek approval from men because the innovations require the men's land and capital. It is crucial to emphasize, however, that gender inequality of asset allocation causes unequal bargaining power, so that generally the only bargaining tool women have is their own labour. In addition, both the social norms and individual perceptions of gendered enterprise types (e.g., crop and livestock) and the gendered division of labour play key roles (e.g., women's responsibility for food provision) in shaping the decision-making patterns concerning innovations, which do not usually necessitate "explicit negotiations" (Agarwal, 1997). Women have more freedom to introduce innovations in "women's crops" such as food crops and vegetables grown for home consumption (e.g. okra, eggplant, millet…etc). Such norms are shared by both men and women at community, household, and individual levels. Women's status as subordinate leads them to submitting to which innovations are to be adopted, and men's superiority results in underestimation of women's capacity and/or knowledge, which blocks the intra-household information flow from women to men.

Intra-household decision-making over innovation outputs follows similar logic. Who has more say about the outputs from the innovations is strongly related to who contributed to the enterprise in terms of assets, such as resources and labour. The common pattern is that men control the cash profit from marketing the produce, especially when purchasing assets such as land and cows, financing off-farm business, and paying school fees for the children, while women decide how much of the produce is retained for family consumption and for donating to neighbours or relatives. Women can negotiate over the harvest as long as outcomes are beneficial to the family food supply. Moreover, for the purpose of buying basic home groceries, such as soap, salt, and cooking oil, the women have more authority over spending remuneration gained from their own casual labour and from part of the cash profit, as well as the profit earned from the little surplus of food crops grown mainly by them. Such crops, socially perceived as "women's crops", include leafy vegetables and sweet banana. Again, social norms and individual perceptions of gender roles (e.g., women as food providers) and gendered crop types (e.g., food crops) greatly affect the decision-making pattern in innovation outputs. This reality demonstrates that the unitary model, and even Becker's model of 'benevolent dictators', cannot fully explain this gender difference in decision-making authority and intra-household decision-making dynamics, but the different varieties of bargaining models clearly co-exist, as many authors claim (Wolf, 1990, Udry, 1996, Agarwal, 1997, McPeak and Doss, 2006, Browning et al., 2010, Moghadam et al., 2011, Njuki et al., 2011, Doss, 2013, Kebede et al., 2014).

The methodology employed in the study allowed the farmers' voices to identify the factors influencing decision-making patterns, it then confirmed the patterns using quantitative data obtained by household and individual questionnaire surveys. The identified factors were the enterprise types, such as the types of crops and animals, land ownership, capital input contribution, and labour participation. The quantitative data greatly supported the farmers' claims. Firstly, whether the crops are "women's crops" or "men's crops" determines the decision-making authority over their management. The data verified that men have greater decision-making authority and control of profits than women for all crops and animals, but they have even greater authority for socially and culturally perceived "men's crops" or "men's animals" than "women's crops". Secondly, regardless of whether crops are "women's crops" or "men's crops", the more the crops contribute to the household income, the higher the rate of men dominating the decisions about how to grow the crops and spend the profits. Thirdly, who provided the necessary assets (e.g., land, capital inputs, and labour) for producing the crops determines the degree of decision-making power.

Regarding the farmers' claims about "men's crops" or "women's crops", the first evidence from crop management analysis confirmed that men have higher decision-making authority on what the farmers recognise as "men's crops". However, what determines "women's crops" and "men's crops" has not been fully addressed in much of the literature, even though it supports the notion that men grow cash crops and women grow food crops (Miiro et al., 2001, World Bank, 2007b, Mazur and Onzere, 2009), the narrative is often oversimplified. Doss (2002), who examined whether there are men's crops and women's crops in Ghana, argues that most of the crops are grown both by men and women and cannot be simply classified as either men's crops or women's crops, in spite of the complicated gendered patterns of crops grown on lands held by men or women and whether households are male- or female-headed. The crop management analysis in this study came to similar conclusions as Doss (ibid.), i.e., that all the key household crops are grown both by men and women, although men and women contribute their labour to different crops and to different degrees. More importantly, as many farmers expressed, the social norms and their personal beliefs about what are "women's crops" and "men's crops" determine the gender pattern of decision-making authority over different crops. In other words, such social norms and personal beliefs not only dictate that food crops should be grown by women and cash crops by men, but they also influence the use of profits from different crops for household expenditure (World Bank, 2007b). The difference in bargaining power between men and women does not always result from an explicit process of negotiation (Agarwal, 1997), but from pre-established social norms of gendered crops and gendered responsibilities.

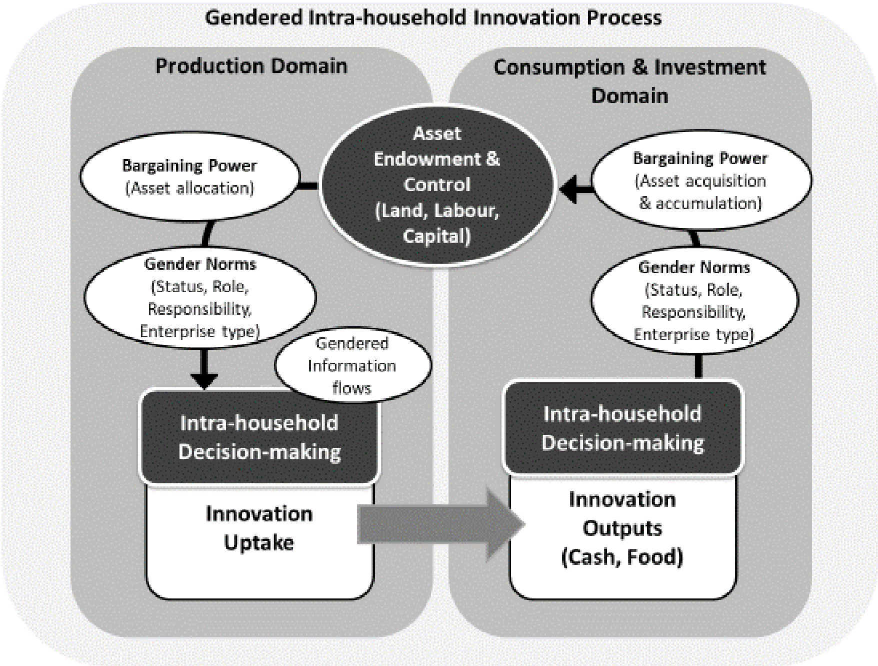
Nevertheless, the second finding shows that the higher the contribution of the particular crops to the household income, the higher the degree of men's decision-making authority over management and expenditure. This finding is similar to that made by Njuki et al. (2011), who found that the higher mean income of a commodity is characterised by a lower percentage income share with women in Malawi and Uganda. This finding suggests evidence of men's capture of profits, even from food crops, meaning that the decision-making patterns are beyond the simple classification of traditional "women's crops" and "men's crops".

The third finding revealed that gender inequality in the decision-making authority concerning innovations is influenced by the gender inequality which exists in asset ownership. This finding is consistent with the work of many other authors (Agarwal, 1997, Meinzen-Dick et al., 2011, Doss, 2013, Quisumbing et al., 2015, Johnson et al., 2016) who claim that the significant determinant of intra-household bargaining power is asset endowment and ownership, as well as the ruling institutions' use and control of such assets. The implicit rules binding the decision-making authority over crop management and innovations are that the party who contributes more input to grow the crops retains the higher bargaining power over the process and the outputs. These underlying rules are often neglected in poverty reduction interventions. Clearly, men hold ownership of most of the lands in the research sites. In the meantime, men have greater capacity to mobilise the labour of all household members, while female farmers mostly rely on labour provided by their children during school holidays (Mazur and Onzere, 2009). Consequently, men's higher intra-household bargaining power over innovation outputs is exerted to further accumulate men's assets, which, in turn, provides greater bargaining power over new innovations. This situation is similar to that which Agarwal (1997) describes as "iterative bargaining", whereby assets accumulated at one point of bargaining, which either strengthen or weaken a person's fall-back position, would affect the outcomes in the next round.

Lastly, this study unveiled the different gender patterns of bargaining power and negotiation in different wealth categories of households. Following Chant (2011) criticism of the lack of attention paid to differences among women, there remains scarce literature on intra-household decision making which captures the heterogeneity of women. Although beyond the scope of this article, there are large differences between those households headed by single women (e.g., widowed, separated, or divorced) and those of women with partners in terms of decision-making authority in innovation processes. Chant (2011) challenges the notion of the 'feminization of poverty' which regards female household heads to be the most vulnerable of women; this study supports such a challenge as it found that these women have much more freedom in innovation decisions than has previously been reported. Even married women are not homogeneous. This study analysed how the wealth status of the household influences the intra-household decision-making patterns. The major finding is that the richer the household is, the more predominantly men hold decision-making authority over their innovations and fewer joint decisions are made. Whilst this finding may initially seem surprising, the reasons for it were clearly evident from farmers. According to the poor and moderate farmers, women have to be more involved in decision-making processes so that men can secure their wives' labour. For these wealth categories, plots are sometimes jointly purchased or rented by women themselves, this encourages the joint decision-making patterns and those which are less male-dominant. On the other hand, for rich men, who often have the capacity to hire casual labour, their wives' labour is less important to them, so the women lack the bargaining power that their less well-off counterparts gain through their labour. Thus, a person's bargaining power is defined by the person's "fall-back position", which is the outside option in case of cooperation failure (Agarwal, 1997). This concept of a "fall-back position" helps understanding of why rich women expressed their fear of divorce.

The decision-making processes in terms of uptake and outputs of innovation in the context of intra-household decision-making are highlighted in Figure 6-7. Deciding whether or not to introduce innovations in the production domain is greatly affected by the bargaining power of household individuals over the use of assets that are necessary for innovations, such as land, labour, and agricultural inputs. Which innovations to be introduced on which crops tends to be conditioned by social norms and individual perceptions of gender roles and responsibilities. After uptake, a further intra-household decision is made over how to allocate the outputs for home consumption and sale, and how to spend the profit in the consumption domain. This decision is based on the consumption preferences shaped by the social norms of gender roles and responsibilities, as well as how much assets were contributed from which party in order to produce the output. The outputs are often used to accumulate further assets, which influence the further innovation uptake in an "iterative" bargaining process. Thus, innovations may act as a bargaining power changer for intra-household asset allocation, either reproducing the existing male-dominant power structure or empowering women in the process.

Figure 6-7. Gendered intra-household innovation process



Source: Authors

6.6 Conclusion

Innovations are crucial for the development and adaptation of the livelihoods of smallholder farmers in SSA. At the same time, innovations have the potential to challenge conventional gender norms and institutions and to reallocate assets within households (Quisumbing et al., 2015). By unpacking farmers' perceptions of gendered decision-making processes, this study has demonstrated that decision-making authority is greatly affected by gendered enterprises and gendered allocation of production assets, which are supported by both qualitative and quantitative evidence. As shown in Figure 6-7, gendered assets determine who controls innovation processes in both production and consumption domains, this reallocates assets within the household and results in either enhancing or challenging the cultural gender norms in the iterative processes. Therefore, this article suggests a broader perspective is required to understand the gender and innovation processes, including bargaining power, which is greatly influenced by gender norms and asset ownership and control.

This study challenges the unitary approach by analysing intra-household dynamics. However, intra-household asset reallocation processes are highly complex because both collective and cooperative bargaining models and non-cooperative models coexist within the same household. It is clear from this study, and from a number of other studies (Meinzen-Dick et al., 2011), that men have more assets, and hence more decision-making authority than women. Nonetheless, women have their own windows of opportunity for decision-making autonomy using their own labour and available inputs. Also, it is noteworthy that there are a high proportion of cases whereby jointly purchased assets lead to joint decision making. As some authors (Chant, 2011, Palacios-Lopez et al., 2017, Doss et al., 2018) contest, it is important to scrutinise the validity of traditional static gender narratives and attempt to comprehend the updated holistic picture of gendered situations in the context of agricultural development.

Furthermore, a dichotomised approach which divides farmers into men and women is not sufficient to fully understand the intra-household decision-making processes; certainly, this study has proved that wealth also influences decision-making patterns. The study found that the key innovations reported by richer women are decided by their husbands to a greater degree than those reported by women in other wealth categories (Figure 6-2). The reason behind this is that rich women are afraid of divorce and their labour, which is their only bargaining tool, is not effective, as their rich husbands can hire external labour. On the other hand, poor women have more decision-making authority as their labour will be necessary to achieve innovations, so their husbands need to seek their agreement.

Therefore, future policy and interventions in agriculture and rural development should not blindly adopt a unitary approach regarding a household as a minimum unit to target; it should take into account intra-household communication and decision-making processes in their innovation support as this greatly influences the innovation processes and outcomes. Also, it is crucial to recognise the risk of overburdening women in a society which defines women's roles and responsibilities in terms of food security. Added to this is the danger of imposing innovations that may widen gender gaps in asset endowment and control, thereby weakening the women's bargaining power over new innovations and their benefits in the future. Innovation support should encourage an increase in more gender equal stocks of, and economic returns from, agricultural assets with a gender-transformative approach (Meinzen-Dick et al., 2011, Quisumbing et al., 2015). Nevertheless, care must be taken, as women tend to lose control of traditionally perceived food crops once they gain higher market value (Njuki et al., 2011). Future studies may be expected to explore how potential future changes, such as commercialisation of food crops and expansion of the land rental market, affect women's freedom to make decisions on innovation processes and outputs. Such studies may possibly lead to better gender-sensitive and transformative policy and interventions for future innovations.

Chapter 7 - Why Are Innovation Networks and Systems Not Inclusive? An Analysis of Diverse Smallholder Farmers' Innovation Processes in Uganda

This chapter is going to be submitted to journal as:

SHIBATA, R., DORWARD, P., CARDEY, S., & CLARKSON, G. Why Are Innovation Networks and Systems Not Inclusive? An Analysis of Diverse Smallholder Farmers' Innovation Processes in Uganda. *Agriculture and Human Values*.

Abstract

Innovation in smallholder agriculture occurs as a result of interactions between multiple actors. This paper investigates the nature of innovation networks and systems experienced by different types of smallholder farmers and how they both enabled and constrained innovation processes. Research was conducted in two contrasting Agro-Ecological Zones (AEZs) in Northern and Western regions of Uganda. Household and individual questionnaire surveys were conducted targeting 531 farmers in four villages, as well as 49 stratified Focus Group Discussions (FGDs) and in-depth interviews with 90 randomly selected farmers. Using a case study approach, 12 innovation processes were explored in detail. Richer, model farmers, and farmers' groups were found to use vertical networks for obtaining knowledge. Wealthier farmers tried-out innovations more and had wider knowledge networks with more actors in Agricultural Innovation Systems (AIS) than poorer farmers. Poorer farmers relied on observation of other farmers and used horizontal informal networks, although in some cases casual labourers played a brokering role through accessing and using knowledge from richer and model farmers. Farmers that had not tried innovations had smaller knowledge and information networks and were specifically constrained by lack of access to

farmers' groups and associated knowledge and inputs. Furthermore, a social class gap hindered knowledge acquisition from wealthier farmers. The paper suggests a farmer-centred as opposed to an innovation-centred approach, which considers heterogeneity within a community and the importance of the removal of barriers for network-excluded farmers through the creation of inclusive institutional environments.

7.1 Introduction

It is widely recognised that agricultural innovation by smallholder farmers is essential for rural livelihoods and poverty alleviation in many Sub-Saharan African countries which have been suffering from decades of productivity stagnation (Hazell et al., 2010, World Bank, 2012, Wiggins, 2014). It is widely acknowledged that innovation is a social process involving collective action, coordination, and exchange of knowledge among a multitude of different actors within a wider social system (Agwu et al., 2008, Sanginga et al., 2009, World Bank, 2012). The innovation process is therefore affected by the types of social interactions and communication which exist in the community, including: network-building, social learning, feedback, dealing with power and conflict (Leeuwis, 2004, Leeuwis and Aarts, 2011); negotiation (Fressoli et al., 2014); and social attitudes and practices (Hall et al., 2006b, World Bank, 2007a). The failure of early models of technology transfer in Sub-Saharan Africa is attributed to limited understanding of the role of this social process (Assefa et al., 2009, Spielman et al., 2009b, Hounkonnou et al., 2012, Faure et al., 2015). Such traditional models often failed due to top-down approaches which promoted ready-made new technologies developed by research institutes and transferred by extension workers to farmers, and also due to limited government resources which led to low coverage of target farmers. This criticism of the linear diffusion of innovations approach gave rise to the innovation systems approach which views innovation as a more holistic process beyond technology development and transfer and emphasises interactive social learning among multiple actors (Assefa et al., 2009, Hounkonnou et al., 2012, Klerkx et al., 2012, Pamuk et al., 2014, Adolwa et al., 2016, Lamb et al., 2016).

However, despite the enormous potential of innovation systems perspectives, there are limited empirical studies on actual innovation processes that identify and explore which actors play what kind of roles in the innovation networks and systems, how the interactions of actors contribute to innovation spread, and what constrains such interactions and dissemination. While many recent studies (Spielman et al., 2011, Sanya et al., 2018) have analysed social networks quantitatively by computing the size of the network, the number of ties, and their density, and usually comparing them between innovators' and non-innovators' networks, many of them omit qualitative aspects of interactions in innovation processes and consequently fail to describe the systemic constraints which may prevent the innovation networks from being inclusive. Moreover, while recent innovation adoption studies have contributed to the identification of attributes of users of innovations, the constraints being faced by non-users have received less attention (Reij et al., 2001, Leeuwis, 2004), hence they have made only limited contributions regarding policy implications for "inclusive innovation" (Foster and Heeks, 2013), which has attracted growing intellectual and global commitment, following the UN's Post-2015 Development Agenda (Heeks et al., 2014) and Sustainable Development Goals (SDGs).

This study, therefore, aims to: understand the innovation pathways and processes that have led to smallholder farmers accessing and using innovations that they consider important; assess how inclusive the innovation networks are for farmers with different socioeconomic characteristics; and identify the constraints that farmers of different types face in their innovation processes.

7.2 Theories of Innovation Networks and Systems

7.2.1 Social Networks and Social Learning for Innovation

Innovation processes entail both social networks and social learning. In recent years, a number of studies with an innovation systems approach have increasingly recognised the important role of social networks and social learning in knowledge exchange, experimentation, and risk mitigation, especially when making new innovations which involve uncertainties (Bandiera and Rasul, 2006, World Bank, 2007b, Mazur and Onzere, 2009, Conley and Udry, 2010, Spielman et al., 2011, Maertens and Barrett, 2013). Social networks are mechanisms connecting individuals to society with patterns of social interaction (Hoang et al., 2006), and are often defined by social and economic institutions which are formal and informal "rules of the game in a society", such as laws, regulations, contracts, norms and customs (North, 1990). Social learning, which goes beyond individual learning, is defined as a learning process in which interdependent social actors simultaneously develop complementary understandings on relevant reality, problems, and boundaries for more desirable change or innovation (Leeuwis, 2004, Leeuwis and Aarts, 2011).

Social networks and learning facilitate, or at times limit, innovation processes by affecting members' access to knowledge and information in society (Spielman et al., 2011), often described as "social capital" and a key asset of individuals (Putnam, 2000, van Rijn et al., 2012). The functions, or characteristics, of ties in social networks are often described as formal or informal, horizontal or vertical (Hoang et al., 2006), or as bonding strong ties or bridging weak ties (Darr and Pretzsch, 2008, Saint Ville et al., 2016). The informal, horizontal, and bonding strong ties are linkages with frequent contact and communication, often seen in farmer-to-farmer interactions, while the formal, vertical, and bridging weak ties are characterised by infrequent contact, such as linkages between farmers and researchers (Adolwa et al., 2016).

Various innovation studies argue what structures of social networks contribute to innovation sharing more efficiently and effectively. Some argue that informal, horizontal, and strong ties of social networks are more effective in innovation dissemination than formal, vertical, and weak ties. Horizontal communication is particularly relevant for poorer farmers who are found to rely more on informal farmer-to-farmer interaction, while wealthier farmers receive more information from extension services and prominent farmers (Reij et al., 2001, Hoang et al., 2006, Matous et al., 2013). Some studies also found that less-knowledgeable farmers tend to be more responsive to information obtained from their peers (Bandiera and Rasul, 2006, Conley and Udry, 2010). Darr and Pretzsch (2008) and Adong et al. (2012) argue that farmers' groups are the most effective pathways of innovation dissemination among farmers. The community's culture and norms, such as its levelling system and food-sharing, also either hinder or contribute to the innovation sharing over a time (Sugiyama, 2011).

In contrast, others highlight the significant role of bridging and vertical ties in obtaining novel knowledge and information. An early study, conducted by Granovetter (1973) emphasised the significant role of weak ties in diffusing novel knowledge or information to a larger number of people. He notes that people from different circles connect "us" to a wider world. In more recent studies, Adolwa et al. (2016) found that the presence of weak knowledge ties is critical for the awareness and learning of soil fertility management, comparing cases in Kenya and Ghana. Thuo et al. (2014) argue that weak ties, such as with researchers, extension workers, input sellers, and buyers, have a significant impact on farmers' information acquisition about new groundnut varieties in Kenya and Uganda.

Nonetheless, many agree that both bonding and bridging ties of social networks are necessary for innovation, and they simply play different roles in innovation processes; weak ties for acquisition of novel knowledge, strong ties for exchange of complex knowledge (Spielman et al., 2011, Adolwa et al., 2016, Saint Ville et al., 2016), described as "search" and "transfer" by Hansen (1999) and "innovation" and "imitation" by Shaw-Ching Liu et al. (2005). Further, Darr and Pretzsch (2008) found that effectiveness of either cohesive or weakly knit networks depends on whether the information is abundant or scarce. Under conditions of information abundance, strong networks disseminate innovations more effectively than weak networks, while in a situation of information scarcity, the pattern is reversed.

7.2.2 Innovation Network and System Constraints and Inclusiveness

There is no doubt that both bonding and bridging networks play significant roles in innovation, however the cases in which social networks do not function well are often ignored or under-reported. With regard to bonding networks, for instance, Matous et al. (2013) found that farmers who are socially well connected within the community tend to be less receptive to agents' recommendations, described as "cognitive social capital" by van Rijn et al. (2012). Meanwhile, Ishikawa et al. (2014) reported that model farmers with greater technology absorption skills tend to be less effective in disseminating the technology to other farmers. Furthermore, the unobserved different characteristics of farms, such as soil fertility, prevent social learning from neighbours, as observed in a comparison study of rice and wheat growers in the Indian Green Revolution (Munshi, 2004), and by a coffee pruning case in Peru (Weber, 2012).

The bridging network stagnates when contact farmers do not play a brokering role. Some studies on bridging social capital have focused on mediators' characteristics. Many claim that the access to formal innovation actors, such as extension staff, increases with farmers' wealth and the size of their personal networks, with greater proximity to the village centre and other households, and with the same religion and ethnicity as their agents (Bandiera and Rasul, 2006, Hoang et al., 2006, Spielman et al., 2009a, Matous et al., 2013, Ishikawa et al., 2014). This is because extension agents focus on those farmers with larger personal networks who are believed to influence many other farmers. This is especially so for public extension agents who strive to meet prescribed technology adoption rates under increasing pressure from short-term output-oriented extension policy (Matous et al., 2013). Nevertheless, Hoang et al. (2006) and Leeuwis (2004) warned that the selected wealthier and more powerful contact farmers are not representative of the community, leaving out the already marginalized farmers due to existing power relations within the village.

The recent work on social network analysis using an innovation system approach has greatly contributed to understanding of the wider innovation systems and networks beyond linear actors, i.e., researchers, extension officers, and farmers. “System” is similar to “network” but wider in scope, as the concept of “system” contains formal and informal social and economic institutions and policies. An Agricultural Innovation System (AIS) framework considers wider systems by acknowledging wider actors, such as market actors and consumers (Hall et al., 2006b, Spielman et al., 2009b, Klerkx et al., 2012, World Bank, 2012). However, such studies often neglect smallholder farmers as a central part of the innovation system or network (Berdegué, 2005, Rajalahti et al., 2008, Assefa et al., 2009, Spielman et al., 2009b, Spielman et al., 2011, Cardey and Garforth, 2013, Chowa et al., 2013, Garforth, 2013), and, more importantly, the relevancy and inclusiveness of the network for different farmers, especially the poor (Fressoli et al., 2014, Dawson et al., 2016, Nemes and Augustyn, 2017).

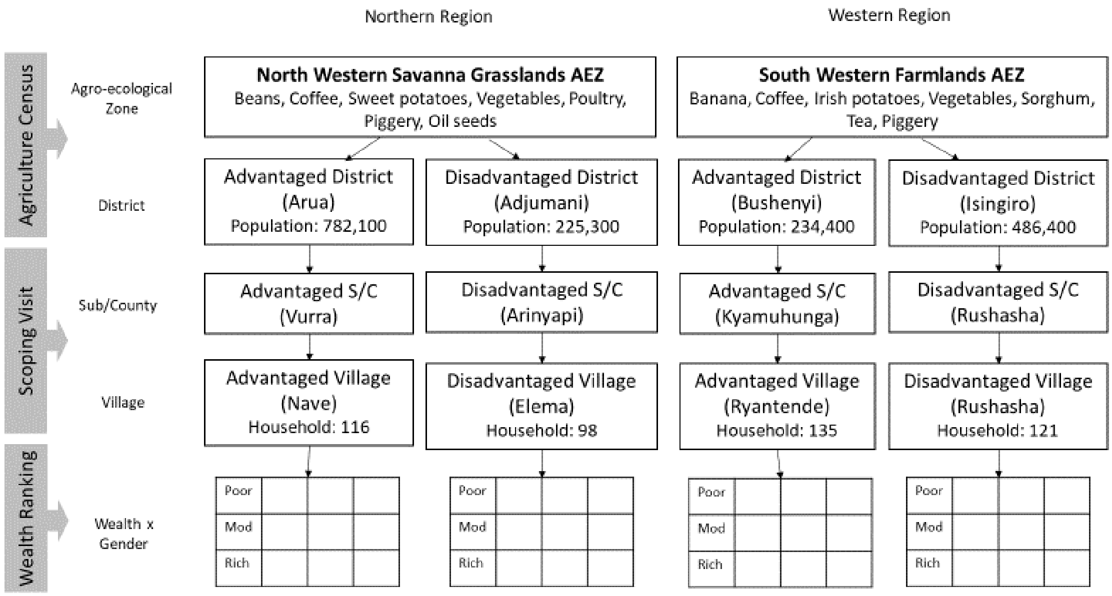
While micro-level analysis of livelihoods in informal settings is crucial for studying inclusive innovation systems (Foster and Heeks, 2013, Santiago, 2014), there are few empirical studies in this area. In the context of developing countries, Berdegué (2005) advocates pro-poor innovation systems by claiming that the opportunities for innovation are unevenly distributed among the rural population. He insists that the poor are driven by “push factors” (responses to negative incentives, such as depleted soil fertility or drought), rather than “pull factors”, including new market opportunities for high value crops and new technologies which are often drivers for the non-poor. This resonates with categorisation of household livelihood strategies and transformations, “hanging-in” and “stepping-up” (Dorward et al., 2009), where the former is driven by push factors and the latter by pull factors. Among the limited number of empirical studies with a holistic approach, Singh et al. (2016) analysed farmers' decision-making on livelihood adaptation in response to a range of relevant risks in drought-prone northwest India, and found that perceived adaptive capacity and perceived efficacy affect farmers' responses and shape the household's long-term response trajectories. Another empirical example of "inclusive innovation" systems is the Promoting Local Innovation in Ecologically Oriented Agriculture and Natural Resource Management (Prolinnova) programme in Africa and Asia, which enhances the innovation systems in which farmers are involved (Waters-Bayer et al., 2009). Prolinnova uses Participatory Innovation Development (PID) approaches and advocates the inclusion of farmers on the upper levels of the "inclusive innovation" ladder of Heeks et al. (2014), enabling them to contribute to the inclusive innovation process and structure (and even post-structure) rather than remaining on the lower levels of the ladder, such as inclusive intension, consumption and impact. Thus, it is important to understand innovation systems from the farmers' point of view, querying on their inclusivity, and holistically including the livelihood strategies and outcomes of the poor.

7.3 Methods

This study used an exploratory, reflexive, stage-by-stage approach and adopted both qualitative and quantitative methods. Extensive field work was conducted in four villages in Northern and Western Uganda between November 2016 and February 2018. Uganda was purposively chosen as a case study for its high population dependent on farming (14th highest in the world, 70.4% in 2016, ILOSTAT), and its nation-wide experiences of pluralistic and demand-driven extension under National Agricultural Advisory Services (NAADS).

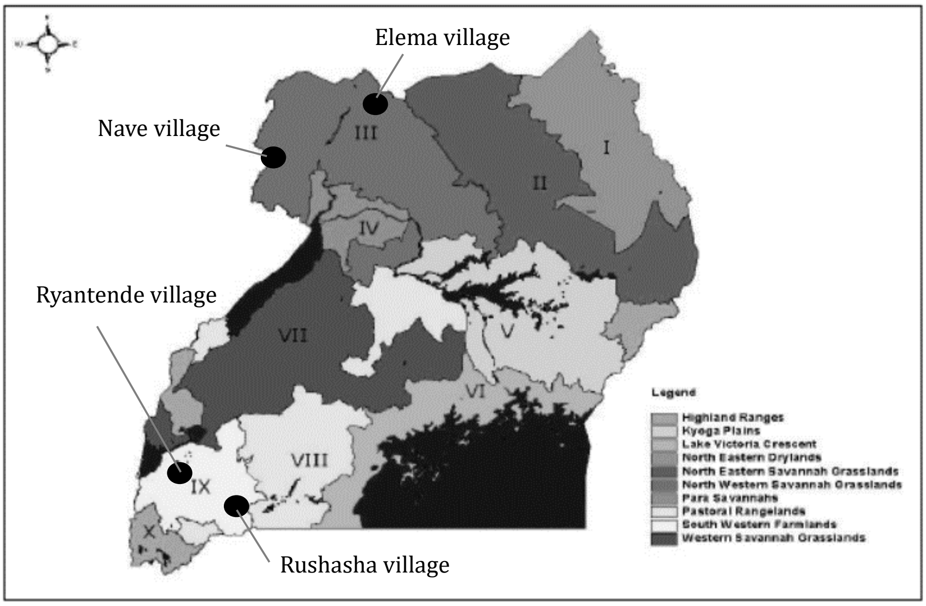
NAADS has been considered one of the first privatised public extension cases in Sub-Saharan Africa since 2001 (Mangheni and Mubangizi, 2007, Parkinson, 2009), despite the fact that it was heavily reformed in 2014 and returned to a conventional, government-led, extension system.

Figure 7-1: Key research stages, activities and locations



The study comprised four stages. The first stage identified the research sites, as elaborated in Figure 7-1. Four districts in two Agro-ecological Zones (AEZs) were identified based on criteria purposively extracted from the Agriculture Census 2008/9 (UBOS, 2010), in order to identify the most advantaged and disadvantaged districts in terms of an enabling environment for innovation. The data collected from the Census were: market access; availability of agricultural services, such as extension officers and agro-input dealers; tractor services and transport; road conditions; percentage of female-headed households; availability of off-farm activities; and, food security status. Furthermore, a scoping study was conducted in July 2016, in which local government informants at District, Sub-County (S/C), and Village levels were interviewed. This scoping study finally led to the identification of four villages which represent the most advantaged and disadvantaged villages in two AEZs in Northern and Western regions, as shown in Map 7-1. These four cases were chosen in order to explore how innovation processes and the inclusiveness of innovation networks differ or are similar in different agroecological and socioeconomic environments.

Map 7-1: Research sites in agricultural production zones of Uganda



Source: MAAIF (2016a)

The second stage included village workshops and Focus Group Discussions (FGDs). The village workshops were conducted with key informants in each village, and used farm system mapping (Feldstein and Jiggins, 1994) and Wealth Ranking activities (Grandin, 1988, FAO, 1990). The male and female key informants separately formulated and compared two maps of farming activities, one representative of 20 years ago and one of the current situations, which indicated a gendered division of labour. The maps were made for the purpose of understanding the background of innovations which would be explored with individual farmers in later stage of the research. In the Wealth Ranking, the key informants categorised each household into poor, moderate, or rich, based on the wealth factors which had been jointly identified in the key informant workshop in each village (hence, using "relative" rather than "absolute" concept of wealth). The results of the Wealth Ranking were triangulated by having three different pairs of key informants perform the categorisation. In the following stage, 49 FGDs were conducted with 166 participants randomly selected from nine socioeconomic groups of farmers (three wealth categories and three gender categories, namely male household heads, female household heads, and wives). Using a participatory innovation process chart, each group discussed the key innovations that the individual farmers had introduced in the last 10 years and together with related issues, including how they learned about the innovations, the purpose of the innovation, resources required, and what the outcomes were, in addition to their key livelihoods and assets. The results of FGDs were recorded in templates and analysed by comparing the responses across the different socioeconomic categories of farmers. Moreover, the results were used to formulate the question and response options in structured questionnaires in the following stage.

In the third stage, a face-to-face structured questionnaire survey was carried out using smartphones and targeting all the household heads and their spouses, if any, who were available during the survey period. Subsequently, 531 individual farmers answered the questionnaire which was programmed and recorded using KoBo Toolbox[24]. Five innovations per village were preselected, based on the list of innovations most frequently mentioned

[24] https://www.kobotoolbox.org/

during FGDs in each village, in order to examine across socioeconomic categories which farmers had tried innovations or not and why. The "try-out" status was investigated as the first and very important stage in the uptake processes. For each innovation, the respondent was asked if they had tried the innovation or not, their reasons for trial and non-trial, and the trial processes they experienced, including information sources, resources, and outcomes. It should be noted that the 531 respondents to the questionnaire did not include any farmers in the rich category (n=26) in the Western advantaged village (Ryantende) as they were not accessible during the survey.

The fourth stage included innovation case study workshops and in-depth farmer interviews. Three innovations, out of the five pre-selected which were found to be more widely used, were chosen for further exploration in the workshops. During the workshop, three to seven participants randomly selected from those who had tried the innovations from various wealth categories were facilitated in participatory activities, namely innovation timeline/history (Douthwaite and Ashby, 2005) and innovation network analysis. Each innovation was discussed in two workshops with male and female participants separately. In total, 24 workshops were conducted, which collected 12 innovation cases from four villages. In the fifth stage which was concurrently conducted alongside with the fourth stage, the in-depth interviews were carried out to 90 farmers who were randomly selected from nine stratified socioeconomic categories and were further asked why they had not tried the pre-selected innovations. The responses were audio-recorded, transcripted and later analysed by comparing the findings across the socioeconomic categories of farmers.

Table 7-1: Research sites and characteristics

AEZ	North Western Savannah Grasslands		South Western Farmlands	
Village	**Nave**	**Elema**	**Ryantende**	**Rushasha**
EEIs	Advantaged	Disadvantaged	Advantaged	Disadvantaged
Distance to District HQ	27km (17km tarmac + 10km marram road) Bike taxi (cheap)	40km (marram road) + 3km rural pathway	22km (tarmac road) Frequent transport	56km (marram road) Once a day up to stage 6km away & expensive
Distance to Market	4km (twice a week)	4.5km by foot or bicycle only	200m (daily)	16km (weekly)
AIS actors	S/C extension, OWC, 2 NGOs, DFA, 2 Cooperatives, NARO (Research Institutes), Universities, Bank, Microfinance (27km distant), 5 VSLA, Many traders, Cassava/Maize milling, Cassava chipping, Seed multiplication within village	S/C extension, OWC, VSLA, No SACCO, No NGOs, No traders, Milling (4.5km far)	S/C extension, OWC, 3 SACCOs (200m), VSLA, 4 Tea factories, Many traders, Agro-input dealers (200m), Milk coolant, Maize milling, Groundnut grinding, Tea processing, Tree nurseries, Fingerlings supplier	S/C extension, OWC, 1 SACCO (24km distant), VSLA, 2-3 traders, Agro-input dealers (56km distant), Tree nurseries (56km distant), Maize milling
No. of HHs	116	98	135	121
Poverty likelihoods ($1.90/day 2011 PPP)	43.09%	55.02%	22.85%	43.01%
No. of HHs by wealth	Rich=20 Moderate=73 Poor=23	Rich=9 Moderate=75 Poor=14	Rich=15 Moderate=50 Poor=32	Rich=5 Moderate=34 Poor=82
Land size (acre) by wealth	Rich: 4.18 Moderate: 2.34 Poor: 2.54	Rich: 17.11 Moderate: 13.25 Poor: 6.60	Rich: 59.25 Moderate: 3.62 Poor: 1.07	Rich: 8.13 Moderate: 4.61 Poor: 0.72
Livelihoods	Crop production, Animal rearing, Agricultural casual labour, Charcoal-burning, Off-farm business (glossary shops)	Crop production, Animal rearing, Fishing, Agricultural casual labour, Charcoal-burning, Firewood collection, Grass-cutting for roof, Milling, Ox-ploughing	Crop production, Animal rearing, Agricultural casual labour (tea-plucking, tree-potting), Milk processing, Tree nursery business, Fish-farming, Off-farm business (e.g., motorbike servicing, shops, carpentry), Bricklaying	Crop production, Animal rearing, Agricultural casual labour, Off-farm business (glossary shops, carpentry)

Crops	Cassava, beans, groundnuts, maize, millet, sesame, bananas, pigeon peas, onions, tomatoes, amaranth	Sesame, maize, cassava, sweet potatoes, groundnuts, sorghum, millet, green gram, cowpeas, pigeon peas, okra, kale, tomatoes, amaranth, eggplants	Tea, bananaes, beans, maize, sweet potatoes, eggplants, cabbages	Bananaes, maize, beans, Irish potatoes, cassava, sweet potatoes, groundnuts, millet, peas, sorghum, eggplants, tomatoes, watermelons, sugarcane, coffee
Livestock	Cattle, goats, pigs, guinea pigs, chickens	Cattle, goats, chickens, pigs	Dairy cows, cattle, goats, pigs, chickens (local, layers), rabbits	Cattle, goats, sheep, pigs, chickens

7.4 Results

7.4.1 Inclusiveness of Innovations

The try-out status of the five innovations identified during FGDs in each village was investigated through individual questionnaires to all farming household heads and their spouses in the research villages (n=531) (see Table 7-2). Of a total of 20 innovation cases, eight found statistically significant associations ($p<0.05$) between try-out rates and wealth categories (stratified by Wealth Ranking). The tendency of a higher try-out rate by the richer farmers is seen for innovations such as the use of ox-plough, vaccination of animals, manure application, and introduction of dairy cows. Resource intensiveness of the innovations seems to affect this association with wealth. Furthermore, it was found that majority of farmers who tried the innovations still continued using them at the time of survey (Table 7-3) i.e. for most innovations and categories of farmers more than 95% of farmers were still using them. In order to understand the exclusion processes beyond the static status of wealth aggregated try-out rates, the next section analyses the innovation processes and networks for the selected cases.

Table 7-2: Try-out rate for pre-selected innovations

Trial Rate (%)	Elema village (n=103)					Nave village (n=151)					Rushasha village (n=175)					Ryantende village (n=102)			
Innovations	Poor (n=10)	Mod. (n=76)	Rich (n=17)	Total	p	Poor (n=25)	Mod. (n=94)	Rich (n=32)	Total	p	Poor (n=110)	Mod. (n=58)	Rich (n=7)	Total	p	Poor (n=42)	Mod. (n=60)	Total	p
Change of planting time for sesame	50.0	51.3	52.9	51.5															
Line-planting	80.0	90.8	94.1	90.3		88.0	96.8	100.0	96.0	*									
Improved Maize variety	20.0	43.4	58.8	43.7															
Use of Ox-plough	0.0	18.4	47.1	21.4	***														
Inorganic Pesticide	0.0	13.2	35.3	15.5	**	12.0	36.2	43.8	33.8	**	3.6	8.6	0.0	5.1		38.1	15.0	24.5	***
Introduction of Onion						48.0	36.2	43.8	39.7										
Improved Cassava variety (Nase14)						8.0	22.3	31.3	21.9										
Vaccination of Livestock						32.0	39.4	62.5	43.0	**									
Manure Application											40.0	46.6	100.0	44.6	***	45.2	63.3	55.9	*
Mulching											49.1	41.4	71.4	47.4		38.1	61.7	52.0	**
Forking of Banana											50.9	63.8	71.4	56.0					
BBW measures																73.8	83.3	79.4	
Introduction of Dairy cows											0.0	1.7	28.6	1.7	***	2.4	11.7	7.8	*

*, **, *** mean values for adopters and non-adopters are significantly different at 10%, 5%, and 1%, respectively.

Table 7-3: Numbers and percentages of farmers who continued to use innovations at time of survey

	Poor		Moderate		Rich		Total	
Innovation	n	%	n	%	n	%	n	%
Forking of Banana	56	100.0%	35	100.0%	4	100.0%	95	100.0%
Manure application	62	98.4%	62	96.9%	7	100.0%	131	97.8%
Line-planting	30	96.8%	151	97.4%	44	97.8%	225	97.4%
BBW measure	30	100.0%	48	94.1%	n/a	n/a	78	96.3%
Change of planting seasons for sesame	5	100.0%	37	94.9%	10	100.0%	52	96.3%
Improved maize variety	4	100.0%	32	97.0%	7	87.5%	43	95.6%
Inorganic pesticide application	21	95.5%	53	91.4%	18	100.0%	92	93.9%
Improved Cassava variety***	6	66.7%	33	100.0%	12	92.3%	51	92.7%
Vaccination of Livestock	6	85.7%	33	89.2%	19	100.0%	58	92.1%
Introduction of Dairy cows	1	100.0%	7	87.5%	2	100.0%	10	90.9%
Mulching	64	92.8%	52	86.7%	4	100.0%	120	90.2%
Use of Ox-plough	n/a	n/a	11	84.6%	7	87.5%	18	85.7%

7.4.2 Case Studies: Farmers' Experiences of Innovation Processes and Network Inclusiveness

For the purpose of further exploration of the innovation processes, and of the innovation networks, three innovations per village (12 innovation cases in total), i.e., those found to be tried out by the higher proportion of farmers in the questionnaire survey, were identified and examined through the participatory workshops. As a result of analysis of the workshop findings, four common patterns of processes were identified and are listed in Table 7-4. The first type (Type A) follows a process whereby rich model farmers and farmers' groups play brokerage roles as collaborative actors within the system. In the Type B process, casual labourers working on model farmers' farms play a brokering role. This type is common in the villages in the Western region whereby the land size per household is much smaller than in the Northern region, hence a higher proportion of farmers depend on providing casual labour as a form of income. Other types include: the rotational digging groups who realise the benefit of changing the planting season and adjusting to climate variability with little intervention from external actors (Type C); and the dissemination of innovation through free seed distribution via a government programme (Type D).

In this section, the innovation processes and networks were examined for all process types. The knowledge networks (whether farmers have access to information from various AIS actors) were compared between farmers who tried innovation and farmers who did not try innovation. Furthermore, the excluded actors (the farmers who did not try) are considered in the innovation network to identify where the missing linkages are, using the results of the questionnaire survey and in-depth interviews to identify reasons for non-trial.

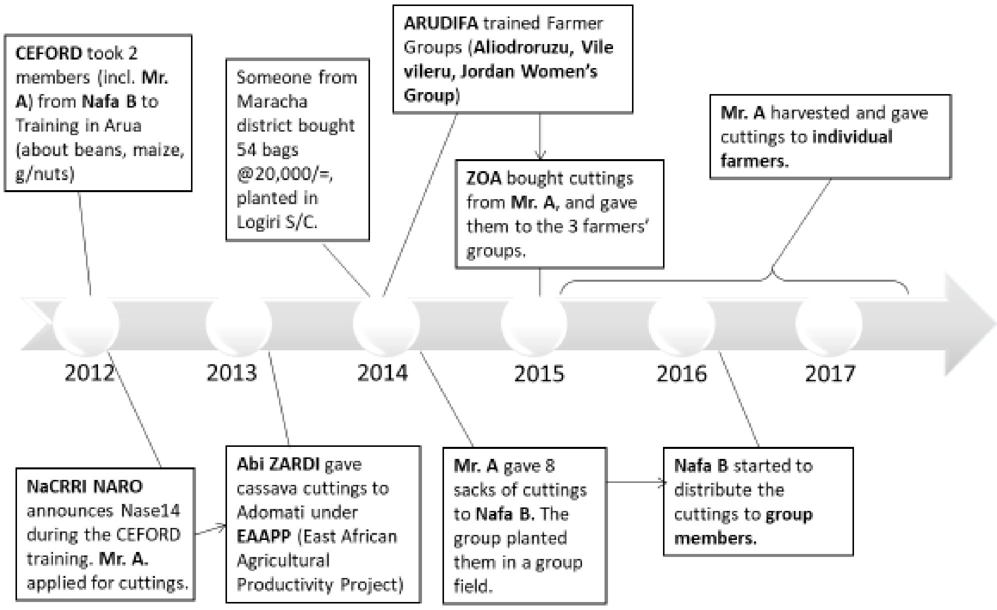
Table 7-4. Types of Innovation Processes (12 innovation case studies)

Process Type	Innovation	Location
A. Model farmers and Farmer Groups as collaborative mediators	Improved cassava variety (Nase14)	Northern advantaged village
	Line-planting of beans and groundnuts	Northern advantaged village Northern disadvantaged village
	Inorganic Pesticide	Northern advantaged village
B. Casual labourers working at Model farmers' farms as mediators	Mulching	Western advantaged village Western disadvantaged village
	Manure	Western advantaged village Western disadvantaged village
	Forking of banana	Western disadvantaged village
	BBW measures	Western advantaged village
C. Self-discovery by Rotational Digging group	Changing planting timing for sesame	Northern disadvantaged village
D. Free hand-outs by politicians and government programmes	Improved maize variety	Northern disadvantaged village

7.4.2.1 Farmers' Experiences of Innovation Processes Type A: Case Study of Improved Cassava Variety (Nase14)

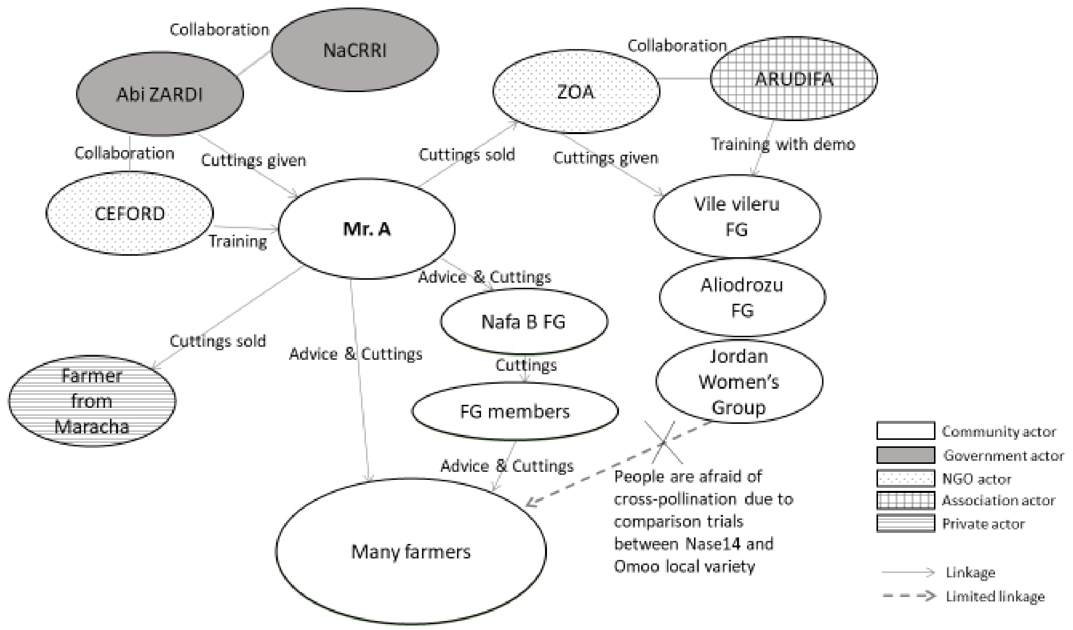
Nase 14 is a hybrid disease-tolerant cassava variety bred by the national research institute, National Crops Resources Research Institute (NaCRRI) under the National Agricultural Research Organisation (NARO). According to the participatory timeline exercise (see Figure 7-2), Mr. A, a rich model farmer in Nave village, who is also the village chairman and a member of a farmers' group, was given some cuttings of the newly released cassava variety from the NARO's regional research centre, Abi Zonal Agricultural Research and Development Institute (ZARDI). In the following year, the event that a commercial farmer in another district came to purchase a large number of cuttings from Mr. A at a favourable price made many in the village realise the economic value of the new variety. Furthermore, an NGO purchased the cuttings from Mr. A and distributed the Nase 14 variety to three other farmers' groups in the area, in collaboration with the District Farmers' Association (DFA) named ARUDIFA. Using his own social networks, Mr. A also distributed the cuttings to his farmers' group and his neighbours and relatives.

Figure 7-2. Innovation timeline of improved cassava variety (Nase 14) in Nave village



Thus, as shown in network diagram below (Figure 7-3), a variety of actors, including government, NGOs, the community, and private actors were involved in introducing and disseminating this new innovation to the village, and Mr. A had the highest centrality (the number of ties) in the network. In this network, a model farmer (Mr. A) and several farmers' groups used weak ties by brokering knowledge between a research institute and other farmers, with support of NGOs and a farmers' association.

Figure 7-3. Innovation network of improved cassava variety (Nase 14) in Nave village



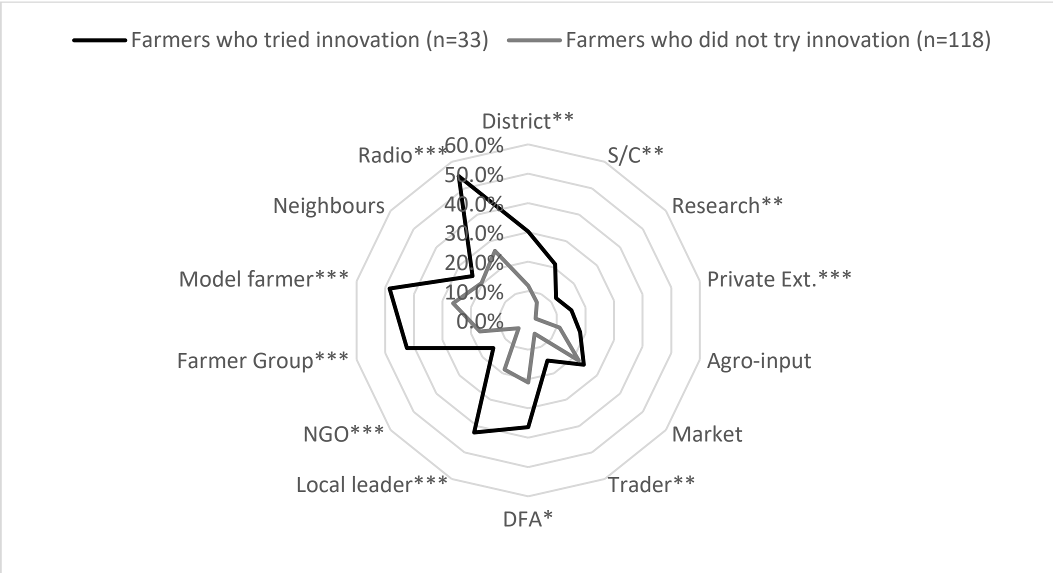
The questionnaire survey revealed that different wealth categories of farmers sourced the information from different AIS actors. Rich farmers acquired information using mainly weak ties such as NGOs (the information source used by 20.0% of rich farmers who tried innovation, moderate-15.0%[25]), DFA (rich-10.0%, moderate-5.0%) and government (rich-20.0%, moderate-10.0%), while poor and moderate farmers acquired information using strong ties with other farmers within village (rich-10.0%, moderate-40.0%). Thus, richer farmers who are considered model farmers are found to often use vertical networks for obtaining knowledge and information and to pass that through the horizontal informal networks to where poorer farmers mostly observe and copy only when the cuttings were given to them.

Next, the study analysed the difference in knowledge networks between those who tried out

[25] Poor farmers are removed from this comparison, due to its small sample size (n=2).

and those who did not. Figure 7-4 below shows whether the farmer has access to information from various AIS actors, which seems to be an important factor dividing those two categories. This suggests knowledge networks at the individual level are a predictor of trial. This survey result supports the findings of the participatory innovation network analysis mentioned above, such that those who tried the innovation have much more access to model farmers and farmers' groups who act as knowledge brokers.

Figure 7-4. Access to information from various AIS actors by farmers who tried and farmers who did not try (Improved cassava variety in Nave village)



*, **, *** mean values for adopters and non-adopters are significantly different at 10%, 5%, and 1%, respectively. The AIS actors with access reported to be less than 10% for both categories were removed from the diagram.

The study further analysed the non-trial reasons behind the exclusion of the innovation network. The key reasons for non-trial, which were reported by the poor farmers at higher rates than other wealth categories, were "Never heard" (poor-29.4%, moderate-19.7%, rich-10.5%) and "No interest" (52.9%, 27.9%, 47.4%). The in-depth interviews further unpacked reasons for "No interest" and revealed that farmers are not interested in this new variety of cassava for a number of reasons: lack of available land; preference for the local variety; the perception that the benefit of the new variety depends on soil types. The "lack of money" to buy planting materials was most frequently mentioned as a reason for non-trial, especially by moderate and rich farmers (poor-23.5%, moderate-63.9%, rich-52.6%). The farmers almost never buy cuttings because they perceive paying for cuttings of their traditional staple food to be wasting money. The farmers who tried the innovation in the village mostly accessed the cuttings from Mr. A or from farmers' groups for free or at a discounted price. The interactions between actors in the innovation network diagram (Figure 7-3) are mostly related to "cuttings". This signifies that access to the cuttings depended on the farmer's social network. Especially poor female household heads and wives strongly expressed their willingness to belong to any farmers' groups in order to access agricultural inputs and support from NGOs and government. However, at the same time, they stated their difficulties in allocating their time to group work (e.g., attending group meetings and providing physical labour as a group member on a group farm) when they are occupied with domestic work, and in paying membership fees. For example:

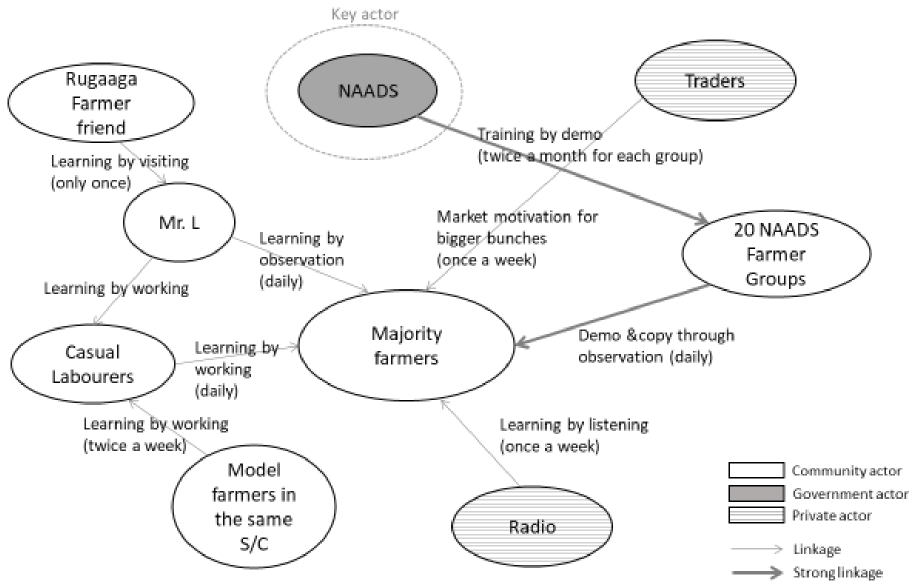
'(I have not introduced Nase14), because I am not in the group. Once they bring the cuttings, they sell to group members. I went there, but the cuttings were finished.' (N12/Poor household-head woman in Nave village)

Thus, not only knowledge networks, but also holistic innovation networks and systems, which include access to inputs, determine the innovation inclusiveness. In fact, there is a large disparity among wealth groups in terms of farmers' group membership which seems to be significant in accessing more holistic innovation systems in Nave village. Only 16.0% of poor farmers in Nave village belong to any farmers' groups, compared to 34.0% of moderate and 43.8% of rich farmers who have group memberships. Since all three innovation case studies from the village (Nase 14, line-planting, and inorganic pesticide) follow similar networks heavily depending on Mr. A and farmers' groups, it is necessary to consider how to include non-farmers' group members in the network.

7.4.2.2 Farmers' Experiences of Innovation Processes Type B: Case Study of Mulching for Bananas

Banana is a staple food in the Western region. In Rushasha village, the most remote village in Isingiro district, banana used to be grown only for home food and brewing purposes. However, in the last four years, banana traders started to come to the village to look for bigger-bunched bananas. This was because of the increasing demand for banana as a result of growing urban populations and because other regions traditionally known as banana growing areas are now affected by disease, such as BBW. Commercialisation of bigger-bunched banana, which is traded at higher prices, boosted the adoption of various banana-related managerial practices, such as mulching, manure application, forking, and BBW control measures (e.g., the removal of male inflorescence). In Rushasha village, as depicted in Figure 7-5, banana growing wealthier farmers actively learned various managerial innovations from prominent model farmers in the neighbouring S/Cs while visiting relatives or friends. Most importantly, such wealthier farmers often hire casual labour to practice the innovations on their farms. Thus, casual labourers played a crucial role in disseminating the learned skills to other farmers. In parallel, a NAADS extension worker played a key role in forming and training farmers' groups by regular demonstrations.

Figure 7-5. Innovation network of mulching in Rushasha village



With regard to information sources for those who tried the innovation, the questionnaire results support the workshop finding that NAADS and other farmers played a key role. Looking at the information sources of different wealth categories, it was found that the poor farmers learned mulching from other farmers within the village at a higher rate than the moderate farmers (poor-24.5%, moderate-8.7%[26]), and the moderate farmers heavily depended on the NAADS extension worker (poor-32.1%, moderate-47.8%), although the association between wealth and information sources is not statistically significant due to small sample size. This suggests that in the parallel networks, where both models (farmers-casual labourers network and NAADS-farmers' groups network) coexist (Figure 7-5), the moderate farmers used the latter network as direct participants in the NAADS training, while the poor farmers may have used either the former network as casual labourers, or indirectly learned from NAADS-trained neighbours.

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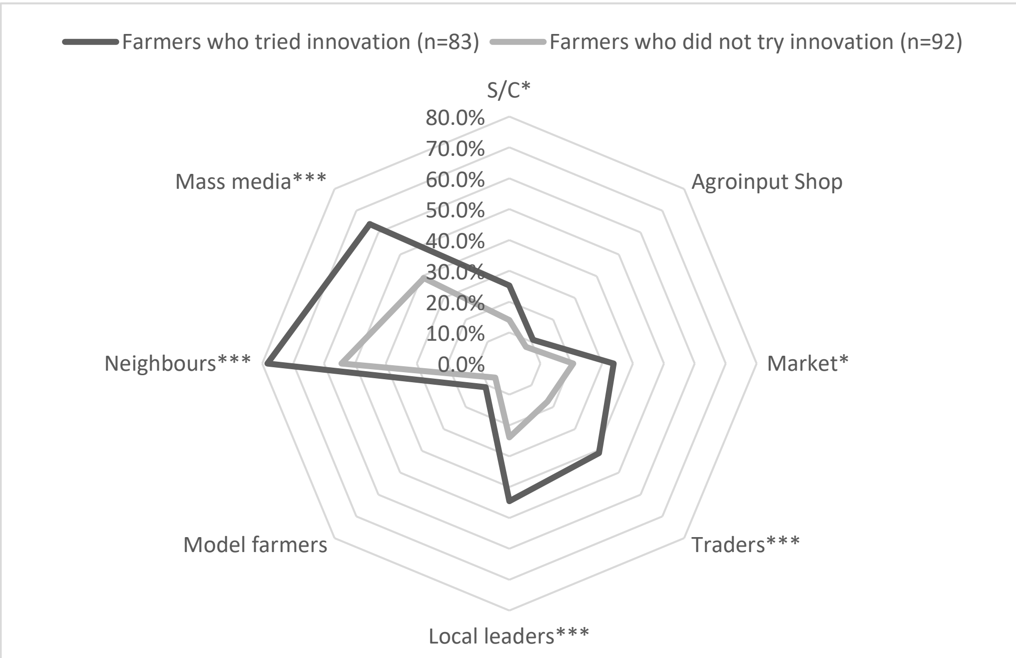
[26] Rich farmers (who tried innovation) are removed from the comparison, due to its small sample size (n=4).

Investigating the knowledge network constraints of those who did not try the innovation, it was found that their network seems to be smaller than the one of the farmers who tried, although the pattern of the network shape is similar (see Figure 7-6). The knowledge network between the farmers who tried and those who did not is statistically different, especially in access to information from traders, local leaders, neighbours, and radio. Being connected to traders is particularly important for the trial of mulching as it motivates farmers to grow bigger bunched banana which has more market value, as seen in Figure 7-5. Those who did not try have fewer linkages with traders compared to those who tried (Figure 7-6).

'I had never tried mulching because before there was no business with matooke (banana). But now matooke has money.' (Ru15/Moderate married woman in Rushasha village)

Figure 7-6. Access to information from various AIS actors by farmers who tried and farmers who did not try (Mulching in Rushasha village)



*, **, *** mean values for adopters and non-adopters are significantly different at 10%, 5%, and 1%, respectively. The AIS actors with access reported less than 10.0% for both adopter and non-adopter categories were removed from the diagram.

As other innovations, the poor farmers raised "Never heard" as a non-trial reason at a higher rate than moderate farmers (poor-12.5%, moderate-2.9%[27]). This reason is clearly a network oriented. Overall, "Lack of money" (poor-46.4%, moderate-41.2%) and "Lack of interest" (poor-25.0%, moderate-44.1%) were the non-trial reasons reported at the highest rates. Through in-depth interviews, it was found that "Lack of interest" translated into the landlessness of especially poor farmers who are not allowed to grow perennial crops like banana on rented land. The knowledge brokering of banana-related innovations was often played by casual labourers who are mostly poor, however they do not have land on which to practice the innovations. Moreover, lack of fallow land from which to cut grass to use as a mulch was found to be a critical factor for poor and moderate farmers. Some farmers who tried the innovation cut grass from their relatives' land, however those farmers who were able to do so still faced problems, such as lack of manpower or lack of money to hire labour. Some farmers who did not try the innovation confessed that there is no land to "waste" for mulching, as the banana farm is occupied by mixed-cropping with beans.

'Mulching is a good practice, but I don't have land where to cut grass and I also don't have money to buy the grass for mulching.' (Ru6/Moderate married man in Rushasha village)

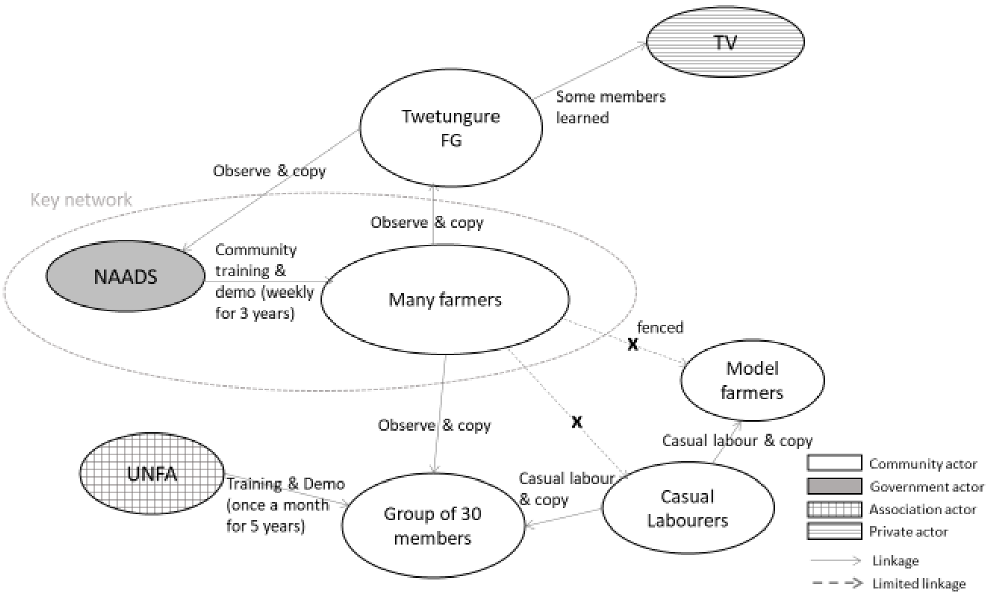
In Ryantende village, selected as the most advantaged village in the AEZ, the innovation processes followed a similar pattern to Rushasha village's mulching experience. Casual labourers hired by model farmers acquire knowledge and information about innovations,

[27] Rich farmers (who did not try innovation) are removed from the comparison, due to its small sample size (n=4).

parallel to the interventions of local government, such as NAADS, who train farmers' groups by demonstration (Figure 7-7). However, the main different characteristic of this advantaged village is the limitation of social learning from model farmers due to a huge social gap between "super rich" model farmers and others, as revealed by both workshop participants and in-depth interview respondents.

'We can't go there (to a model farmer) because of our social class gap. It is not easy for poor people like us to associate with the rich people like him. I fear because they will accuse me of going to their plantations without their knowledge.' (Ry17/Moderate married woman in Ryantende village)

Figure 7-7: Innovation network of mulching in Ryantende village

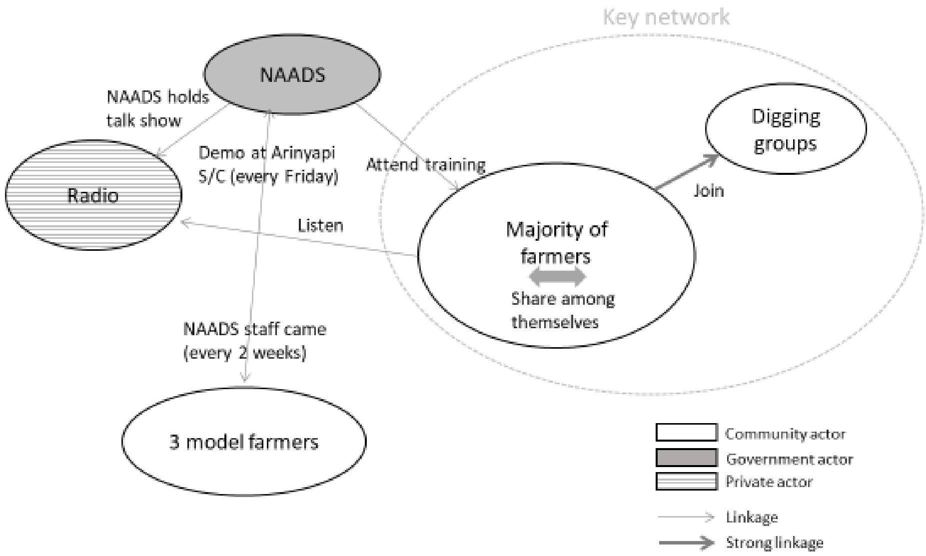


Even in such a village where the information from model farmers is "blocked" and there is usually no collaboration between model farmers and government, the innovation process of BBW measures tells a different story. One of the rich model farmers invited district agricultural staff to train the community how to fight against BBW because of his own interest to limit the outbreak. The high try-out rate of BBW control is also attributed to the legal sanctions that exist for non-compliancy. Neighbours even reported defaulters to the police. Contradictorily to their brokerage role, the fear of bacterial contamination made the rich model farmers prohibit others from entering their plantations. Thus, social learning can be affected by various factors, including the type of innovation, the "social class gap" and the motivation of model farmers to share innovations for their own benefit.

7.4.2.3 Farmers' Experiences of Innovation Processes Type C: Case Study of Changing Planting Time of Sesame

In the Northern remote village of Elema, digging in members' gardens rotationally is a common practice. Despite external interventions, such as NAADS activities and sensitisation over radio, farmers discovered for themselves that planting sesame about a month earlier than traditionally meant they adjusted to the changed rainfall pattern and this led to a better yield (Figure 7-8). The members of the rotational digging group often assess members' yields when helping with each other's farming activities and share ideas among themselves. Whose garden is to be dug first is usually chosen by lottery. In this way, group members started to realise that June-planting (early planting) produces better yields. Such social learning was accelerated by the growing importance of sesame as a crop over the last 10 years or so. Farmers repeatedly mentioned a recent problem of elephants destroying their farms, this made them resort to growing the most affected food crops, such as maize and sweet potatoes, near their houses. Sesame is one of the few crops which are rarely destroyed by elephants. Furthermore, high market demand for sesame in South Sudan contributed to the farmers' increased attention to this crop.

Figure 7-8. Innovation network of changing planting time for sesame in Elema village

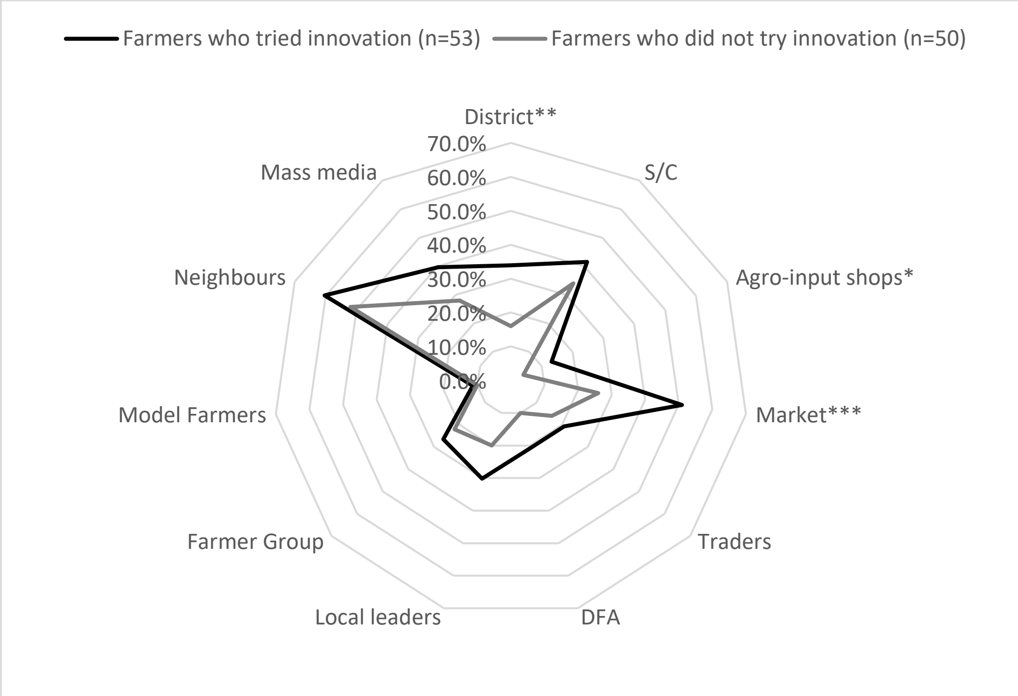


Consistent with the findings of the innovation processes and network discussed above, the main information sources are self-realisation ("own ideas") (moderate-56.4%, rich-40.0%[28]) and other farmers within or out of the village (within: moderate-17.9%, rich-30.0%; out: moderate-10.3%, rich-10.0%), although no statistical significance was found in any relationships between wealth and information sources. The government (moderate-5.1%, rich-10.0%) and radio (moderate-5.1%, rich-10.0%) also contributed, albeit marginally, to the dissemination of the information, but only for moderate and rich farmers.

As in other innovation cases, the network's "shapes" of the farmers who tried and those who did not are similar, yet the former network is wider than that of the latter (Figure 7-9) indicating that a higher proportion of those who tried out have access to the information sources. The differences are statistically significant for access to market and district officers.

[28] Poor farmers (who tried innovation) are removed from the comparison, due to its small sample size (n=5).

Figure 7-9: Access to information from various AIS actors by farmers who tried and farmers who did not try (Changing planting time for Sesame in Elema village)



*, **, *** mean values for adopters and non-adopters are significantly different at 10%, 5%, and 1%, respectively.

Regarding the non-trial reasons, “lack of information” was reported at the highest rates (poor-100.0%, moderate-67.6%, rich-62.5%), which means that the knowledge and information network plays a key role in determining whether or not to try the innovation. As suggested by the evidence that poor and moderate farmers raised “lack of market” as a reason for non-trial (poor-20.0%, moderate-13.5%, rich-0.0%), and that access to market is a key difference between the networks of those who tried out and those who did not (Figure 7-9), the market seems to be the factor which affects trial decisions. A number of farmers who did not try out mentioned that they believe that they plant at the correct time because they have been planting at the same time every year. This is reflected in the “No interest” in the non-trial reason (poor-0.0%, moderate-35.1%, rich-37.5%).

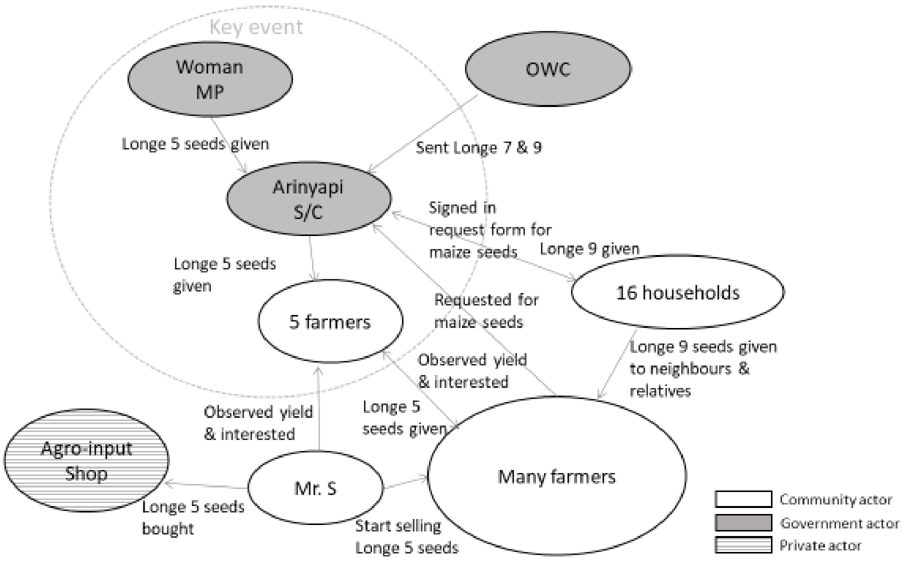
‘Whenever I plant in June and early July, I always have a good harvest, so I see no reason (to

change planting time).' (E4/Moderate married man in Elema village)

7.4.2.4 Farmers' Experiences of Innovation Processes Type D: Case Study of Improved Maize Variety

In the Northern region, maize is grown as one of the staple foods, beside sweet potatoes, millet, and cassava. Many farmers in the region grow a local maize variety from which the seeds are kept and reused for many years. In 2014, a Woman Member of Parliament (MP) from the region gave improved maize seeds (Longe 5) to Arinyapi S/C which then distributed the seeds to five farmers per village who were identified by the communities as serious farmers. Longe 5, a drought and disease-tolerant, high-yielding variety, was released by NARO in 2000. The five farmers planted the seeds, which yielded well. Many farmers observed this and took a great interest in this new variety. Some got seeds from the original five farmers, while others went to buy the new variety seeds from agro-input shops. Operation Wealth Creation (OWC), a free government input hand-out programme which started in 2014 as a reform of the 13 year-long serving extension programme NAADS (World Bank, 2018), distributed Longe 7 seeds in 2016, and Longe 9 in 2017. The quantity of the seeds given was based on land size. Due to inadequate quantities delivered to S/C, only 16 households in the village received the seeds from OWC. Many other farmers requested seeds, but did not receive any, however, some of those who did divided them among neighbours and relatives.

Figure 7-10. Innovation network of improved maize seeds (Longe 5, 7 and 9) in Elema village



As Table 7-2 shows (see section 4.1), there are large differences in trial rates among different wealth groups (20.0% of the poor, 43.4% of the moderate, and 58.8 of the rich). The information sources of those who tried are predominantly government for both moderate and rich farmers, but at higher rate for the rich (moderate-60.6%, rich-87.5%[29]), which is consistent with the innovation process and network (Figure 7-10). The moderate farmers counted on other farmers within village at higher rate than the rich farmers (moderate-15.2%, rich-0.0%). There was no significant difference between the knowledge networks of those who tried and those who did not. The questionnaire survey found that major reasons for non-trial were lack of knowledge and lack of money across all wealth groups, although the higher percentages were found for the poorer farmers ("never heard": poor-75.0%, moderate-58.1%, rich-57.1%; "lack of money": poor-62.5%, moderate-53.5%, rich-42.9%). Some farmers said that they did not introduce the improved maize variety as they did not receive seeds from S/C and did not know where to buy them. Others mentioned that they

[29] Poor farmers (who tried innovation) are removed from the comparison, due to its small sample size (n=4).

knew it was available at agro-input shops, but they had no money to buy it.

'I missed getting it from s/c and I don't have money for buying. It's expensive.' (E3/Poor married man in Elema village)

In 2017, after the questionnaire survey, the community saw a nation-wide outbreak of fall armyworms which destroyed most of the improved maize planted. The farmers who planted the improved maize seeds (on the lands of 0.5-8 acres) lost not only their harvest, but importantly capital invested in land preparation and planting in terms of family labour and cash for hiring labour. As a result, farmers lost confidence in the improved maize seeds. A perception was established that fall armyworm came with Longe 7 and 9 and practical experiences have proved that local varieties (and Longe 5 which has rough surface of leaves which reportedly prevented the pest attack) are more resistant to the pest. Moreover, most farmers who introduced improved maize seeds mentioned during in-depth interviews that they kept the seeds for the following seasons, not knowing that F1 hybrid seeds do not yield well after the second generation. These examples show the risks of free input hand-outs without adequate consideration of local needs, transparent sharing of information or facilitating opportunities that encourage farmers to trial innovations and identify their advantages and limitations for new contexts. Ironically, it is also a social learning effect that such negative messages of the new maize varieties spread fast within the community, even to the farmers who did not receive the seeds, discouraging them to introduce the varieties in future.

'I got 10 kg of improved maize seeds, though I used to use local seeds before. I planted on two acres, but the yield was poor because it was disturbed by armyworm. Local seeds are better. I kept my local seeds. I believe the worms were brought together with the seed.' (E9/Rich married man in Elema village)

"Yeah I don't try improved maize, because many others who planted it which failed to germinate, and above all are destroyed by armyworms, so it scared me." (E5/Moderate married man in Elema village)

7.5 Discussion

Why are innovation networks and systems not inclusive? This article argues the inequal accesses to innovation networks and innovation systems failure cause exclusion of some farmers, as discussed below. The first section of the results analysed the try-out status (whether they have tried or not and the continuity) of 20 pre-selected innovations, and the key finding for most of the innovations was that the richer the wealth category of farmer, the higher the try-out rate. Then, examining 12 innovation cases in detail, using workshops, led to the finding that innovation processes vary depending on the innovation types and locations where different social networks exist and different learnings occur. The most common processes of innovations were found to be model farmers and/or farmers' groups acting as bridging roles between formal institutions, such as government extension staff and NGOs, and other farmers. Another common processes identified were when both model farmers and formal agents are the source of new information, and casual labourers and farmers' groups, respectively, bridged the gap in parallel. Community-based social learning which used strong ties among digging group members, with little input from external actors, also occurred, as seen in the case study of the sesame planting season in Section 4.2.3. Additionally, in the case of the improved maize variety (Section 4.2.4), a government-led seed distribution network followed a government administrative route with weak input-based ties and without extension advisory services.

These findings are consistent with the social network and learning arguments made in many studies that claim both cohesive and weak ties play critical roles in innovation adoption (Darr and Pretzsch, 2008, Spielman et al., 2011, Adolwa et al., 2016). Both “searching” by bridging networks and “transferring” (Hansen, 1999) by bonding networks were evident regarding the innovations examined. Nevertheless, the realities are much more complex than a simple dichotomy of horizontal or vertical, strong or weak, or informal or formal networks. A wide range of community actors clearly play significant, but different, roles in innovation dissemination. Such actors include model farmers, casual labourers, farmers’ groups, and rotational digging groups. The networks are subjective and a social construct. In the case of the improved variety of cassava (Section 7.4.2.1), the membership of farmers’ groups is crucial in order to access knowledge and inputs. Among the group members and others with close relationships with the members, the ties can be horizontal and contribute to information dissemination. However, for poor female farmers who report that they do not have spare time to join the groups, the relationship or tie with the farmers’ groups can be vertical and weak. In addition, it is not always easy to determine whether the relationship is vertical or horizontal, as in the case of model farmers and casual labourers in banana managerial practices. The source of information for those who tried innovations is varied among wealth categories. The common tendency is that the poorer farmers depend more on bonding networks and the richer on bridging networks.

It is also noteworthy that different AEZs have different types of social networks which affect innovation processes and networks. In North Western Savannah Grasslands AEZ (Northern region), both advantaged and disadvantaged villagers commonly help digging and planting in each other's gardens rotationally as a group (locally called "oya" or "lapi"), and a higher rate of farmers (30.7%) are members of farmers' groups compared to farmers in two villages in South Western Farmlands AEZ (Western region) (5.1%). This could be why group-led innovation cases are more frequently seen in the Northern region. However, the difference between advantaged and disadvantaged villages within the Northern region is that farmer groups in the former village are connected through weak ties with NGOs, associations, and research institutes, while the farmers' groups (or digging groups) in the latter village are not. Therefore, in the disadvantaged village, self-realisation of the benefit of early planting of sesame was seen in spite of little influence from external actors. On the other hand, in the Western region where large banana or tea plantations commonly use hired labour on a daily basis, casual labourers played a brokering role in learning and disseminating knowledge and skills from the model farmers who hired them, and subsequently disseminated that knowledge. Nevertheless, a difference between advantaged and disadvantaged villages is the level of social learning that occurred between model farmers and other farmers, and in the advantaged village, the social class gap that exists and the landlessness of casual labourers "blocked" the information flow. Saint Ville et al. (2016) similarly revealed in a comparative case study of two farming communities in Saint Lucia that how farmers access new agricultural knowledge, either through bridging social capital or bonding social capital, differs with context and the structures of social (kinship) networks.

The research also sought to identify and examine the constraints that exist for farmers who are excluded from innovation networks. The common finding from the case studies is that the farmers who tried out innovations have greater access to information from various AIS actors at statistically significant levels (see Figure 7-4, 7-6, 7-9). Thus, the knowledge networks of the farmers who tried the innovations are wider than the networks of those who did not try, and those who tried have higher social capitals. This result is consistent with other studies which compared network size between innovators and non-innovators (Spielman et al., 2011, Adolwa et al., 2016). However, many studies have not focused on investigating non-trial or non-adoption reasons, hence generating limited understanding of the innovation network constraints. More importantly, many studies provide merely quantitative snap-shot views of innovation networks without necessarily taking account of qualitative interactions among actors from the process point of view. This study attempted to reveal the network constraints through farmers' real experiences of innovation processes, using a combined use of an innovation timeline and network analysis. Across all the innovation cases examined, the poorer the farmers are, the more frequently "never heard" is given as a reason for non-trial thereby indicating an important effect of not being part of or linked into networks. The excluded often face network constraints in the following ways. In the Nase 14 network, poorer farmers fail to join farmers' groups due to the limited time they have available, and as a result they are excluded from the knowledge and input networks. In banana-related innovation networks in the most advantaged Western village, a social class gap hinders social learning. In contrast, when it is in the interest of the rich farmers to disseminate information in an innovation (e.g., BBW), they become a collaborative actor. Regarding early planting of sesame, many of those who are outside the main social learning network (e.g., rotational digging groups) continue their routine farming methods. The introduction of improved maize seeds, spread through a government-led programme network, whereby the free seed handouts were distributed according to the land size, leaving out the farmers who are peripheral to the local administrations and model farmers.

Having a wider knowledge network is not an only necessary factor for innovation uptake. The findings indicated that there are a variety of reasons for non-trial beyond knowledge, such as lack of interest and how relevant that knowledge is to them. This in itself may reflect lack of access to inputs, limited availability of land, the level of importance of the particular crop for livelihoods, and even taste preference. Thuo et al. (2014) claim that social network factors influence "information acquisition", but not for "adoption" of groundnuts in Uganda and Kenya. Lambrecht et al. (2014) found that different factors were important in influencing different stages of adoption (awareness, try out, and continued adoption) of fertiliser in DRCongo. In the awareness stage, education and social capital were important, in the try out stage, extension intervention was key, and in the continued adoption stage, capital availability. This calls for a systems thinking approach (Darnhofer et al., 2012) beyond simply focussing on provision of knowledge or advisory services because non-adoption is not simply due to lack of knowledge, despite the fact that it is a significant pre-condition for adoption or adaptation. Reasons for non-trial are highly complex and often closely related to the socioeconomic status of the farmer. Therefore, none of the innovations are neutral in socioeconomic contexts and innovation adoption is affected by a number of factors, including resource endowments and rights to use, social structure, wealth status, and livelihood strategies. This suggests the importance of thoroughly considering what innovations are relevant for specific groups of farmers.

These findings resonate with the criticism of the Technology Supply Push paradigm in which enabling institutions are widely ignored (Hounkonnou et al., 2012), and the promoted innovation is assumed to be of benefit to most farmers, framed by Leeuwis (2004) as 'pro-innovation bias'. Furthermore, Nhantumbo et al. (2016) attribute the poor adoption of most promoted agricultural technologies to the failure to match farmers' real development priorities. It is questionable how relevant mulching or manure application is for land-scarce farmers who cannot grow perennial crops such as banana. Berdegué (2005) calls this "institutional failure" and this includes a failure to secure access for the poor to productive assets, such as land or credit, due to weak property rights, failure of coordination to enforce contracts, and social norms which discriminate against the poor. He claims that the types of innovation processes and the role of the poor in them are determined by the institutional system as well as the asset position of the poor.

Finally, it is clear that social learning effects are diminished with higher heterogeneity among farmers. Such heterogeneity can be based on resources or social positioning, or both. Munshi (2004) concluded that the heterogeneous characteristics of individual farms, such as soil fertility, prevent farmers from learning from neighbours' experiences, especially when the performance of new technologies is sensitive to unobserved characteristics. The current study also found many cases where social learning was weakened due to the "social class gap", a point often echoed by poor farmers in the advantaged Western village. This is consistent with findings of Berdegué (2005), and implies that social stratification may prevent the formation of social networks for innovation. It was also reported, during in-depth interviews, that poor farmers tend to shy away from asking "successful" farmers about innovations as they are fearful of being considered jealous neighbours ready to trick the successful farmers with witchcraft. Furthermore, whose priorities matter depends on the power relationships within communities. As Hoang et al. (2006) and Chambers (1995) warn, the bias of extension services towards the wealthier and more powerful elite farmers convenient contact farmers represents an institutional failure to address the reality of the marginalised population. This situation is concerning as there is much evidence to suggest that smallholder farmers in Sub-Saharan Africa are becoming increasingly heterogeneous, as seen in the large disparity in land distribution (Jayne et al., 2010, Jayne et al., 2014).

In the AIS framework, innovations are deemed to occur through learning within and between a multitude of different actors (Klerkx et al., 2012, World Bank, 2012), consistent with "the strength of weak ties" described by Granovetter (1973). However, the AIS framework does not necessarily consider the effects of heterogeneity within actors on social learning. Although the AIS perspective corresponds to the study finding that most of the innovations occurred as a result of interactions with different AIS actors, this study found that heterogeneity within communities diminishes social learning due to the exclusive innovation networks and systems. Rajalahti et al. (2008) claim that AIS approaches should take account of existing asymmetries in power, resources and capacity, among AIS actors, as it may exclude some actors, particularly poor smallholder farmers. This resonates with the recent studies (Papaioannou, 2014, Papaioannou and Srinivas, 2019) which question the value-neutrality of innovation, redefining innovation as a political process extending beyond technological and socio-economic processes. Moreover, while "the use" is more important than "the production" of innovations where inclusive innovation is concerned (Foster and Heeks, 2013), "the ladder of inclusive innovation" of Heeks et al. (2014) should not be looked at as a linear process: the factors at the lower levels, such as intension and consumption (or use), seem to be dictated by the upper levels of the ladder's structure, such as social networks and systems. Therefore, there is an increasing need to examine the quality of interactions among heterogeneous actors, particularly with respect to cooperation, power relations and conflicts in networks and systems, because they are likely either to promote or discourage social learning.

7.6 Conclusion

This study explored innovation networks and constraints by learning from farmers' experiences of actual innovation processes in diverse contexts and environments of Western and Northern Uganda as a case study. Most of the cases examined found that wealthier model farmers play a key role in brokering the innovation processes, using both strong and weak knowledge ties. In the meantime, the brokering role of poorer casual labourers is often overlooked, especially when model farmers do not play effective brokering roles. Additionally, weak ties connecting community and external AIS actors are often deemed as a significant innovation accelerator. However, such important vertical weak linkages are typically captured by wealthier farmers, and many external AIS actors do not recognise the vertical relationships or hierarchies within communities. Moreover, this study demonstrated the importance of understanding whether and how innovation networks function and whether the networks are inclusive or exclusive, through investigating dynamic innovation processes over time and from farmers' perspectives.

This study found that social learning effects diminish due to socioeconomical and biophysical heterogeneity within the community actors. The barriers which prevent some farmers from joining farmers' groups and social class gaps were reported as exclusion factors. Also, resource constraints, such as land and credit hamper poor farmers' innovation capacity and limit the relevance of some innovations. In order for knowledge networks to be inclusive, it is crucial to highlight enabling institutions and policies which support the appropriate targeting of farmers and which create “interactive learning spaces” among multiple actors as well as to ensure sustainable and equitable access to land, labour, and credit, as part of an innovation system.

Many recent studies advocate for grouping farmers into smaller homogeneous typologies in order to explore farmers’ type-specific opportunities and constraints for tailor-made innovations (Tittonell et al., 2010, Kuivanen et al., 2016). This leads to the need to create innovation networks which are relevant, and which fit the socioeconomic conditions of different farmers. With the current emphasis on demand-driven extension approaches combined with scarce public funding for field-based advisory services (Parkinson, 2009, Chowa et al., 2013), it is increasingly important to rethink inclusiveness of innovation networks and systems and to address institutional failures relating to heterogeneity of farmers’ contexts. The findings of this study strongly support the need for a paradigm shift from technology or commodity-centred approaches to farmer-centred approaches. The former automatically select or bias a certain socioeconomic category of farmers, rather than perceiving the issues from the stance of the marginalised farmers. Such a paradigm shift includes the need for an innovation support system to be part of a wider social learning system, which has the potential to become a truly enabling innovation system.

Chapter 8 - Conclusion

8.1 Introduction

This study explored the dynamics and diversity of smallholder farmers' innovation processes, in particular, knowledge and information sources, intra-household dynamics in decision-making, and innovation networks, adopting a systems approach. This concluding chapter highlights key research findings, the empirical, theoretical and methodological contributions of this study, and policy implications. Finally, the chapter concludes with questions for further research, based on reflections arising from this study.

8.2 Key Research Findings

8.2.1 Knowledge and Information Systems for Innovation

Innovation happens when new knowledge and information are utilised. However, where and how the farmers obtain the knowledge and information and how the farmers' perceptions of information sources affect the actual utilisation of the knowledge are not well understood. This study contributed to more insightful understanding of smallholder farmers' knowledge and information systems, focusing on farmers' actual utilisation of the information from AIS actors, based on the innovations that they had actually introduced over the previous 10 years, and access to and perceptions of the AIS actors which might have affected the utilisation. Importantly, the findings provided empirical evidence of constraints upon knowledge and information systems which excluded some categories of farmers. The key points emerging from the analysis are shown below.

The farmers' socioeconomic and environmental conditions affect utilisation of and access to knowledge and information

The study found that the knowledge and information systems (a major subsystem of AIS) of smallholder farmers are profoundly influenced by the differential socioeconomic and environmental conditions which shape the utilisation of and access to AIS actors differently. "Other farmers" are found to have played the most significant role as a smallholder farmer's knowledge and information source, as nearly half of the farmers interviewed (47.8% of 531 farmers) used this information source in their innovations. The probability that this source was used increases with the Western AEZ, no matter what farmers' characteristics were. Regarding access to the information from other farmers, 58.2% of farmers claimed to have access, and the probability of having access increases with the Western AEZ, larger land size and non-migrant status.

The second most influential contributor is "the government". Their information contributed to 20.9% of the smallholder farmers in making their innovations in the research sites. The higher the wealth level is and if the farmers are from the Western AEZ, the higher are the chances that they utilised the government's information in their innovations. In the disadvantaged villages, the richer farmers utilised the government's information more than the poorer. In terms of access, 24.3% of farmers have access to the government's information, and the probability of having access increases with the Northern AEZ, and the disadvantaged enabling environment, and if the farmers are male and non-migrant.

Moreover, 11.9% of the farmers used the information from "other sources" (e.g. NGOs, agro-input dealers, radio), a tendency increasing with farmers' group membership. In all the four research sites, the usage of other sources significantly increases with wealth level. On the other hand, this utilisation level is extremely low compared to the access to the other sources' information (70.6% of farmers). The probability of having an access increases with farmers' group membership, total education year, and household size, no matter which agroecological zone nor enabling environment it is.

Also, over a quarter of the farmers (29.4%) counted on their "own ideas" or knowledge to implement the new practices: the probability that they used their own ideas increases with the Northern AEZ. It is evident that farmers are innovating even without external knowledge inputs. It is also notable that especially in the land abundant Northern AEZ, farmers did not necessarily need external knowledge in extensification.

Importantly, comparing factors affecting all the information source categories, wealth is a commonly important factor associated with utilisation of information obtained both from "government" and "other sources", while there is no significant farmers' characteristics which affect the utilisation of "other farmers' information". This signifies that external information sources are biased to the wealthier farmers. Furthermore, being non-migrant is important for accessing "government's" and "other farmers' information", while it does not affect the access to "other sources' of information". This means that migrants have less exposure to "the government's" and "other farmers' information".

Gaps between access to and actual utilisation of information, especially for "other sources' information"

The finding that higher "utilisation" of the information from AIS actors is associated with better "access" to their information is statistically significant; this signifies the importance of access as a precondition of knowledge usage. However, better "access" to AIS actors does not necessarily facilitate the "utilisation" of the information. For example, the radio, the market vendors and local leaders were found to be relatively well "accessed" by farmers, yet their information is rarely "utilised" in innovation. This is reflected in the wide gap between the farmers with access to (70.6%) and those who used (11.9%) the information from "other sources".

Looking at the farmers' socioeconomic and biophysical characteristics, most importantly, the factors associated with utilisation are not necessarily the same as the ones with access. For example, access to government's information increases with the Northern AEZ, while the utilisation decreases. This could be due to the government's information in the Northern AEZ being less useful. On the other hand, the common factors affecting both "access" and "utilisation" for other farmers' information are the Western AEZ and farmers' group membership. Thus, either different or common factors influence both access and utilisation. To comprehend the reasons behind these patterns of access and utilisation of different types of knowledge and information sources requires an in-depth understanding of farmers' perspectives of AIS actors' information, which will be explained below.

Farmers' attitudes affect knowledge and information systems

This study explored the deeper understanding of the farmers' knowledge and information systems through investigating the farmers' attitudes to the actors. Whether farmers access the knowledge and information and put them into practice depend heavily on farmers' attitudes (pro-activeness in information-seeking, trust, and perceived usefulness) to the information sources. Moreover, such attitudes are different for different socioeconomic categories of farmers in different locations. This study has identified three types of perceived gap between farmers and various actors: other farmers (i.e. the "social class gap"), government actors (i.e. male-rich biased "demand-driven" extension practices), and market actors (i.e. lack of trust), as discussed below. The findings suggest that the utilisation of knowledge and information would not be achieved by just simply improving 'infrastructural' accessibility to the AIS actors but by understanding and addressing farmers' perceptions to them. Those three perception-related gaps in linkages with other farmers, government, and private actors need to be further addressed so that AIS can function in a more inclusive way. Thus, the findings provide insights to "inclusive" knowledge and information system and AISs. Furthermore, the multifunctionality of AIS actors should not be overlooked, as seen in the examples of moral support and inputs being offered: their function can extend well beyond knowledge provision.

Other farmers are important information sources for poor female farmers, but the 'social class gap' should be addressed

The farmers are highly active in accessing information from model farmers and neighbours, whose information is well trusted. Farmers constantly observe other farmers' practices and yields and choose which farmers they will learn new practices from. The farmers who have friendly and generous characteristics and who have received any training from external actors are the most generally preferred. Many other studies have reported that peer farmers are the most used and preferred information source (Solano et al., 2003, Bandiera and Rasul, 2006, Dolinska and d'Aquino, 2016), however, many of them have not fully captured the differential cognitive reasons and the different farmers' characteristics and environmental conditions. Of all the gender categories, married women place most trust in information from neighbours. They are particularly likely to learn from other women in the community, as seed and food exchanges are common amongst the women. Moreover, poor female farmers tend to choose their parents as their most trusted and preferred information source, because of the psychological support they offer for their hard work, and their high availability for consultation at any time. Similarly, another study uncovered that women value informal interpersonal communication (Lamontagne-Godwin et al., 2018).

Nevertheless, the existence of a "social class gap" impeding social learning was frequently mentioned, especially by the poorer farmers in the advantaged Western village. As initially mentioned, the Western AEZ is a significant factor associated with higher access and utilisation of other farmers' information, probably attributed to their densely populated nature and the social structure with numerous casual labourers bridging the knowledge of model farmers. However, the farmers in the Western AEZ are less active and trust the other farmers' information less than those in the Northern AEZ, which may be caused by "the social class gap". Therefore, this analysis shows the importance of the other farmers' information in the farmers' innovations, as well as the risks of diminished social learning due to a social class gap which is an exclusion factor.

Government actors are biased in favour of rich male farmers

Many studies have reported the rich and male bias of government extension services (Hoang et al., 2006, Katungi et al., 2008, World Bank, 2008, Matous et al., 2013), however, few of them explored the cognitive reasons behind this. This study found that the government sources are well trusted and actively sought by rich male farmers in advantaged villages. Nevertheless, proactiveness in seeking information from the government was found to be extremely low. Notably, a demand and service gap was found between farmers and government extension staff. Farmers perceived that the extension office should not be visited if there was no project running, for example, if they were not invited to receive a handout of free seeds, while the extension staff reported that they could act only on demand from the farmers: they had adopted a demand-driven approach, which, combined with limitations to their operational budget and means of transport, required them to wait for farmers at their office. More especially, the female farmers reported that they were underrepresented at the government extension office, which prevented them from visiting it. Nevertheless, they strove to access to the government's information through farmers' groups, yet the overwhelming volume of domestic and farming work made it difficult for the poorer female farmers to gain group membership. In addition, the poorer farmers hesitated to access government extension staff, as they perceived that the officers were interested only in supporting large-scale farmers who grew cash crops for export, such as tea. Furthermore, the farmers in the Northern AEZ have higher access to the government's information than those in the Western AEZ, but they use the information at a much lower rate than the Western AEZ. This signals that the information shared by the government actors are less relevant or inapplicable for the farmers in the Northern AEZ. In fact, the farmers in the Northern advantaged village perceive the government's information less "useful" than other villages. These findings unveil the perception-related gaps between differential farmers and the government actors beyond merely accessibility.

Private actors are the least trusted information sources

The farmers who counted on other sources of information for their innovations are few. The trend in access to actors over the last 10 years shows a significant increase in access to the private actors, though it is still minimal. The limited linkages between private actors and smallholder farmers are frequently reported by other studies, but many of them give little attention to the farmers' attitudes towards the private actors. This study found that traders and market vendors are the least trusted information sources compared to other actors, especially in disadvantaged villages, which may account for the very low utilisation rate, despite high access availability. Traders are more actively accessed by the poorer than the rich, while the trend is opposite for the market vendors. The farmers revealed that their lower trust level was due to the fact that their information, such as market prices, could not be trusted until the produce was actually delivered to and paid for by the traders and market buyers. The radio, like other ICT devices, is merely a means of transmitting information, therefore the greatest significance is attached to the identity of the person providing it. These results show that there is a huge gap between access and utilisation of "other sources' information" (which includes private actors' information), and disclose the low level of trust which may be causing the low level of utilisation for different farmers in different enabling environments.

8.2.2 Intra-household Decision-making on Innovations

For fuller understanding of smallholder farmers' innovation processes, intra-household dynamics in decision-making cannot be ignored, as innovations have implications as both an opportunity for empowerment and a risk of perpetuating gender inequality. Intra-household dynamics in innovation processes are mostly neglected in the AIS literature, yet are very crucial for making the innovations happen. The bargaining framework was applied, as opposed to the unitary model, to uncover the decision-making processes within the households which shape individual farmers' innovation processes.

Men have higher decision-making authority on innovation uptake and use of innovation outputs

This study investigated who within the household decided to introduce their recent innovations and who controlled the use of innovation outputs. A contribution of this study is the empirical findings of male capture of decision-making authority in innovation processes. Concretely, a higher percentage of self-decision was seen for married men's innovations, compared to that for married women. Married women must ask for "permission" from their husbands to introduce new innovations, except growing vegetables and other food crops for the purpose of home consumption on a small scale. The perceived reasons include men being the family heads and their "bosses", women not knowing the family land boundary, the land where the innovations take place belonging to men, and gendered roles and responsibilities regarding the enterprises (e.g. food crops and cash crops).

With regard to the decision-making on use of innovation outputs, husbands tend to decide how to spend cash outputs when purchasing assets, investing in off-farm businesses, and paying school fees for their children, while wives decide on how much of the harvest is to be kept for home consumption and distributed to neighbours and relatives. The reasons behind this tendency were due to the gender norms associated with the enterprises (e.g. "men's crops" and "women's crops"), accepted gender roles and responsibilities (e.g. women being in charge of food provision to family), and the production assets (land, labour and farm inputs) that the innovations counted on (e.g. innovation outputs are men's because the production required men's land). These reasons perceived by the farmers are particularly important, as they show underlying factors behind the male capture.

Stronger male dominance in decision-making for richer households

The comparison among different wealth groups found stronger male dominance in the richer households. The innovations made by rich married women were controlled to a greater degree by their husbands, compared to the innovations made by married women whose financial status was low or moderate. Rich wives had a fear of being divorced, due to their weak fallback position. On the other hand, the greater share of the innovations made by rich married men tends to be decided by themselves, compared to the innovations made by those married men of low or moderate financial status who confessed that they needed the cooperation (labour) of their wives in introducing innovations. These findings from wealth aggregated information add to the diverse insights on gender dynamics in decision-making. The implications of these findings are that the innovation support for poor and moderate married men without involving their wives may result in difficulties in implementing recommended innovations due to lack of required labour, and also that the innovation support for rich women may encounter their powerlessness in deciding on introducing the recommended innovations without seeking for approval from their husbands. These relationships between wealth and gender in innovation-related decision-making have previously been understudied.

Gendered crops and importance of the crops for the household income influence decision-making power in crop management

The claims about gendered enterprises in relation to decision-making authority were empirically confirmed by this study. The management of the crops and livestock which is socially acknowledged to be "men's crops" or "men's animals" was largely decided by men, while men exerted less control over "women's crops" or "women's animals".

Importantly, this empirical confirmation of gendered enterprises extended to examining the relationship between the level of importance of the crop to each household and the decision-making patterns, while bearing in mind that the gendered enterprises are not static but rather fluid. It has emerged that "traditional" food crops ("women's crops") are increasingly commercialised nowadays, due to rapid urbanisation. The results demonstrated that the husbands' decision-making powers over crop management and outputs increase in accordance with the level of importance of the crops to household income. This finding suggests new evidence of men's capture of profits, even from food crops, meaning that the decision-making patterns are beyond the simple and traditional classification which is often made by many other studies (Miiro et al., 2001, World Bank, 2007b, Mazur and Onzere, 2009) that regard food crops as "women's crops" and cash crops as "men's crops".

Intra-household allocation of production assets determines decision-making power over innovations

Another claim above on the relationship between production assets used for innovations and the decision-making power over the innovations was empirically demonstrated. The party who provides the production assets (land, capital inputs, and labour) to grow the crops was found to have more authority to decide on management and output control, according to both qualitative and quantitative evidence.

Regarding land, the decision-making authority about innovations was found to be affected by land ownership. The empirical evidence demonstrated that joint decision-making on innovations was associated with jointly owned land. Furthermore, the wife's autonomy in making decisions about her innovations appears where the household's land is owned by the wife, while it is predominantly the husband who decides on his innovations if the household's land belongs to him. For capital inputs, the party who paid for the inputs to grow the crops has a greater voice over the management of the crop and the profit generated, if any. With regard to labour, despite each farming activity having its own tendencies for intra-household labour allocation (e.g., ploughing and planting by both, weeding, harvesting, and post-harvesting either by women alone or by both, spraying pesticides exclusively by men), the provision of labour at each stage of crop production and marketing is associated with the decision-making power over management (for all the crops) and profit (for the crops which generate any profit). Thus, this study provided an evidence of the theoretical claim by other authors regarding asset ownership and control as key determinants of intra-household bargaining power (Agarwal, 1997, Meinzen-Dick et al., 2011, Doss, 2013), but in the context of innovation.

Conceptual framework of "iterative" gendered intra-household innovation processes

Decision making in innovation processes is deeply gendered and is shaped by the endowment and intra-household allocation of production assets, such as labour, land, and capital, as well as social and personal norms of gender enterprises and roles. The conceptual framework of "iterative" processes of gendered intra-household innovation processes, which was drawn from these findings (Figure 6-7 in Section 6.5), has much to contribute to the AIS framework, which largely lacks a gender lens. The AIS literature often uses a unitary model which considers only a household as a unit of analysis and sometimes incorporates a gender aspect in analysis only in terms of the gender of the household head (e.g. whether male or female-headed household), or uses a neo-classical individualistic model which treats individuals as if they have freedom to decide all by themselves based on their rational thinking. However, this study shows that intra-household decision-making over innovations are influenced by which productive assets are required to make the innovations and how they are internally allocated within the households, and social and personal norms of gender roles on who should grow or rear which crops or animals. Therefore, it is recommended that such intra-household dynamics be considered when providing innovation support, as the supported innovations may act as a bargaining power changer affecting intra-household asset allocation, either by reproducing the existing male-dominant power structure or by empowering women in the process.

8.2.3 Inclusive Innovation Networks?

This study found that the wealthier farmers have a higher try-out rate of innovations than the poorer. The reasons for this pattern were examined by using a social network framework. It is widely acknowledged that innovation happens and spreads as a result of interactions between multiple actors, but the current AIS framework does not provide adequate insights into the inclusiveness of the innovation networks and systems, particularly in increasingly heterogeneous communities. The study investigated the nature of innovation networks and systems experienced by different types of smallholder farmers, and how they both enabled and constrained innovation processes.

Model farmers, farmers' groups and casual labourers play brokering roles in different social structures

The key finding was that innovation processes vary depending on the innovation types and locations where different social networks exist and different forms of learning occur. Nevertheless, wealthier model farmers, farmers' groups and casual labourers were found to have played brokering roles in passing knowledge and information from external actors to other farmers within the community. The most common process of spreading knowledge about innovations was found to occur when model farmers and/or farmers' groups played bridging roles between formal institutions, such as government extension staff and NGOs, and other farmers. Innovation was also frequently introduced when both model farmers and formal agents were the source of new information, and casual labourers and farmers' groups, respectively, bridged the gap in parallel. Community-based social learning which used strong ties among digging group members, with little input from external actors, also occurred. Additionally, a government-led seed distribution network followed a government administrative route with weak input-based ties and without extension advisory services.

It is also noteworthy that different AEZs have different types of social network and structure which affect innovation processes. In the Northern region, where communal digging is a common cultural practice, and a high proportion of farmers belong to farmers' groups, group-led innovation cases were more frequently observed. On the other hand, in the Western region, where large banana or tea plantations commonly used hired labour on a daily basis, casual labourers played a brokering role in acquiring knowledge and skills from the model farmers who hired them, and subsequently disseminated that knowledge. This demonstrates the different roles of actors in the different sociocultural and environmental locations for different types of innovations. This study finding suggests the AIS framework should take into account the diversity within the communities rather than treating farmers as merely one category of AIS actors, which enables the analysis on which actors are included in or excluded from the innovation networks in which processes.

Elite capture of bridging ties? The poor count on informal bonding ties, the rich count on formal bridging ties

For the same innovations in the same locations, the information sources were found to be different for different wealth categories of farmers. The common tendency is that the poorer farmers depend more on bonding networks and the richer on bridging networks. Generally, richer model farmers often use vertical networks for obtaining knowledge and information and pass that through the horizontal informal networks: poorer farmers mostly observe and copy. In the case of the improved cassava variety, rich farmers and those with moderate wealth level acquired information and cassava cuttings using weak and bridging ties such as NGOs, government, radio, and farmers' groups, while the poorer were informally given the cuttings by them. In the innovation process of mulching bananas, in the parallel networks, where both models (farmers' and casual labourers' network and NAADS-farmers' groups' network) coexist, the moderately well-off farmers used the latter network as direct participants in the NAADS training, while the poor farmers may have used either the former network as casual labourers, or indirectly learned from NAADS-trained neighbours. Thus, across most of the innovation cases examined through this study, the bridging ties which are important for obtaining novel knowledge as stated by Granovetter (1973) are captured by the wealthier farmers. This could be one of the reasons why the try-out rates are higher for the wealthier and lower for the poorer.

Exclusion from social networks prevents innovation uptake

The common finding from the case studies is that the farmers who tried out innovations had greater access to information from various AIS actors at statistically significant levels. In other words, the knowledge networks of those who tried out the innovations were wider than the networks of those who did not try them, meaning that the former had higher social capital. On the other hand, the excluded farmers often faced network constraints; for example, the farmers who failed to join farmers' groups due to their overwhelming domestic and farming work (often poor female farmers) were largely excluded from the knowledge and input networks connected with the new variety of cassava. In banana-related innovation networks, a social class gap hindered social learning, unless the dissemination of the information matched the interest of the rich model farmers, as in the case of BBW. Regarding early planting of sesame, many of those outside the main social learning network (e.g., rotational digging groups) continued their routine farming methods based on their own ideas. In the case of improved maize seeds, the farmers who were peripheral to the local administrations and model farmers were excluded from a government-led programme network providing free seed handouts. These findings suggest that inclusion in the social networks should be ensured and network constraints should be addressed, when describing and analysing innovation systems and seeking to enable innovation, particularly to benefit all types of farmers. Additionally, these findings indicate that more is needed than the use of the widely practiced design of focussing on farmers' groups and assuming that innovations and ideas will spread from them through communities.

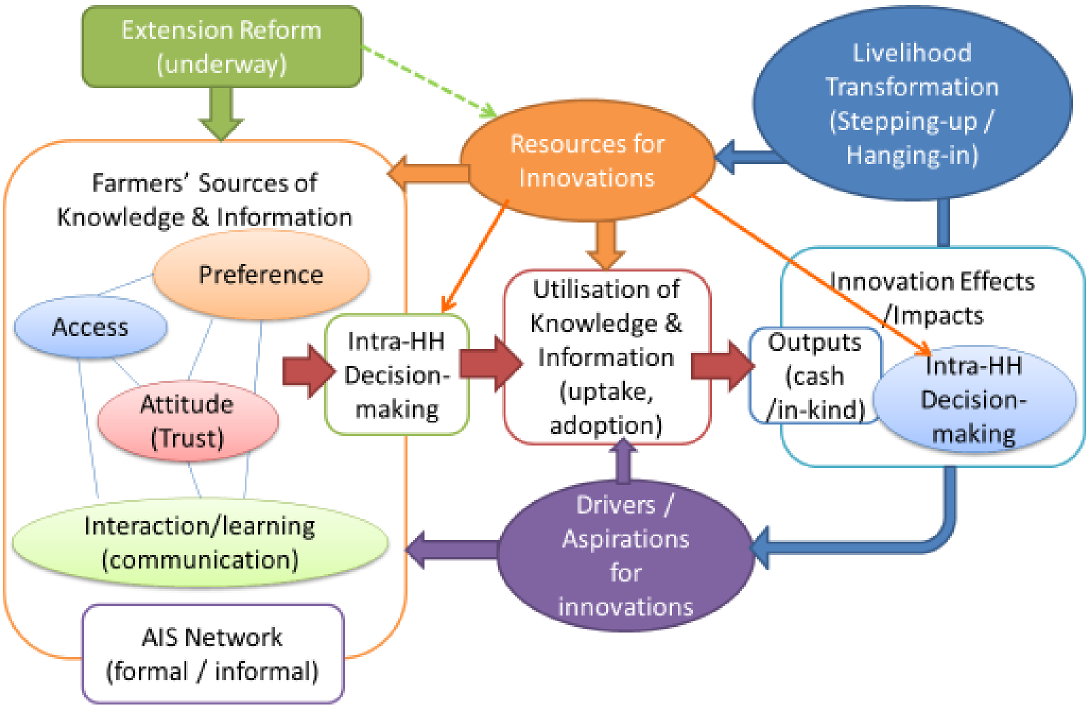
Not only knowledge but diverging interests, relevancy, and aspirations as exclusion reasons

Having a wider knowledge network is not the only factor necessary for innovation and uptake. How relevant the new knowledge is for the users matters. The findings indicated that there were a variety of reasons for non-trial beyond lack of knowledge, such as lack of interest due to limited access to land and inputs, the low level of importance to their livelihoods of that particular crop, low priority for other reasons, and even taste preference. Reasons for non-trial are highly complex and often closely related to the farmer's socioeconomic status. The examples of irrelevant innovations found in this study include mulching of bananas for the land-scarce farmers who practised inter-cropping for maximum use of their limited farmland, and inorganic pesticides for farmers who grew crops on land rented from cattle keepers who did not allow the tenant farmers to use the chemicals. Thus, none of the innovations are neutral in socioeconomic contexts, and this suggests the importance of thoroughly considering what innovations are relevant for specific groups of farmers. As this study found that social learning effects diminish in proportion to socioeconomical and biophysical heterogeneity within the community actors, there is an increasing need for considering inclusive innovation systems which can address the different interests and priorities of different farmers. Therefore, it is important to study the diverse aspirations and conditions of different farmers even within the same community, without pre-assuming that all farmers in the same area have the same aspiration and need, as it affects the effectiveness of the social learning.

8.2.4 Synthesis of Key Findings

This study explored the innovation processes of smallholder farmers with different socioeconomic and biophysical characteristics as they encountered the AIS. The frequently seen mismatching between farmers' needs and innovation support interventions can be attributed to the lack of a thorough understanding of this complex system, a black box of farmers' AISs. The framework of the farmers' innovation processes from the AIS perspective (see Figure 8-1) has been formulated by the author in the process of and as a result of the research, which brings together the three main research findings (described in sections 8.2.1 - 8.2.3).

Figure 8-1: Farmers' innovation processes from AIS perspective



Source: Author

In summary, first, smallholder farmers' innovation processes are based on their knowledge and information systems which combine access and attitudes (trust, information-seeking behaviour, perceived usefulness, and interactions/learning) in a complex manner, and are shaped by the farmers' differing socioeconomic and environmental circumstances. In detail, as explained earlier, other farmers' information is the most used by the smallholder farmers, particularly in the Western AEZ, but the access is lower for migrants, the farmers with smaller lands, and in the Northern AEZ. While farmer-to-farmer knowledge exchange is the most preferred by the poor, female farmers, "social class gap" with rich model farmers is a limitation. The government's information is accessed by male and non-migrants in disadvantaged, and Northern AEZ, but used by richer farmers in the Western AEZ at higher rates. The passiveness of poor and female farmers towards government's information and "demand-driven" approach of government extension services block knowledge and information sharing between them. Other sources' information is widely accessed but not used, due to the low trust in the information given by the private actors, such as market vendors and traders. They all act as constraints for "inclusive" knowledge and information systems.

Secondly, in the context of the family farming commonly undertaken by the majority of SSA's farmers, this study provided empirical evidence that innovation processes are profoundly affected by gender dynamics, particularly where the authority to make decisions on innovation uptake and control of outputs are concerned. In the intra-household decision-making processes, intra-household asset allocation influences bargaining power, which then affects the decision-making over the innovation uptake and use of outputs. Equally, sociocultural and personal assumptions about gendered enterprises, roles and responsibilities shape innovation decision-making patterns. The gender inequality in asset ownership and control combined with the gender norms often limit women's decision-making authority in innovation processes, which often demotivates them to make innovations.

Thirdly, beyond individual and household levels, when innovation processes at community level are being contemplated, the inclusiveness of the innovation networks and systems should be taken into consideration in the AIS framework. This study found that higher percentages of richer farmers tried out many of the major innovations which were introduced in the previous 10 years in the research sites, compared to the poorer. When the farmers' real experiences of innovation processes at community level were examined as case studies, unequal access to networks of innovatory knowledge and inputs emerged as an excluding factor. Such exclusions from innovation networks are the exclusion from farmers' groups, other social learning networks (e.g., rotational digging groups, learning from model farmers), and government administrative networks providing free handouts. Moreover, the innovation systems often fail to support heterogenous aspirations and relevance, especially for the poor and the landless.

8.3 Key Contributions of the Study

8.3.1 Empirical Contributions

Existing innovation adoption studies often overlook the diversity of farmers' interest in innovations and focus on one or a few pre-selected innovations which are considered important by the researchers. In contrast, this study investigated the major innovations that the farmers actually introduced recently (over the last 10 years). Consequently, the different patterns of innovations introduced by different socioeconomic categories of farmers were observed. For example, the poor recently introduced soil management-related innovations (e.g. manure application, mulching, composting, and digging of trenches) and managerial practices (e.g., pruning, and forking) at a higher rate than the rich, while the rich introduced land preparation and planting methods (e.g. line-planting, inter-cropping, spacing.), livestock-related innovations, and expansion of planted areas at a higher rate than the poor. The study further endeavoured to understand their aspirations for future innovations. As a result, it was found that farmers aspire to extensification of farming rather than technology-based intensification. Such findings are hard to obtain by conventional technology adoption studies. This reduced “pro-innovation bias” (Leeuwis, 2004) is a major contribution of this study.

Another empirical contribution of this study is a qualitative and quantitative understanding of differential farmers’ knowledge and information systems, achieved by exploring farmers’ perceptions of AIS actors. The study found that farmers are innovating, using different sources of information which are shaped by these perceptions. As a result, three gaps in perception were found between farmers and three different types of actors, namely government, community and private actors. The gap in farmer-government linkages arises from the fact that the current government research and extension systems are heavily biased in favour of farmers who are male and/or rich, leaving out poor female farmers. Both farmers and extension staff fail to take the initiative in seeking to make contact with each other: for example, female farmers do not feel sufficient confidence in communicating with the male extension staff, while the extension staff are inhibited by their adoption of a “demand-driven” approach, and hampered by low manpower and a restricted budget. The gaps in farmer-to-farmer linkages include the “social class gap” issue raised by the Western advantaged village and lack of a link between farmers’ group membership and the external actors. Regarding the gaps in farmer-private actor linkages, relations between farmers on one side and traders and vendors on the other reveal a similar lack of trust on a more individual level. Underused ICTs were found in the research sites: which runs counter to other recent studies.

A further empirical contribution is the examination of intra-household dynamics in relation to innovation processes, which is under-investigated by other researches. Underlying factors determining decision-making authority over innovation processes are found to be social and individual beliefs about gender roles and responsibilities (e.g. "women's crops" or "men's crops"), as well as the bargaining power related to intra-household productive asset allocation. Another new contribution is the empirical evidence that the men's decision-making authority over crop management and control of the profit increases, if the financial contribution of the crop to the household increases (e.g. shift to more food crops being grown for cash).

In addition, the try-out rates of new innovations are higher for the richer farmers, and this is strongly related to the higher level of access to various AIS actors. The innovation networks are characterised by the elite capture of "bridging" ties, the poor farmers' reliance on "bonding" ties, and the existence of "weak and vertical" ties within the community. The innovation processes were also found to be strongly affected by the existing social networks or structure (e.g. a farmers' group-based network in the Northern region, and a casual labour-based network in the Western region).

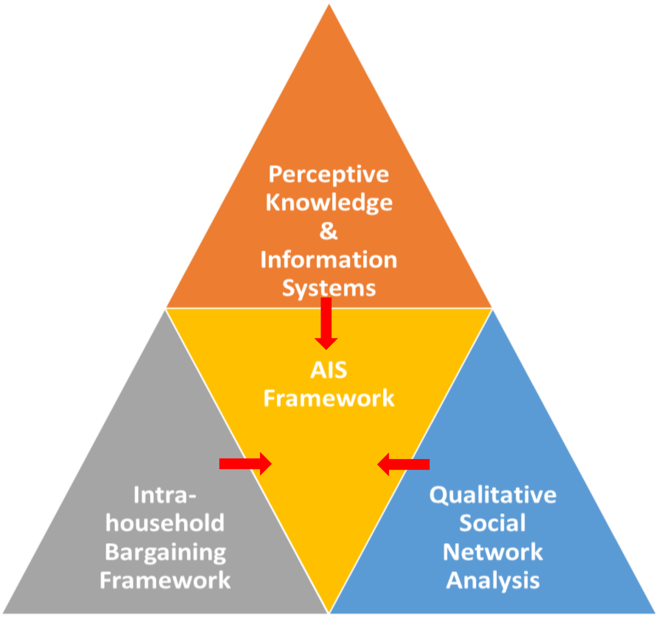
8.3.2 Theoretical Contributions

An original contribution of this study to existing theoretical knowledge is showing how the AIS framework can be made more relevant to its SSA context, where the use or uptake of existing knowledge rather than the generation of new knowledge is crucially important for inclusive development, and the increasingly heterogeneous smallholder farmers need more attention. The AIS framework was initially derived from the industrial sector in developed countries with free market economies and relatively democratic political systems (Assefa et al., 2009), and later adopted by Hall and his colleagues in the agricultural domain. Many AIS approaches tend to apply “hard systems thinking” with a common goal and a clear boundary, unlike the later stage of AKIS’ “soft systems thinking” (Klerkx et al., 2012), and often overlook the diversity of smallholder farmers. The AIS framework may be useful for developing commercial commodity goods which involve multiple actors in the value-chains (Assefa et al., 2009). Nonetheless, this type of thinking limits ability of the current AIS framework to uncover the divergent and conflicting interests of heterogeneous interdependent actors, especially when the importance or relevance of “innovation” to different smallholder farmers varies. To fill the gaps, this study clearly demonstrated the diverse, non-static, and subjective attitudes to AISs of different smallholder farmers, recommending a “soft systems” view of the AIS framework.

8.3.3 Methodological Contributions

This study made contributions to the limited AIS framework by concretely and empirically providing three major components as “soft systems”, namely perceptive knowledge and information systems, an intra-household bargaining framework, and qualitative social network analysis (see Figure 8-2). Thus, such complementarity can enable the current AIS framework to serve as a useful tool for more farmer-centred, pro-poor and inclusive innovation systems.

Figure 8-2: Pro-poor and inclusive AIS framework



Source: Author

Each component will now be explained in more detail. Analysing the perceptive knowledge and information systems as a particularly important subsystem of the AIS provides a potential tool to understand the AIS better. They involve analysing access to, preference of, attitudes to and interactions with innovation actors, which are interrelated differently for different farmers. The intra-household bargaining framework provides a better understanding of the decision-making processes significant to the farmers' innovation systems. Gender norms on roles and responsibilities and intra-household productive asset allocation for innovations are crucial in order to understand how innovation systems and processes are shaped. The qualitative social network analysis contributes to the current AIS framework with a qualitative assessment of innovation networks and the interactions amongst a multitude of AIS actors involved in the innovation processes. Focusing on the main innovations enables to analyse the interactions among AIS actors in the innovation processes which either include or exclude different farmers beyond knowledge and information (different from the first component in this way). These three components add dynamic and diverse viewpoints to the current AIS systems, encouraging a farmer-centred rather than an innovation-centred approach. It should be noted that all those three frameworks (perceptive knowledge and information systems, intra-household decision making, and qualitative social network analysis) address the farmers' heterogeneity in terms of socioeconomic, institutional (e.g. enabling environment) and agroecological characteristics, and therefore it is instrumental for a deeper understanding of diverse AISs.

Another methodological contribution of this study is the selection of contrasting study locations (four villages) in terms of AEZs and enabling environments for innovation (e.g., the most advantaged and disadvantaged). In consequence, this approach was able to capture the complex diversity of AISs and the differences and commonalities of AIS features in different locations. For example, the information sources leading to their recent innovations, the type of actors brokering knowledge in innovation processes (e.g., casual labourers and farmers' groups), and the enterprises which shaped intra-household decision-making patterns had commonalities within the same AEZs. On the other hand, for instance, the difference between the richer and poorer farmers, in terms of reliance on government information, is greater for the disadvantaged villages than for the advantaged villages, and contrarily pro-activeness in information-seeking and trust in the information from private actors (e.g., market vendors, traders, and agro-input dealers) are higher for the advantaged villages than for the disadvantaged villages.

Furthermore, innovation studies often use a unitary model (which considers a household as a unit of analysis) or an individualistic model (which see an individual farmer as a unit of analysis), thus failing to capture intra-household dynamics which profoundly affect innovation processes. This study explored intra-household dynamics by interviewing both wife and husband from the same household where possible.

A further contribution is the focus on identifying the main innovations that have been widely taken up in each community, and holistically looking at the processes that have led to this for the different types of innovations and for the different types of farmers. This method enabled the study to uncover that innovation processes of different types of innovations can follow the same or different pathways even in the same community. For example, in the Western advantaged village, model farmers were more active in spreading the BBW measures when the prevention of the disease was beneficial for themselves, while they were not active in other banana-related practices such as manuring and mulching. This example shows the role of actors' interests which can facilitate innovation processes. Moreover, looking at innovation processes for the different types of farmers provides an insight into the differential interactions with AIS actors involved in the innovation processes and the disaggregated views of farmers and reasons for trialling innovations or not.

Another methodological contribution is the addition to and modification of the existing participatory methods, namely Wealth Ranking, the Effects Diagram, and Social Network Analysis (SNA). Wealth Ranking, was initially developed by Grandin (1988) and adopted widely by many studies: the author has used the tool in a different way by investigating the wealth category of both 10 years previously and at the time of the survey. This enabled the study to identify which households had transformed their wealth status, which assisted in further understanding of the relationship between innovations and wealth transformation. Regarding the Effects Diagram (Smith, 2000, Dorward et al., 2007), the author added the intra-household decision-making feature to the tool by further inquiries on whose decisions were taken for each allocation or expenditure of innovation outputs. Another original feature of this study is the combined use of qualitative SNA (FAO Agrinatura, 2017a), an innovation timeline (FAO Agrinatura, 2017b) which is also called innovation history (Douthwaite and Ashby, 2005), and individual questionnaire surveys on information sources. In the participatory workshops, a social network was analysed only after key actors had been identified, a clear understanding of the nature of the linkages amongst them had been established, and an innovation timeline had been developed. This innovation network was later analysed using the quantitative data from questionnaire survey (particularly, individual farmers' sources of information about the innovation, with the farmers' attributes). Through this combination of tools, innovation networks were understood both qualitatively and quantitatively [in the innovation processes, rather than quantitative SNA (which often uses UCI Net) being limited to a snapshot view of networks.

8.4 Policy Recommendations

The key findings in the above sections all have policy implications. The better understanding of what influences innovation processes by using the proposed AIS framework provides ways to design systems and approaches that will more effectively enable innovation and growth for all types of farmers, particularly the poorer whose growth and transformation have been most difficult to achieve. The policy implications below are arranged in a sequence from the recommendations for wider region beyond the Uganda's case to those more specifically for Uganda.

8.4.1 Policy Recommendations beyond Uganda's Case

From technology-centred ToT to inclusive farmer-centred AIS approaches

The findings of this study strongly support the need for a paradigm shift from the technology-centred Transfer of Technology (ToT) approach to the inclusive farmer-centred AIS approach. Although the ToT approach favours a certain socioeconomic category of farmers, rather than perceiving the issues from the stance of the marginalised farmers, this has a mainstream approach in SSA (Assefa et al., 2009), if not Transfer of Inputs (ToI) in Uganda, as seen in the OWC programme discussed below. In order for knowledge networks to be inclusive, it is crucial to highlight enabling institutions and policies which support the appropriate targeting of farmers and which create "interactive learning spaces" among multiple actors as well as to ensure sustainable and equitable access to land, labour, and credit, as part of an innovation system.

Make productive assets accessible to women, and support the transformation of gender norms

The decision-making over the use of innovation outputs is strongly related to the intra-household contribution of productive assets such as land, labour and capital inputs, in order to make the innovations. The government should support women's equal access to productive assets, which could motivate women to engage in more innovations and to raise their bargaining power on the outputs as a result. Furthermore, this policy should be accompanied by challenges to the conventional social norms on gendered status, roles and responsibility, and enterprise types. This study found that the women's decision-making authority decreases with the crop's importance for the household income. This tells us that we must be cautious, particularly where income-generating crops are concerned.

Address increasing heterogeneity within communities

This study found that heterogeneity within communities diminishes social learning effects among community actors. Many recent studies advocate grouping farmers into smaller homogeneous typologies in order to explore farmers' type-specific opportunities and constraints with relation to tailor-made innovations (Tittonell et al., 2010, Kuivanen et al., 2016). This leads to the need to create innovation networks which are relevant to the specific needs of their potential members, and which fit the socioeconomic conditions of different farmers.

Shift from extension favouring the rich and the male to inclusive extension system

The current extension system's bias in favour of the rich and men was found by this study. Access to government information increases with land size, education years, being male, and residence in the village where he was born. In addition, government sources are well trusted and actively sought for by male rich farmers in advantaged villages. As a result, the farmers who are richer, older and have a larger household size could utilise government information for their recent innovations at a higher rate than farmers in other categories. On the other hand, the female farmers do not visit the extension offices, since their staff are predominantly male. The poorer hesitate to access government extension staff, as they perceive that the officers are only interested in supporting large-scale farmers who grow cash crops for export, rather than subsistence farmers. The government extension service should be accessible to all socioeconomic categories of farmers. This could be facilitated by the gender-balanced recruitment of frontline extension staff, which should be taken into consideration in the on-going extension reform in Uganda, but this policy implication is applicable even in wider region.

Address the gap between farmers and extension staff: Fix "demand-driven" approach

The study unveiled the farmers' lack of initiative in seeking information from government such as district and S/C. Farmers perceived that extension offices should not be visited if no project was running, especially if they were not called by the local leaders to pick up free hand-outs of inputs from the offices. Contrarily, the extension staff reported that they could act only in response to the demand from the farmers' side, since they had adopted a "demand-driven" approach. Their passivity was exacerbated by the limits of their operational budget and access to means of transport: consequently, they had to wait for farmers to come to them at their office. This gap should be closed by improving the narrowly defined "demand-driven" approach of the current government extension, and proactively assisting farmers in building their capacities of demand articulation. The importance of understanding gaps of perception between farmers and extension staff can be commonly applied beyond Ugandan case studies.

Address a gap within community: Facilitate farmer-to-farmer learning

Through this study, it became clear that the current innovation processes at community level are mediated by model farmers, farmers' groups, and casual labourers, yet a gap of perception within the communities prevents social learning. Regarding the lack of linkage with model farmers, the poor farmers addressed a "social class gap" between them and the rich model farmers, which disabled social learning through observation of their fenced farms. This is often mediated by casual labourers who work for the model farmers, but the resource gaps between the poor and the rich farmers make the new knowledge irrelevant for the poor. With regard to the barriers with farmers' groups, poor female farmers are not able to join the groups, due to the overwhelming volume of domestic and farming work and the expensive membership fee. Therefore, it is important for innovation interventions to facilitate farmer-to-farmer extension with fuller comprehension of farmers' perceptions and devise better communication strategies to diverse categories of farmers, without assuming that any automatic innovation transfer will arise from their contact farmers to the rest of the community.

Address a gap between farmers and private actors: Low level of trust

This study found that there is a huge gap between the proportion of farmers who have access to and used other sources' information in their innovations. This could be attributed to the farmers' low level of trust towards the information from the private actors. This problem should be addressed by more thorough analysis on the farmers' perceptions towards private actors and by exploring ways of how to mediate the gap.

8.4.2 Policy Recommendations for Uganda

Consider inclusiveness in the government's commodity-based approach

The Ugandan government has adopted a commodity-based approach in their agricultural sector policy since 2015/16 (MAAIF, 2016a), prioritizing 12 commodities, namely, bananas, beans, maize, rice, cassava, Irish potatoes, tea, coffee, fruit and vegetables, dairy, fish, meat, and four strategic commodities, namely, cocoa, cotton, oil seeds, and palm oil. In the North Western Savannah Grasslands AEZ, beans, coffee, vegetables, poultry and oil seeds (supplemented with sweet potatoes and pigs as commodities important for food and nutrition security) are strategic commodities. In the South Western Farmland AEZ, bananas, coffee, vegetables and tea (supplemented with Irish potatoes, sorghum and pigs as food and nutrition security commodities) were identified as the commodities of focus.

Two potential exclusions should be addressed here: gender-based and wealth-based. Firstly, gender-based exclusion in intra-household decisions could be expected from this approach. In the North Western Savannah Grasslands AEZ, this study found that, amongst all the common crops grown, beans were the subject of the most male-dominant decision-making over crop management (36.2% of bean management cases were found to be decided by men). Pigs were the most male-dominated livestock in terms of decision-making about management (60.0% cases decided by men) and profit (75.0% cases decided by men). In the South Western Farmlands AEZ, coffee (66.7% over management, 16.7% over profit), bananas (58.7%, 49.3%), tea (57.1%, 42.9%), and Irish potatoes (54.8%, 60.0%) were found to be the most highly male-dominated crops. As these male dominant enterprises are the government's strategic commodities in the AEZs, their support needs much gender-sensitive measures.

Where wealth is concerned, possession of an extensive land area was the wealth factor most commonly identified in all four villages studied. Particularly in the South Western Farmlands, land scarcity is the biggest constraint on the poorer farmers. As indicated in the study site profile, Table 4-2 (Section 4.2), the average land areas owned by the poor households are 1.07 acres and 0.72 acres in the advantaged and disadvantaged villages, respectively. Importantly, the study found that 54.8% and 81.4% of the poor households rent additional lands from other farmers (0.91 acres and 0.47 acres on average). The government promotes perennial crops such as bananas, coffee and tea in the AEZ, which are important for export; in fact, however, those crops are not practicable on the rented lands, as they are rented per season. For this category of land-scarce farmers, short-term crops with intensification measures could be supported instead.

The implications above are derived from the Ugandan context, however the commodity-based approach is widely applied in other countries and therefore the policy implication can be more widely applied.

Recover "lost 5 years" of public extension by re-shaping extension reform

Since 2014, when the former NAADS programme was abandoned, the government has been working on an extension reform, namely the Single-Spine Extension System (SSES). As the former NAADS programme, which used to deploy at least two technical extension staff members (one for crop and another for livestock) and one management staff member at each S/C, was cancelled, there was literally no extension staff member at S/C level for several years. The Directorate of Agricultural Extension Services (DAES) was re-created under MAAIF, and the National Agricultural Extension Policy (NAEP) and National Agricultural Extension Strategy (NAES) were formulated in 2016. Despite the Cabinet's decision to recruit 5,000 extension workers for local governments, the actual budget allocation for the agricultural extension function remains at only 31% of the estimated budget in the implementation plan FY2016/17-FY2019/20 (BMAU, 2019). As a result, only 3,854 extension workers have been recruited even after four years of SSES implementation by FY2018/19, and the current ratio of extension workers to farmers is 1:1,800 as opposed to the recommended ratio of 1:500 (Ibid.). The procurement of motorcycles and extension facilitation started in FY2018/19, but the late release of funds has hampered the delivery of the extension service to farmers. Through this study, it was uncovered that the 20.9% of the farmers counted on the government's information in their recent innovations, most of which were derived from the former NAADS programme which ended five years ago. The current absence of government extension has made a genuinely severe impact on the farmers in the research sites, and therefore recovery from the NAADS restructuring should be quick and effective.

Uganda's experience of NAADS demonstrated that the privatised and pluralistic extension system moderately influenced the smallholder farmers' innovations over the last 10 years, however their extension services were found to have favoured the male and the rich. Furthermore, the political decision to suddenly remove the NAADS from the extension domain without any alternative extension system in place created a total absence of government extension service on the ground, and greatly interrupted the innovation processes at community levels. This shows that such removal of the extension component should not be done abruptly but in a carefully planned manner. These implications are relevant to other countries which adopted similar extension policy.

Question OWC's free input hand-outs and its disconnection from the extension system

The extension system has moved away from "knowledge transfer" to untimely and sub-standard free input distribution (World Bank, 2018), since the NAADS restructuring in 2014. The military took responsibility for distributing the free inputs under a Presidential initiative, Operation Wealth Creation (OWC), while the role of NAADS has been severely restricted to that of input procurement. Large-scale centralised purchases of low-quality seeds are set at above-market prices ("OWC distortion") and are reportedly crowding out potential investment in extension services (Ibid.). The absolute lack of coordination between MAAIF, NAADS-OWC, NARO and local government extension offices was frequently mentioned during this study's stakeholder interviews. The authoritarian attitude of the military-led OWC scared away other key stakeholders, which limited effective dialogue and coordination, while the OWC staff (mainly veterans) claimed to be motivated to bypass formerly "corrupt" local management in procurement and distribution of inputs.

Most importantly, the input is distributed without a necessary transfer of knowledge. This study discovered the danger of input distribution without advice. Most farmers who introduced improved maize seed distributed by OWC mentioned, during in-depth interviews, that they kept the seed from their crop for the following seasons, not knowing that F1 hybrid seeds do not yield well after the second generation. Furthermore, when the community saw a nation-wide outbreak of fall armyworms, which destroyed most of the OWC's improved maize seed that was planted, a perception was established that fall armyworms came with the improved seed. Consequently, input distribution without relevant information can limit innovation uptake.

Currently, the OWC spends nearly half of the agricultural sector budget (UGX 326.4 Billion equivalent to approximately USD87 Million as an annual average for FY2016/17-FY2018/19). This may be a huge waste of public money, especially when there are many reports that most of the distributed seeds and seedlings are dried (as observed on the research sites). It would be rational to think that the input distribution should be used only for purposes of demonstration, and the rest of the budget should be used to improve the underfunded public extension system mentioned above. This finding can be applicable especially to other countries which promote the free input distribution to the farmers.

8.5 Reflection and Considerations for Further Research

This section identifies and reflects on some issues which could have been handled differently in the research, and research gaps which require further investigation.

Firstly, this study is limited to the earlier part of the innovation processes, mainly knowledge and information systems and their utilisation for innovations, leaving out the innovation outcome and effects on livelihood transformation. Initially, the innovation effects or impacts were in scope of this study, which is why the related data were collected during the Phase III data collection (see Section 3.4.3.4), using Participatory Budgeting and the Effects Diagram. It was found that 17 households had transformed their wealth status over the previous 10 years and they were then interviewed. Although the findings from the Effects Diagram were partially used for intra-household decision-making on innovation outputs, due to the limitations of time and word count, the study failed to elaborate on the important topics of innovation processes and the outcomes of innovation, particularly differential effects on different farmers. Nonetheless, the author will use the data collected to continue to research this knowledge gap.

Secondly, this study has limited coverage of the other important factors in innovation processes, such as combinations of different AIS actors at different stages in innovation-making, collective social learning dynamics beyond individual perceptions of AIS actors, and multifunctionality of AISs beyond knowledge and information provision. The systematically designed mixed-methods approach offered many advantages and was successful but may also have led to some compromise in capturing the systemic and complex views of innovation processes. However, time, resource and word count limitations meant that it would not have been feasible to explore these issues further in this thesis.

Finally, the author learned that using qualitative methods to explore the diversity of smallholder farmers needs compromise, in the form of simplification of socioeconomic and locational categories. This study looked at three wealth categories (poor, moderate, rich), four gender categories (unmarried men, married men, unmarried women, married women), and four locations (the advantaged and disadvantaged in two AEZs), which requires many combinations of those categories. On the one hand, quantitative methods (e.g., regression models) can afford such complexity, but only at a superficial level. On the other hand, the qualitative methods seem to provide much more depth, but the comparison amongst many socioeconomic categories is not simple. Therefore, in the qualitative work, the number of different categories and combinations investigated could have been reduced.

In summary, further research should be considered in the following areas:

- Differential innovation outcomes or effects on different socioeconomic categories of smallholder farmers in different locations
- In-depth understanding of interactions and linkages between different farmers and AIS actors in innovation learning processes
- Investigating how the farmers' low level of trust towards information from private actors is affecting under-utilisation of their information

- Intra-household decision-making over the innovation processes, in relation to the assets allocated to the innovations
- Aspiration-based constraints rather than pre-selected innovation-based constraints for different socioeconomic farmers in different agroecological and enabling environments
- Better methods of establishing typologies of smallholder farmers, and analysis of their differential innovation processes and systems
- Political economy theory deployed to investigate whose demands receive most attention in multi-actor innovation processes
- Effective extension approaches to support diverging interests and aspirations in increasingly heterogeneous smallholder communities
- Better approaches to design systems that will more effectively enable innovation processes for the poorer who are found to be largely excluded from the innovation processes and networks

8.6 Conclusion

The smallholder farmers' AISs have been found to be highly complex and intertwined with various factors, including knowledge and information systems, farmers' perceptions of AIS actors, intra-household dynamics, and social networks involved in innovation processes. The original contribution of this study was the empirical evidence on the diversity and detail of the differential farmers' innovation systems with "soft systems thinking" which can add pro-poor and inclusive insights to the existing AIS framework. The policy recommendation suggested better coordination among government, community and private AIS actors, which can best be achieved by shifting from the technology-centred ToT approach or from the traditional AIS approach to the inclusive farmer-centred AIS approach proposed in this thesis. Further study should consider the other key aspects of innovation processes, such as innovation effects and dynamic social learning processes, with more reflexive mixed methods. This will achieve better policy and interventions to design and support pro-poor and inclusive innovation systems.

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Appendix 1: Enabling Environment for Innovations (EEI) Ranking

					%Crop	FemaleHI	Ext%	Ext.No.	Credit	Lcl Mrket	Dis Mrket	Input Dle	Ext Dstar	Nursery	Research	Pblc Trsp	Feeder	Gravel	Tarmac	Pickup	Lorry	Tractor	Motorbike	Bicycle	Storage	Food Shr	Ecnmic A	TOTAL
RANK	District	Reg	AEZ	ZARDI	A2.10	A2.1	A3.1	A3.1.	A3.19	A3.23	A3.24	A3.25	A3.26	A3.27	A3.28	A3.29	A3.30	A3.31	A3.32	A3.33	A3.34	A3.35	A3.36	A3.37	A3.42	A6.1	A7.1	
1	Budaka	E		Buginyanya	81.2	14	42.5	49.5	42	12	9	18	32	19	3	13	11	7	6	44	41	17	47	18	5	24	18	307
2	Hoima	W	WSG	Bulindi	66.3	15	12	49.5	8	41	45	54	22	12	43	2	23	34	36	6	9	10	13	31	15	4	10	315
3	Koboko	N	NWSG	Abi	71.3	21	78	20.5	29.5	29	2	6	5	4	10	5	39	11	64	31	11	44	15	7	41	26	7	317
4	Bukwo	E		Buginyanya	98.4	1	71.5	49.5	25	65	3	1	1.5	1	14	3	2	1.5	73	29	15	8	69	78	12	73	33	340
5	Arua	N	NWSG	Abi	80.4	39.5	71.5	8.5	27	20	50	14	34	13	44	9	20	27	23	20	18	14	29	27	19	25	16	376
6	Jinja	E	LVC	Mukono	58.1	39.5	6	49.5	1	63	37	25	17	53	66	20	40	3	13	1	1	1	1	1	26	3	48	397
7	Mukono	C	LVC	Mukono	62.3	68	33	49.5	52	5	12	13	18	59	29	8	27	14	10	4	5	6	6	22	42	7	21	399
8	Masindi	W	PR(Eastern)/PS(Westen	Bulindi	78.2	18.5	56	20.5	40.5	50	17	51	48	9	6	17	10	16	3	13	21	4	24	26	38	10	63.5	408
9	Sironko	E	NESG (Northern)/HR(S	Buginyanya	87.1	7	47.5	49.5	44	44	11	16	3	3	4	4	38	19	18	50	56	24	56	73	52	53	41	411
10	Iganga	E	KP	Buginyanya	80.2	26	11	49.5	32	14	65	20	26	41	40	57	51	50	14	25	22	9	14	25	11	27	11	430
11	Mbarara	W	PR(Eastern)/SWF(Weste	Mbarara	76.7	43.5	25	20.5	17	21	29	7	43	17	24	33	41	41	17	12	7	21	32	38	47	36	46.5	438
12	Soroti	E	KP	Ngetta	81.2	31	21	20.5	20.5	39	40	47	38	26	32	30	17	36	37	23	52	40	20	5	20.5	51	3	454
13	Kisoro	W	HR	Kachwekano	84.2	57	45.5	49.5	12.5	15	7	4	6	14	57	16	9	30	63	21	17	64	46	48	45	20	46.5	468
14	Wakiso	C	LVC	Mukono	59.6	52.5	26	20.5	34	7	8	24	28	24	7	26	31	8	4	19	48	43	12	57	76	49	29	472
15	Rukungiri	W	SWF	Kachwekano	75.1	45	14	20.5	35	38	34	31	47	32	64	23	59	49	44	5	12	50	4	8	3	16	15	472
16	Kalangala	C	LVC	Mukono	47.1	67	4	20.5	72	76	6	10	8	10	1	10	7	1.5	8	68	62	48	60	68	79	2	45	475
17	Ibanda	W		Mbarara	82.4	29	20	49.5	10	69	46	34	36	46	18	24	16	12	28	18	36	47	8	10	20.5	68	19	480
18	Luwero	C	WSG(Southern)/PR(Nor	Mukono	77.7	72.5	31	49.5	26	77	67	26	35	25	9	11	12	5	15	34	43	13	30	30	54	9	49	487
19	Bundibugyo	W	PR(Northern)/HR(South	Rwebitaba	81.1	2	37	49.5	48.5	60	19	5	10	8	5	52	57	42	62	63	74	49	37	69	60	22	29	488
20	Kabale	W	HR	Kachwekano	75.9	60	10	20.5	4	47	48	11	19	31	31	21	13	33	9	40	40	70	70	67	39	34	39.5	495
21	Bushenyi	W	SWF	Kachwekano	82	30	17	20.5	38	18	24	44	39	39	21	42	44	47	21	14	14	20	18	53	59	18	51	503
22	Kamuli	E	KP	Mukono	83.3	20	50	8.5	43	6	68	39	62	57	55	25	32	53	38	11	4	5	10	12	9	19	62	513
23	Nebbi	N	NWSG/PS(Eastern)	Abi	94	32	23	8.5	19	36	38	12	15	20	23	14	24	44	30	70	67	57	66	50	53	62	60	516
24	Mpigi	C	LVC(Eastern)/PR(Weste	Mukono	63.7	69.5	24	49.5	29.5	53	54	22	27	16	12	39	35	31	19	32	26	16	17	37	30	45	69	522
25	Gulu	N	PS(South-Western)	Ngetta	82.6	72.5	39.5	49.5	31	59	20	38	53	27	22	29	8	51	29	49	35	28	36	35	29	39	8	529
26	Kaberamaido	E	KP	Ngetta	88.2	37.5	8	20.5	14.5	43	25	48	25	37	54	31	25	18	42	48	58	76.5	65	41	6	71	5	535
27	Butaleja	E		Buginyanya	92.8	4	66	8.5	77	33	36	41	33	62	28	45	55	24	43	41	34	25	51	33	14	6	61	548
28	Namutumba	E		Buginyanya	81.7	16	51	74.5	64	30	28	17	30	34	59	35	22	26	25	33	30	18	23	23	58	31	44	549
29	Kayunga	C	KP	Mukono	83	51	59	74.5	56.5	61	52	32	24	43	62	22	53	15	27	3	3	2	2	2	46	17	36.5	549
30	Mbale	E	KP(Southern)/HR(North	Buginyanya	79.6	34	64.5	49.5	69.5	37	31	23	21	55	26	7	18	10	2	30	33	33	27	39	78	15	65.5	560
31	Bukedea	E		Nabuin	92.8	62	70	49.5	39	2	16	3	11	69	39	47	14	22	16	26	59	27	19	19	73	50	24	561
32	Tororo	E	KP	Buginyanya	83.2	28	44	20.5	45	13	55	50	31	21	27	49	42	38	39	60	63	55	52	45	31	11	53	562
33	Ntungamo	W	PR(Southern)/SWF(Nor	Kachwekano	91.6	13	39.5	8.5	28	67	57	28	9	15	60	32	52	23	12	17	10	38	41	61	75	47	74	566
34	Moyo	N	NWSG	Abi	81	58	52	49.5	7	31	5	29	13	7	8	36	54	58	58	71	68	76.5	53	63	65	70	9	568
35	Kibaale	W	WSG	Bulindi	89.1	10	19	20.5	22.5	23	41	27	55	56	34	71	72	77	53	43	47	36	34	42	50	5	42.5	570
36	Oyam	N		Ngetta	79.9	23	2	49.5	50	8	23	49	29	36	48	59	34	35	22	58	49	63	74	43	2	69	17	573
37	Manafwa	E		Buginyanya	90.3	17	73	49.5	71	4	43	2	7	6	16	12	45	52	73	66	51	72	63	71	62	54	51	574
38	Kapchorwa	E	NESG (Northern)/HR(S	Buginyanya	89.9	18.5	74.5	49.5	58	54	26	21	12	5	61	6	21	32	5	69	76	39	77	80	57	32	79	585
39	Mityana	C	WSG	Mukono	81.5	61	63	49.5	56.5	22	22	40	51	42	11	50	48	20	11	39	29	26	39	62	66	13	29	592
40	Bududa	E		Buginyanya	91.5	11	13	74.5	22.5	28	10	9	14	48	2	66	63	59	73	65	53	69	71	75	23.5	66	70	595
41	Masaka	C	LVC(Eastern)/PR(Weste	Mukono	83.1	66	22	20.5	51	25	60	42	45	30	30	44	50	43	34	15	8	37	25	47	34	33	57	599
42	Pallisa	E	KP	Buginyanya	89.2	12	77	74.5	59	42	49	19	56	54	37	65	66	62	49	27	13	11	38	36	17	44	23	606
43	Kasese	W	WSG(Southern)/HR(Nor	Rwebitaba	77.7	8	36	74.5	6	32	69	62	46	40	35	70	33	39	24	22	25	22	28	66	68	21	63.5	615
44	Busia	E	KP(Northern)/LVC(Sout	Buginyanya	75	37.5	68	49.5	48.5	64	70	63	37	44	51	15	6	72	47	47	32	19	40	44	8	46	39.5	617
45	Apac	N	KP(Southern)	Ngetta	86.3	27	15.5	49.5	74	17	30	52	41	23	20	46	64	56	48	51	27	58	54	14	44	60	31	625
46	Kampala	C	LVC	Mukono	19	77	80	1	66	62	1	30	4	2	72.5	1	2	6	1	46	73	76.5	72	76	80	1	77	629
47	Buliisa	W		Bulindi	69	24.5	55	49.5	67.5	52	21	35	78	68	17	27	15	40	35	64	45	41	68	54	16	14	65.5	630
48	Mayuge	E	LVC	Buginyanya	90.3	22	30	49.5	55	26	78	69	73	64	41	34	61	64	51	8	6	3	9	15	32.5	48	34.5	636
49	Pader	N	NESG	Ngetta	85.2	80	5	4.5	53	11	73	15	16	70	72.5	38	71	76	73	76	60	35	64	11	23.5	67	1	644
50	Kyenjojo	W	WSG	Rwebitaba	82	33	76	49.5	12.5	10	59	37	68	51	19	73	65	63	40	7	23	51	7	29	74	29	34.5	652

51	Kumi	E	KP	Nabuin	87.4	52.5	62	2.5	36.5	35	53	60	20	18	72.5	43	46	17	20	67	64	71	50	28	61	55	12	**658**
52	Ssembabule	C	PR	Mbarara	72.3	54	34	20.5	9	66	63	53	77	63	50	28	47	29	73	10	19	15	5	13	49	38	75	**664**
53	Kabarole	W	WSG	Rwebitaba	72.1	69.5	61	49.5	36.5	56	39	61	49	50	15	48	29	9	7	42	55	42	16	34	70	12	58.5	**666**
54	Lira	N	NESG (Eastern)/KP(Sou	Ngetta	83.6	49	58	4.5	76	3	62	43	57	33	42	41	30	28	32	35	24	12	43	40	55	64	67	**668**
55	Kanungu	W	SWF(Northern)/HR(Sou	Kachwekano	78.1	47	27	49.5	24	73	51	64	42	11	65	58	78	75	65	36	66	46	33	70	18	58	27	**684**
56	Nyadri	N	NWSG	Abi	88.4	5	47.5	49.5	69.5	57	78	79	72	22	52	18	28	48	56	73	77	76.5	57	6	36	35	6	**684**
57	Yumbe	N	NWSG	Abi	93.7	46	74.5	20.5	67.5	9	27	33	60	28	49	19	43	25	50	16	20	66	59	32	40	75	71	**691**
58	Nakasongola	C	PR	Mukono	81.7	24.5	79	49.5	54	79	74	55	52	75	13	53	4	4	46	57	65	23	35	17	28	41	73	**694**
59	Kaliro	E		Buginyanya	88.6	9	64.5	74.5	62.5	27	66	70	71	73	72.5	51	26	13	55	2	2	7	3	3	48	63	22	**699**
60	Amuria	E		Nabuin	84.8	63.5	1	74.5	11	34	61	66	66	60	72.5	68	74	74	73	9	37	31	22	9	4	78	2	**700**
61	Bugiri	E	KP(Northern)/LVC(Sout	Buginyanya	87.1	6	54	49.5	61	24	75	71	44	74	72.5	37	5	54	45	72	75	76.5	55	16	32.5	40	14	**719**
62	Adjumani	N	NWSG	Abi	89.9	55	28	49.5	3	72	58	73	50	38	33	74	56	70	73	75	61	60	62	24	22	52	38	**724**
63	Katakwi	E	NESG	Nabuin	84.2	65	41	8.5	2	71	44	75	58	61	38	55	37	66	66	52	31	62	61	51	1	79	51	**734**
64	Isingiro	W	?	Mbarara	83.9	42	38	49.5	20.5	49	18	36	40	52	25	60	75	61	52	62	44	59	67	72	68	61	72	**737**
65	Kamwenge	W	WSG	Rwebitaba	86.4	41	67	74.5	5	48	72	56	59	35	58	61	36	60	73	38	57	67	49	65	37	57	25	**740**
66	Kiboga	C	WSG/PR(Central)	Mukono	83.3	50	35	49.5	33	58	56	45	75	65	72.5	63	58	21	26	37	16	30	42	60	68	8	68	**751**
67	Rakai	C	LVC(Eastern)/PR(Weste	Mbarara	86.3	74	57	49.5	14.5	51	14	58	23	45	53	54	77	67	31	56	72	61	44	46	64	37	76	**758**
68	Dokolo	N		Ngetta	84.4	35	53	2.5	75	45	42	76	61	49	56	64	62	68	57	74	69	68	75	20	7	76	13	**773**
69	Mubende	C	WSG/PR(Southern)	Mukono	91.1	48	49	49.5	16	46	71	57	63	66	63	72	49	55	33	24	38	45	21	58	63	56	36.5	**774**
70	Kitgum	N	NESG/NED(Eastern)	Ngetta	80.7	63.5	9	49.5	60	19	64	67	64	47	36	62	69	57	59	77	70	52	76	56	27	65	42.5	**788**
71	Amolatar	N		Ngetta	90.4	36	29	49.5	46.5	70	32	68	65	67	72.5	69	60	73	73	61	54	54	26	4	25	72	32	**802**
72	Amuru	N	NWSG	Ngetta	88.8	75	45.5	20.5	73	16	78	74	69	29	46	67	73	69	54	45	28	32	31	21	51	59	55	**807**
73	Kiruhura	W	?	Mbarara	85.5	3	32	74.5	40.5	1	47	59	76	77.5	47	76	67	78	61	54	42	53	48	49	72	43	78	**819**
74	Abim	N		Nabuin	93.7	71	3	20.5	62.5	68	35	77	54	58	72.5	40	19	37	73	55	50	76.5	73	59	10	80	54	**821**
75	Nakaseke	C		Mukono	89	76	15.5	49.5	46.5	80	33	65	74	72	72.5	56	68	46	60	28	39	34	11	52	71	30	58.5	**835**
76	Nakapiripirit	N	NESG	Nabuin	75.3	43.5	60	74.5	79	75	15	79	67	77.5	72.5	79	76	79	73	59	46	29	58	64	13	28	26	**839**
77	Lyantonde	C		Mbarara	83.1	56	42.5	49.5	18	78	78	72	70	71	45	78	70	71	41	53	71	56	45	55	77	74	56	**914**
78	Kotido	N	NED (Northern)/NESG(S	Nabuin	70.8	78	69	80	79	74	13	8	79.5	77.5	#N/A	77	80	45	73	78	78	65	79	74	35	23	80	**#N/A**
79	Moroto	N	NED	Nabuin	45.3	59	7	49.5	79	55	4	79	79.5	77.5	72.5	75	79	#N/A	73	79.5	79.5	76.5	78	77	56	42	4	**#N/A**
80	Kaabong	N	NED	Nabuin	71.7	79	18	20.5	65	40	78	46	1.5	1	#N/A	80	2	65	#N/A	79.5	79.5	76.5	80	79	43	77	20	**#N/A**

Northern: Yellow

Central: Red

Western: Green

Eastern: Blue

Appendix 2: EEI's Indicators at District level

Indicator	Category	Weight
A2.1: Percentage of Female Headed Households	Gender	1
A3.1: Percentage of Ag HHs visited by Extension Worker during the past 12 months	Extension	1/2
A3.1: Mean number of Ag HHs visited by Extension Worker during the past 12 months	Extension	1/2
A3.19: Percentage of Ag HHs reporting having Access to Credit	Credit	1
A3.23: Percentage of Ag HHs reporting access to local produce market above 5km to facility and district	Market access	1/2
A3.24: Percentage of Ag HHs reporting access to district produce market above 5km to facility and district	Market access	1/2
A3.25: Percentage of Ag HHs reporting access to local input dealer above 5km to facility and district	Input dealer	1
A3.26: Percentage of Ag HHs reporting access to Extension services above 5km to facility and district	Extension	1
A3.27: Percentage of Ag HHs reporting access to Nurseries above 5km to facility and district	Nurseries	1
A3.28: Percentage of Ag HHs reporting access to Agricultural Research Centres above 5km to facility and district	Research Centres	1
A3.29: Percentage of Ag HHs reporting access to Public Transport above 5km to facility and district	Public Transport	1
A3.30: Percentage of Ag HHs reporting access to Feeder Roads above 5km to facility and district	Road	1/3
A3.31: Percentage of Ag HHs reporting access to All Year Round Gravel Road above 5km to facility and district	Road	1/3
A3.32: Percentage of Ag HHs reporting access to Tarmac Road above 5km to facility and district	Road	1/3
A3.33: Percentage of Ag HHs by kind of access to Car/ Pick up	Transport	1/4
A3.34: Percentage of Ag HHs by kind of access to Lorry	Transport/Marketing	1/4
A3.35: Percentage of Ag HHs by kind of access to Tractor	Cultivation	1
A3.36: Percentage of Ag HHs by kind of access to Motorcycle	Transport/Marketing	1/4
A3.37: Percentage of Ag HHs by kind of access to Bicycle	Transport/Marketing	1/4
A3.42: Percentage of Ag HHs that reported having a Storage Facility by district	Storage	1
A 6.1: Percentage of Ag HHs that reported having experienced Food Shortage by district	Food Security	1
A7.1: Ag HHs that practiced Other Economic Production Activities by district	Other income	1

Appendix 3: Questionnaire for Research Village Identification

For District Office / Sub-County Office

AIS Stakeholders

- Who are the key stakeholders who are supporting innovations in your district/sub-county?
- What are the innovations that they are promoting? Why?
- How are they supporting the innovations? (e.g. training, input distribution…etc)
- Who are their target groups? Why?
- How do they target them?

Stakeholders	Priority Enterprises/Crops	Supported Innovations	Target group/Target method
Agricultural Office			

Enabling Environment for Innovations

Category	Question	Answer
Land	In which S/C or village, farmers have the easiest/hardest access to land (quantity, quality)?	Easiest: (justification) Hardest: (justification)
Other natural resources (Access to Water)	In which S/C or village, farmers have the easiest/hardest access to water (e.g. irrigation)?	Easiest: (justification) Hardest: (justification)

Labour	In which S/C or village, farmers have the easiest/hardest access to labour (family-paid/unpaid, hired)?	Easiest: (justification) Hardest: (justification)
Gender	Which S/C or village is the most advantaged/disadvantaged in innovation-making, due to gender-equality/inequality? Justification.	Advantaged: (reasons) Disadvantaged: (reasons)
Access to Extension	Which S/C or village is the most advantaged/disadvantaged in terms of extension services as innovation support? Justification. (distance to services, number of extension organisations working in the S/C –government, NGOs, private…etc, farmer:extension worker ratio, coverage area/extension worker ratio)	Advantaged: (reasons) Disadvantaged: (reasons)
Access to Credit	Which S/C or village is the most advantaged/disadvantaged in terms of credit as innovation support? Justification.	Advantaged: (reasons) Disadvantaged: (reasons)
Access to Market	Which S/C or village is the closest/furthest to local produce market?	Closest: (km) Furthest: (km)
	Which S/C or village is the closest/furthest to district produce market?	Closest: (km) Furthest: (km)
Access to Traders	Which S/C or village has the most/least traders?	Most: (justification) Least: (justification)
Access to Input dealers	Which S/C or village is the most advantaged/disadvantaged in terms of access to	Advantaged: (reasons)

	agro-input dealers? (distance to the nearest input dealers, number of dealers, quality, price)	Disadvantaged: (reasons)
Availability of Agro-processors	Which S/C or village has the easiest/hardest access to agro-processors?	Easiest: (justification) Hardest: (justification)
Access to Nurseries	Which S/C or village is the closest/furthest to the nearest nurseries?	Closest: (km) Furthest: (km)
Access to Agr. Research Centre	Which S/C or village is the closest/furthest to the nearest Agricultural Research Centre (NARO/ZARDI)?	Closest: (km) Furthest: (km)
Access to Public Transportation	Which S/C or village is the easiest/hardest access to public transportation?	Easiest: (reasons) Hardest: (reasons)
Road	In which S/C or village, farmers have the easiest/hardest access to roads (road conditions, seasonality)?	Easiest: (reasons) Hardest: (reasons)
Access to transportation means	In which S/C or village, farmers have the easiest/hardest access to transportation means (lorry, pick-up, motor-bike, bicycle)?	Easiest: (reasons) Hardest: (reasons)
Access to farming tools	In which S/C or village, farmers have the easiest/hardest access (own, borrow, hire) to farming tools (tractor, ox-plough, hoe, plough…etc)	Easiest: (reasons) Hardest: (reasons)
Access to Storage	In which S/C or village, farmers have the easiest/hardest access to storage? What kinds of	Easiest (reasons)

	storages available?	Hardest: (reasons)
Food Security	Which S/C or village the most/least experiences food shortage?	Least shortage: (justification) Most shortage: (justification)
Other economic activities	In which S/C or village, the most/least farmers are engaged in other economic activities?	Most: (justification) Least: (justification)
Farmer Groups	In which S/C or village, farmers are the most/least active in collective actions (collective marketing, collective learning, collective input-purchasing…etc), such as participation to group activities?	Most active: (justification) Least active: (justification)

Performance of Agricultural Production

In which S/C or village, farmers adopt new practices/innovate the most/least in order to improve their livelihoods? (what kind of practices?)	Most: (justification) Least: (justification)
Which S/C or village has the highest/lowest agricultural productivity and income?	Highest: (justification) Lowest: (justification)

Appendix 4: Research Protocol for Phase I

"Understanding dynamics and diversity of smallholder farmers' innovation characteristics and processes in Agricultural Innovation System in Uganda."

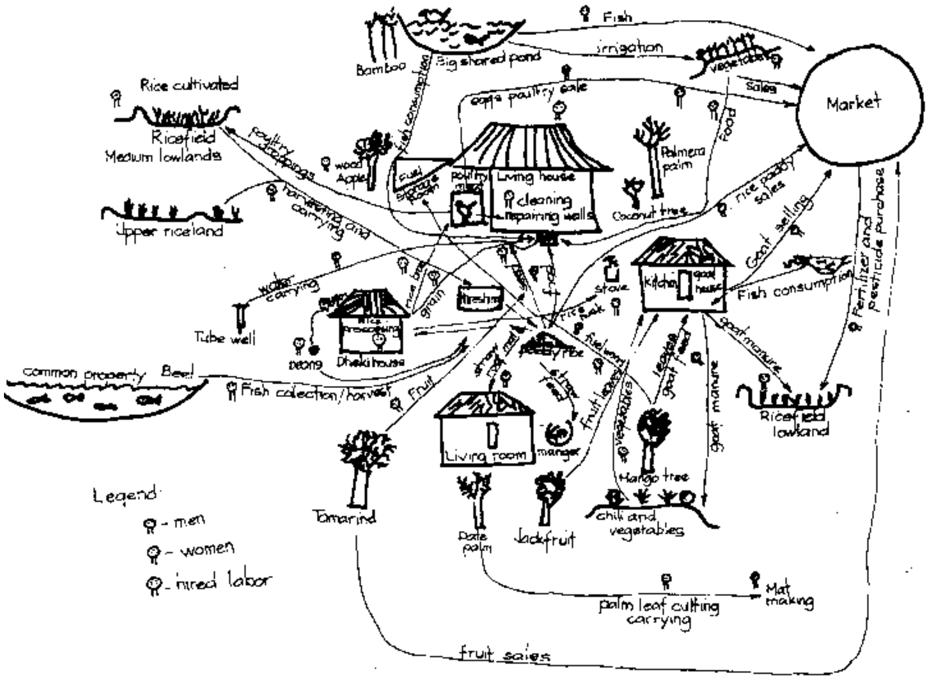
*Before each activity, "Research Participant Information Sheet" and "Consent Form" will be read to all participants in local language. Then, each participant who agrees with the content is requested to sign on "Consent Form".

PHASE I

1. **Village Focus Group activities (Livelihoods/Farm System Map, Agricultural Innovation Timeline, Wealth Ranking)**

Livelihoods/Farm System Maps –Female KIs (2h) 9-11am / Male KIs (2h) 11am-13pm

- Researcher and her Research Assistant (RA) explain the purpose and procedure of the farm system map exercise by presenting an example of a map.
- 6 female Key Informants will be divided into two groups. (older / younger) RA and the translator will guide those two groups separately.
- One group (older) will work on a farm system map of 20 years ago, and the other (younger) will work on a map of present.
- Start from drawing their houses in the centre of the flipchart. Then, ask them to draw what typical farming and non-farm activities in the village are/were, as well as related-resources (land, water source, market, storage…etc).
- Ask them to connect those activities and resources with lines and arrows.
- Ask them to draw legends showing who were engaged with those activities (men, women, child, hired labour…etc).
- RA and translator make sure that the drawing is as self-explanatory as possible.
- In plenary session, each group presents their map, and the whole group will discuss on how the livelihoods, farm system and resources have changed over time. (Research Assistant will facilitate and take notes, and translator translates for Researcher.)
- Snack & soda will be provided after the session.
- In the end of the day, Farm System Map template will be filled in by PC by Researcher and RA.



Source: Feldstein and Jiggins (1994)

Key questions during Livelihood/Farm System Maps

Information to be collected	Key questions to be asked
✧ Main livelihoods in the village ✧ Changes in livelihood types	• What are the main livelihoods in this village? Any differences among farmers? What are the factors which make the livelihoods different from one another? (wealth, gender, age, land?) • What do people grow (crop, livestock)? • How did people's livelihoods in this village change over time? (including non-farm activities)
✧ Key resources for production (5 capitals: natural –land, water, weather…; human-education, health…; physical-infrastructure, farming tools, markets…; financial-cash, saving…; social-farmer groups, cooperatives, relationship with stakeholders/AIS actors…) ✧ Access and control (gender, age, wealth…) ✧ Their changes over time	• What are the key agricultural-related resources in this village? • How did the resources change over time, both in quantity and quality? And why? • Does everyone in the village have the same level of access (utilisation) and control over the resources? Any differences among gender, age, wealth groups? • Do youths (household head/member) have control over land (any plot)? • Do women (household head/spouse/member) have control over land (any plot)? • Have the access and control of those resources changed over time for different groups?

Dynamic Wealth Ranking (2h) 14:00-16:00pm

- Definition of wealth terms (factors): In a plenary session, identify wealth categories (3-4 categories) with local terms (as many as identified) and clear definitions and wealth factors for each wealth category (e.g. land hold size, number of livestock, housing materials…etc).
- Card sorting: Make 3 pairs (men, women, mix) of KIs working together with the task of sorting out cards which have names of household heads and serial numbers and place them in different wealth categories. (1 category should not contain more than 40% of all the households)
- Identification of transformed households: KIs will be asked to identify specific households which made movements (either up or down) between different wealth categories, with reasons where possible.
- Ranking calculation: Combine the results of 3 different pairs and make a final ranking of all households.
- Ask LC1 for household type (Female-headed households, Youth-headed households) and non-farmers

2. Stratified Focus Group

Agricultural Innovation Categorisation / Timeline (2.5h)

- 5 participants x 9 stratified groups (as indicated below) will participate in the activity.
- In this activity, RA will facilitate the session and take notes in the provided format. Translator will translate what and how exactly each participant mentions. Researcher will take note and crosscheck with RA after the session.
- Participants will be first asked what their main livelihoods and farm systems (crops/livestock) are. ("Section A: Basic Info" in the provided form.)
- Researcher and RA will explain the meaning of 'innovation' before the exercise. (innovation=any new changes in what they do and how they do in their farming activities.) Read the definition of Nielsen (2001). Participants will focus on only innovations that they are/were directly involved.
- Participants will be asked to mention all the innovations that they were involved/have actually implemented in last 10 years (including abandoned innovations as well). Researcher or Translator will write down in a flipchart (see example in the photo below).
- After noting down a list of all the innovations, participants are asked on the processes. (following the questions in "Section B: List of Innovations and Innovation Processes" in the provided form.) Researcher or Translator will write down in a flipchart. (Reasons, Information Sources, Intra-household Communication, Resources, and Duration)
- After completing Section B, continue Section C: Innovation Evaluation and Section D: Changes in Innovation Types for discussing the changes in how, what, why they innovate.
- Short break (Snack & soda will be provided).

- Section E: Agricultural Extension Services will be discussed.
- After the session, Researcher will crosscheck her notes with RA’s.

Stratified Groups

	Wealth	Gender	Age (Youth)
Group 1	Wealthy	Men (HH head)	Mixed age
Group 2	Moderate	Men (HH head)	Mixed age
Group 3	Poor	Men (HH head)	Mixed age
Group 4	Wealthy	Women (Spouse)	Mixed age
Group 5	Moderate	Women (Spouse)	Mixed age
Group 6	Poor	Women (Spouse)	Mixed age
Group 7	Wealthy	Women (HH heads)	Mixed age
Group 8	Moderate	Women (HH heads)	Mixed age
Group 9	Poor	Women (HH heads)	Mixed age
Group 10	Wealthy	Mixed (3-boys, 3-girls)	Youth non-HH head farmers managing own plots
Group 11	Moderate	Mixed (3-boys, 3-girls)	Youth non-HH head farmers managing own plots
Group 12	Poor	Mixed (3-boys, 3-girls)	Youth non-HH head farmers managing own plots

Appendix 5: Livelihoods/Farm System Map

Name of Village:

1. Women's / Men's Farm System Map

Date:

Time:

Name of Participants:

1. 2. 3. 4. 5. 6.

20 years ago

Main livelihoods (crops, livestock, non-farm activities)
Women's responsibility
Men's responsibility
Both Men's and Women's responsibility
Work done by Hired Labour (cash/in-kind)
Agricultural-related resources (land, water source, market, storage…etc)
Note

Present

Main livelihoods (crops, livestock, non-farm activities)
Women's responsibility
Men's responsibility
Both Men's and Women's responsibility
Work done by Hired Labour (cash/in-kind)
Agricultural-related resources (land, water source, market, storage…etc)
Note

Changes between 20 years ago and present

Differences between maps made by men and women

Appendix 6: Stratified Focus Group Discussions (Innovation and Innovation Process)

Date:
Name of Village:
Stratified Category:

Participants:

1. 2. 3. 4. 5. 6. 7.

A. Basic Info

1. What are the main livelihoods for you? /How do you make a living?

2. What is your landholding size? What is the land size you use annually? Is it your land?

Participant	Owned	Used	Rented in	Rented out	Usage for the remainder	Whose land?

3. If you keep livestock, which type and how many? Are they your animals?

Participant	Cattle	Goat	Pig	Chicken	Guinea pig	Sheep

B. List of Innovations and Innovation Processes

1. What innovations have you implemented last 10 years? Under which crop/enterprise? Which year?
2. Why did you make the innovations?
3. How did you know/learn about the innovation? Which stakeholders were involved in the process and how?
4. Within your family, who initiated the innovation? To whom and how did you disseminate the innovation?
5. What types of resources and how much of them did the innovation require? How did you manage to obtain the resources?
6. How long did it take to apply the innovation, from the moment you got to know about the innovation until you actually used it? What happened in the process?

No.	1. Innovation	2. Reason	3. Info-source, Occasion	4. Intra-HH communication	5. Resource	6. Duration

Notes:

C. Innovation Evaluation

What were the most difficult innovations for you, why?
What were the easiest innovations for you, why?
Which innovations were the most important for your livelihoods? Why? Was the innovation transformational?
Which innovations do you wish to make in future? What are the expected challenges?

D. Changes in innovation types and processes

Have what you innovate, why you innovate, and how you innovate changed over the last 10 years? How?

What	
Why	
How (e.g. info source)	

E. Agricultural Extension Services

What kind of agricultural extension services do you have access to? How do you benefit from those services? Which information sources are useful? Reliable? Do you actively

seek for agricultural advice, from where?
Regarding to public extension services, how did you benefit before NAADS, with NAADS, and after NAADS (e.g. OWC)?

Before NAADS	
With NAADS	
After NAADS	

What do you suggest for the public extension services so that you can innovate better?

Notes:

Appendix 7: Wealth Factors

	Nave	Elema	Ryantende	Rushasha
Wealth Factors	• The type of school's children in a home go to (private, government schools and no school at all) • The quantity of land that a family opens up • The type of transportation as an asset (motorcycles, bicycles and a vehicle) • The number of meals in a day and type of meal • The land sizes they own • The type of phones they own either simple phones or a smart phone • The commodities that they conduct their businesses in • The type and number of livestock • Type of clothes	• Land size owned and opened. • Livestock type and number • Livelihoods (e.g. casual labour, grass-selling, charcoal-selling, brewing) • % of food from own farm or market • School for their children (e.g. not going, government/private schools) • Housing (grass-thatched, semi-permanent) • Capacity to hire external labour • Whether selling own produce • Crop types (e.g. vegetables) • Land-opening capacity (e.g. hiring casual labour, ox-plough)	• Housing type • Food availability at home • Income • Family • Health facility in the area • How to use land (even in small land, zero-grazing, maize, beans, cassava, pottery, brick-laying) • Land size • Quality of land (land fertility)	• Land size owned • Number of animals • Education level of children (e.g. no schooling, stopped at primary level, boarding private schools) • Casual labour for daily food • Number of meals per day • Clothing • Food in storage • Housing • Size of banana plantation • Affordability of medical expenses
Characteristics of Poor	• Houses are temporary made of mud blocks and are grass thatched • They usually have one building in a homestead • They eat once in a day. Some wait for food from neighbours. • Their children do not in most cases go to school • They rent out most of their land • They have very limited or not cattle and goats • They have poor clothing • They rent out their labour a lot.	• Having at least 5acres of land (some have even 20 acres) but only less than 1 acre is used. • Grow sweet potato in 1/8 acre of land. Small garden for cowpea leaves. Sesame of less than ½ acre, s/potato of 1/8 acre, g/nuts of ¼ acre, maize of ¼ acre, kitchen garden (growing okra). • There is no livestock (no goats, no chicken). • Selling firewood, grass, hand hoe handles, handcraft (mingling stick). • Cutting trees • Casual labour (working at someone's garden)	• No land • No house (house is rented). Even if there is a house, it is grass-thatched. • Go and get food from somewhere (e.g. farm labour) • Children is not at school (cannot afford) • Poor dressing	• Has small land less than ¼ acres • Has no animal at all • Children do not attend school because the parents cannot afford school related expenses. • Work for money they go to other gardens to work for money and food in form of payments. • They have small grass-thatched houses commonly known as huts. • Eats once a day • Has one pair of clothes.

		• Buying food. Can't sell any crop. (70% of food consumption come from market, 30% from own garden) • They cannot afford school fee. • They have only 1 house.		
Characteristics of Moderate	• Have semi-permanent houses • They send their children to government schools with universal primary/secondary education programs • They open up about 2.5 acres of land averagely • They can keep up to 5 cattle (by luck e.g. dowry), 8 sheep and 20 poultry • They have averagely 2 meals a day • They own from 3 to 4 acres of land • They generally have a moderately strong vision • They occasionally hire in labour • Have got phones, solar panels for lighting and phone charging with not greater than 10 watts of capacity • Only few have bicycles.	• Having 5-10 acres. (using 2 acres) -1 acre of simsim,1/4 acre of g/nuts, 1/2 acre of greengram,1/4 acre of sweet potato. • Selling charcoal. • 2-4 goats, 4-6 chickens. • They do not have any cow. • Send children to UPE schools. • Brewing local waragi. • Selling grass for roofing. • Selling chicken and goats. • Food -50% from market, 50% from own produce. • Hiring poor for lajalaja for charcoal burning/cutting logs, and for farm work. • Selling sesame, g/nuts, maize. • 50% of income from produce goes to school fee, medical treatment, and 50% for home consumption.	• 5-10 acres of land • Children are at UPE government schools • Enough food to eat • Semi-permanent house • Having tea plantation, and some animals (5 goats, 5 sheep, 100 chickens) • Give small portion of land to sons	• Children attend primary school and cannot go beyond primary seven level. • Has some animals (1-3goats, 6-10 hens, but no cow) • Eats twice a day • A pair of clothes • Can afford some food to keep in a granary • Has semi-permanent house • Can afford health related expenses • Owns about 3 acres of land • Has 1.5 acres of banana which acts as food security.
Characteristics of Rich	• Have about 10 cows in a kraal, 10 goats/sheep, 2-3 pigs • Own a bicycle or a motor-cycle • Open up four or five acres of land • They in most cases send their children to private schools • Have permanent/semi-permanent buildings • They have three meals in a day	• Having 10-20 acres of land, and 5 acres opened. • Having more than 10 cows, 15-25 goats, more than 10 chickens. • 2-4 acres of sesame, 1-2 acres of g/nuts, 1 acre of pigeon pea (intercropped with g/nuts), 1/2 acre of s/potato, 1/2 acre of maize. • Hiring labour, ox-traction for opening	• Enough land (100-300 acres) – banana plantation • Business (e.g. tea plantation, cattle, fish pond, poultry) • Having animals (more than 100 cows, 200 goats, 6000 chickens) • Having 2 vehicles • Children are at school (private school)	• They have big land sizes of about 5-20 acres • They have permanent houses • They afford health related expenses like hiring boda- boda to take the sick person at the health centre • Have big banana size plantation (2.5-5acres) • Has enough food (irish potatoes, beans,

	(they take one of these weekly; fish, vegetable, meat and beans once in a week) • They own solar panels of greater than 30 watts' capacity • They also own mobile phones • Have averagely > 5 acres of land	land. • Growing vegetables. • 50% of produce is sold to market. (e.g. sesame, g/nuts, vegetables, cows, goats). • Engaged in other businesses (growing crops for selling). • Taking children to schools in Bibia.	• Having more than 20 workers at home • Good permanent house.	maize and millet) • They afford in paying school related expenses at levels (that is from primary up to the university or any other tertiary institutions) boarding school outside.
Transformation Pathways	• Gradual process	**From Rich to Moderate and Poor** • Poor marketing • Unreliable rainfall • Used to have ox-plough but the cows are stolen. • Growing crops (e.g. simsim) is difficult to time. • Disturbance by elephants **From Moderate to Rich** • Changed types of crops (vegetable during dry season with water pump irrigation) • Sourcing tomato seeds from stockist in Adjumani town • Support from Sub County (e.g. group Taakoni-Mauza received generator and pipes through CDD in Oct 2014). • Credit (VSLA): borrowed money for opening land and weeding to grow vegetable. Hiring external labour from moderate and poor farmers. After only 3 months, market the produce.	**From Poor to Moderate** • Through hard working, passion to work, good planning • Having small family so saving for small business to buy land. **From Moderate to Rich** • Get capital (loan scheme) e.g. 1m/= for tea plantation, buying goats (goat multiplication) **From Rich to Moderate** • Poor resource utilisation (go to loan and fail to pay back the loan, due to poor utilization of fund.) • Coming from a rich family. Land is given, but selling property or misuse. • Young generation goes for luxury items (car, phone) **From Moderate to Poor** • Poor planning • Problems come abruptly (e.g. loan default, luxury items, prostitute, theft, robbery, business caught by fire…etc)	**From Poor to Moderate** • Saving some little from their wages in banks and saving groups. • Hire land to grow more crops for both food and sell • Proper utilisation of small land they have and hire • Using little capital to start small business **From Moderate to Rich** • Improve the variety of the animals (from local to exotic) • Better farming and agriculture practices like building houses for the hen for safety of laying the eggs. • Selling of maize, banana, irish potato, and bean to buy motorcycles to do bodaboda business for increased incomes. **From Rich to Moderate** • Too much alcohol drinking • Illiteracy, Lack of certificate of education (not completed courses) • Extravagancy • Ignorance / poor land use. • Disease and death of cows • Assets taken away due to defaulting loans.

Appendix 8: Innovation Types mentioned during FGDs

Innovation Types (based on Stratified Focus Group Discussions)

			Elema village															Nave village															Ryantende village															Rushasha village														
Category	Innovations	enterprise	WM	MM	PM	WW	MW	PW	WF	MF	PF	WYB	MYB	PYB	WYG	MYG	PYG	WM	MM	PM	WW	MW	PW	WF	MF	PF	WYB	MYB	PYB	WYG	MYG	PYG	WM	MM	PM	WW	MW	PW	WF	MF	PF	WYB	MYB	PYB	WYG	MYG	PYG	WM	MM	PM	WW	MW	PW	WF	MF	PF	WYB	MYB	PYB	WYG	MYG	PYG
Land management	Bush fallowing																																																	x													
	Crop rotation	beans																																																x													
		sorghum																																																x													
		maize																																																x													
	Mix-farming (using grazing land for crop)																																																	x													
Planting seasons	Change of planting seasons (early planting)	simsim	x		x	x	x			x	x																																																		
		tomato				x																																																								
		maize				x					x																																																		
		beans																																																								x						
		irish potato																																																							x						
Enterprise selection	Expansion of enterprise	simsim	x																																																										
		okura					x																																																						
		dodo					x																																																						
		goats																															x														x							x							
		banana																																			x																									
		tea																																					x																							
	Specialization of enterprise (stopped fish farming)																															x																													
	Producing for market	simsim	x																																																										
		tomato																x																																												
		onion																x										x																																		
		cabbage																x																																												
		g/nuts																										x																																		
		maize																										x																																		
		beans																										x																																		
		banana																																															x													
		goats																																																							x						
	Introduction of new crop	tomato	x										x																																																
		sorghum					x																																																						
		simsim						x						x																																															
		songo								x																																																				
		ntula								x																																																				
		cabbage											x																																																
		dodo											x																																																
		sukuma											x																																																
		maize																																															x													
		cassava																																															x													
		peas																																																	x											
		s/potato																																															x													
		irish potato																																																x								x			
		beans																																															x													
		watermelon																																																x												
		sugarcane																																																x												
		banana																x							x																								x													
		coffee																							x																																				
		tea																																	x																											
		tick tree		x																																																										
		grafted mango			x		x			x																	x	x			x																															
		grafted citrus			x					x																																																			
		local mango																																															x													
		avocado																																															x													
	Improved seeds /New variety	simsim	x																																																										
		sorghum (serena)	x							x																																																		
		g/nuts	x							x										x							x																																		
		maize	x	x	x						x									x											x																														
		cassava				x												x		x	x				x		x				x																														
		millet								x																																																				
		beans								x										x	x				x						x																	x														
		s/potato								x																																																				
		banana																			x																										x														
		onion																			x		x		x	x	x																																		
		tomato																			x		x		x	x																																			
		cabbage																			x													x																													
		eggplant																			x																																										
		tea																																					x																							

Land-opening	Use of ox-plough		x				x								x																																																				
	Useof tractor																				x																																															
	Hiring labour for harrowing						x																																																													
	Ox-ploughing business		x																																																																	
Land preparation	Zero/minimum-tillage, Planting without harrowing	g/nuts	x																																																																	
																						x																																														
		beans																								x																																										
	Ploughing without bush-burning																					x							x																																							
		maize																									x																																									
Planting	Line-planting	simsim	x	x		x						x																																																							
		tick tree		x																																																																
		g/nuts				x									x					x		x		x																																												
		cassava				x															x	x		x							x																																					
		sorghum (serena)										x																																																								
		beans																			x	x		x		x						x																																				
		maize																			x	x		x				x	x			x																														x			
		tomato																				x																																														
		onion																				x		x				x	x																																							
		rice																				x																																														
																											x																																										
	Proper spacing	watermelon																																																		x												
	Making nursery bed	onion																								x																																									
	Reviving plantation by replacing old suckers with new ones	banana																																						x																										
	Buying seeds from market due to lack of stock	simsim		x																																																															
		beans																																						x																										
Weeding	Frequent weeding	g/nuts																									x																																								
		s/potato																																					x																											
		banana																																																	x														
		beans																																																			x											x	
		maize																																																			x												
		irish potato																																																													x			
	Herbicide application																		x																																																	
		eggplant																																		x																																	
		tea																																			x																															
	Pruning	tea																																			x				x																											
		banana																																					x			x	x								x				x	x										
		coffee																																																	x														
		sugarcane																																																			x												
Irrigation	Irrigation (water pump)	tomato	x			x																																																												
	Irrigation (watering can)	cabbage																																		x																																	
		eggplant																																		x																																	
	Irrigation (water bottle)	watermelon																																																		x												
	Water-harvesting by digging ditches	tea																																				x																														
		banana																																					x														x											
Soil management	Forking	banana																																																	x				x	x		x	x						
	Heaping	irish potato																																																												x			x
	Fertilizer					x																																																													
		maize																		x																	x		x									x																		
		beans																																			x																															
		tea																																							x																								
		banana																																																				x											
		irish potato																																																					x										
	Liquid fertilizer	tomato																										x	x																																						
		irish potato																																																			x	x										
	Human urine	banana																																				x																														
	Manure application	cabbage											x																																																					
		tomato																		x																																																
		beans																		x																																																
		banana																		x																		x	x	x			x											x	x	x	x	x							
	Manure application for seedbed	onion																										x																																								
	Compost application	coffee																																		x																																	
		banana																																						x												x													
		maize																																														x																	
	Use of tea dust	banana																																								x																								
	Use of zinc	tea																																								x																								
	Mixing weeds in soil	banana																		x																																																
	Mulching	beans																				x				x													x																											
		eggplant																																		x				x					x			x																	
		cabbage																																											x			x																	
		banana																																				x		x	x	x	x								x	x		x	x	x	x	x	x		x				
		watermelon																																																			x												

Control of Pests and Diseases	Purchasing own spray pump																																		x																														
	Pesticides application to seeds	irish potato																																																				x							
	Pesticides application	tomato	x			x	x																x		x		x	x	x	x																																	
		onion																					x		x			x		x																																	
		maize					x											x																		x																			x									
		eggplant											x								x												x				x				x			x																
		cabbage																			x								x				x								x			x																
		beans																x			x		x												x																											
		redpepper																x																																												
		watermelon																																														x												
		irish potato																																																x	x			x						x
	Local pesticides	tomato			x					x																																																				
		dodo								x																																																				
		eggplant								x																																																				
		cabbage											x																																																	
	Use of cooked banana leaves to prevent caterpillers	banana																																																		x									
	Local pesticides against termites				x																																																									
	Pesticide for storage	beans																	x																																											
	Local pesticides for storage	maize	x																																																											
		greengram	x																																																											
		beans																	x																																											
		cassava																	x																																											
	Removal of male inflorescence	banana																																														x						x							
	Uprooting BBW-affected suckers	banana																																			x																									
	Use of ash after uprooting BBW-affected suckers	banana																																					x																							
	Sterilization of farming tools	banana																																		x	x		x																							
Post-harvest handling/ marketing	Sun-drying for storage using tapoline	maize																		x																										x																
	Use of taplin for drying	beans																							x																																					
		cassava																							x																																					
	Collective marketing																			x																																											
	Collaborative marketing with neighbours	eggplant																																				x																								
	Drying/Storing for marketing	cassava																										x																																		
	Marketing processed produce to schools	maize, onion, cassava, beans																									x																																			
	Quality seed multiplication for sell	cassava																x																																												
	Paste-making business	g/nuts	x																																																											
	Milling business		x																																																											
	Use of motorbike/vehicle for transporting produce																	x																																												
	Construction of storage																		x																																												
	Change from granary to own house for storage																			x			x																																								

Introduction of animals	Introduction of bee-keeping																																		x																																
	Introduction of animals	zero-grazing																															x				x																												
		cross cow																																			x														x			x											
		cattle																																																				x			x							
		goats																																		x			x																										
		Boar goats																																							x																								
		pigs																																			x		x																x										
		improved pigs																																					x																										
		chicken																																																				x										
Fodder/Feeds for animals	Growing pasture	zero-grazing																																					x																										
	Buying bran/mash as feed	chicken																																											x									x											
	Food suppliment (banana peals, maize stalk)	cross cow																																																						x								
	Reducing no. of animals to avoid overgrazing.	zero-grazing																																							x																								
Multiplication method of animals	AI																																	x																																
Animal Disease controls	Spraying of animals	cattle	x									x																																																					
		dairy cow																																							x																									
		goats																																											x	x					x														
		pigs																																																				x										
	Use of stirup pump for spraying animals	cattle																																																			x											
		goats																																																			x											
	Try out various accaricide	dairy cow																																							x																									
	Deworming of animals	goats																			x																x										x					x														
		cattle																																																		x													
	Vaccination of animals																		x	x	x	x		x																																										
		goats																										x					x																																		
		dairy cow																																							x																									
	Use of drugs to treat disease	poultry																																											x																				
	Local herb for controling mites/diseases	poultry																			x																							x																						
	Application of human drugs to treat disease of animals	chicken																										x																																								
Animal houses	Construction of house for animals	dairy cow																																	x																																
		pig																																			x																														
		chicken																																																			x											
	New house for animals near home																		x																																															
Rearing methods	Free-ranzing of animals(from tethering)	goats																																																x														
	Tethering of animals (from free-ranzing)									x																																																									

Appendix 9: Questionnaires for Household and Individual Survey

Understanding dynamics and diversity of smallholder farmers' innovation characteristics and processes in Agricultural Innovation System in Uganda

Name of Village: ………………………………………………..
Household No.:…………………………………………………..
Name of Enumerator:………………………………………..
Date:………………………………………..
Time:………………………………………
Location: Resident of respondent? Y/N

Introduction:
The Section I will be answered by either household head or spouse (alternating gender of respondent). If the household type is male or female-headed household without spouse, this will be answered by the head of household. The Section II will be answered by household head and spouse separately.

SECTION I: HOUSEHOLD

A. Identification

A6: Is the respondent for Section I a Household Head or Spouse? [1-Household Head, 2-Spouse]	

B. Basic Household Information

B1: Household Type Household Type: 1-Male-headed household with spouse, 2-Male-headed household without spouse, 3-Female-headed household with spouse, 4-Female-headed household without spouse.	
B2: Did your household exist 10 years ago? [Y/N] *If NO, go to B4.	
B3: What was your household type 10 years ago? Household Type: 1-Male-headed household with spouse, 2-Male-headed household without spouse, 3-Female-headed household with spouse, 4-Female-headed household without spouse.	
B4: How many members does your household have? 1-Nine or more, 2-Eight, 3-Seven, 4-Six, 5-Five, 6-Four, 7-Three, 8-Two, 9-One	
B5: Are all household members ages 6 to 12 currently in school? 1-Yes, 2-No, 3-No one ages 6 to 12	
B6: Can the (oldest) female head/spouse read and write with understanding in any language? 1-No, 2-No female head/spouse, 3-Yes	
B7: What type of material is mainly used for construction of the wall of the dwelling? 1-Unburnt bricks with mud, mud and poles or others, 2-Unburnt bricks with cement, 3-burnt bricks with mud or cement, 5-wood, 6-iron sheet,	

7-cement blocks	
B8: What type of material is mainly used for construction of the roof of the dwelling? 1-grass thatched, 2-iron-sheet, 3-tile, 4-others (specify)	
B9: What source of energy does the household mainly use for cooking? 1-Firewood, Cow dung, or Grass, 2-Charcoal, 3-Paraffin stove, 4-Gas, 5-Biogas, 6-Electricity	
B10: What type of toilet facility does the household mainly use? 1-None, 2-Uncovered Pit latrine, 3-Ecosan, 4-Covered Pit latrine without slab, 5-Covered Pit latrine with slab, 6-VIP latrine, 7-Flush toilet	
B11: How many mobile phones do members of your household own? 1-None, 2-One, 3-Two, 4-Three or more	
B12: Does any member of your household own a smart phone? 1-No, 2-Yes	
B13: Does any member of your household own a radio? 1-No, 2-Yes	
B14: Does any member of your household own a TV? 1-No, 2-Yes	
B15: Does every member of the household have at least one pair of shoes? 1-No, 2-Yes	

C: Details of Respondents (HH head and Spouse)

	C1: Name	C2: Age	C3: Sex [M/F]	C4: Marital Status	C5: Highest Education level	C6: Can you read and write in any language? [Y/N]	C7: Main activity (multiple choice)	C8: Resident in the village? [1-yes, 2-only holidays, 3-rarely back]	C9: Years in this house hold (years)	C10: Farming experie nce (years)	C11: Group Memb er [Y/N]	C12: Original ly from this village? [Y/N]	C13: If not, when did you come to this village? (year)	C14: From where? (distric t)	C15: Why did you come to this village ?
HH head															
Spouse															

C4: Marital Status: 1-Never married, 2-Married, 3-Widow (not remarried), 4-Divorced (not remarried), 5-Married but separated
C5: Highest Education:1-Never been to school, 2- Primary level (specify the level, e.g. P1, P2, P3…), 3-Vocational Training, 4-O' level (specify the level, S1, S2…etc), 5-A' level (specify the level, S4, S5, S6), 6-PTC (Year1, Year2) 7-Technical School (specify the level Year1, Year2, Year3), 8-Technical Institute (specify the level Year1, Year2), 9-Thirtiary level (specify the level, Certificate, Diploma, Degree, Postgraduate)

C7: Main Activity: 1-Farmer mainly in crop production, 2-Farmer mainly in livestock production, 3-Fishing, 4-Casual labour (farming, non-farming, labour for charcoal-burning, tea-plucking, 5-Artisan, 6-Trader, 7-Formal work (Work at factory, work for government, work for any other private companies, work for individuals), 8-Own business (specify), 9-Student, 10-Not working at all
C-15: Why did you come to this village?: 1-marriage, 2-agricultural opportunity, 3-non-agricultural opportunity, 4-family matters, 5-other (specify)

D: Farming Assets in Household

	Does your household have this? [Y/N]	Who usually use it? (select all that apply) [1-Husband, 2-Wife/Female-head, 3-Children, 4-hired labour]
Forked hoe (W)		
Watering can		
Ox-plough		
Walking Tractor		
Knapsack-sprayer		
Water pump for irrigation		
Wheelbarrow (for farming purpose)		
Bicycle (for farming purpose)		
Motorbike (for farming purpose)		
Pick-up (for farming purpose)		

*W-to be asked only to Western Region

E: Access to Agricultural Services by Household

	Present (last 12 months)		10 years ago	
Services	Used? [Y/N]	Type [select all applicable]	Used? [Y/N]	Type [select all applicable]
From where have you sourced necessary farm inputs?		1-Agro-input shops, 2-Market, 3-Government, 4-NGO, 5-District Farmer Association,6-Farmer Group, 7-Other farmers out of village, 8-Other farmers within village, 9-Other (specify)		1-Agro-input shops, 2-Market, 3-Government, 4-NGO, 5-District Farmer Association,6-Farmer Group, 7-Other farmers out of village, 8-Other farmers within village, 9-Other (specify)
Have you done collective marketing		With whom did you market your produce? 1-NGO, 2-Farmer association, 3-Farmer group, 4-		With whom did you market your produce? 1-NGO, 2-Farmer association, 3-Farmer group, 4-

(selling together with other farmers)?		Neighbour/friends, 5-Other (specify)		Neighbour/friends, 5-Other (specify)
Have you used any external agro-processing services (e.g. milling) either before marketing or home consumption?		Which service provider? 1-Private business, 2-Government, 3-NGO, 4-NGO, 5-Neighbour/friends		Which service provider? 1-Private business, 2-Government, 3-NGO, 4-NGO, 5-Neighbour/friends
Veterinary Service		Which service provider? 1-Government, 2-NGO, 3-Private vet, 4-Other farmers		Which service provider? 1-Government, 2-NGO, 3-Private vet, 4-Other farmers

F: Land

Type and Size of Household Landholding

*Please ask about 10 years ago, if the household exists more than 10 years (check the answer to the previous question- B3).

	Present	*10 years ago
F1: Landholding size (acre)		
F2: Who has the ownership of the land? 1-husband, 2-wife, 3-husband and wife jointly owned, 3-father, 4-others (specify)		
F3: How is the quality (fertility) of the land? 1-poor, 2-fair, 3-good		
F4: Land used for crop production out of own land (acre)		
F5: Crops grown on OWN land (write all)		
F6: Land used for grazing of animals out of own land (acre)		
F8: Land rented in (acre)		
F9: From where do you rent in? [1-Other farmer within village, 2-Other farmer out of village, 3-Family/friends, 4-		

Government, 5-Company, 6-Other (specify)]		
F10: What is the mode of payment for rented-in land? [1-Paid in cash, 2-Paid in kind, 3-Free]		
F11: Purpose of rent-in? [1-Growing crops, 2-Grazing animals, 3-Both, 4-Other (specify)		
F12: Land size for Rent-in for Crop Production (acre)		
F13: Crops grown on RENTED-in land (write all)		
F15: Land rented out from own land (acre)		
F16: To whom do you rent-out? [1-Other farmer within village, 2-Other farmer out of village, 3-Family/friends, 4-Government, 5-Company, 6-Other (specify)]		
F17: What is the mode of payment for rented-out land? [1-Paid in cash, 2-Paid in kind, 3-Free]		

G: Family and Hired Labour

G1-2: How many men, women and children work on farming activities within your household?

*If the household exists more than 10 years, please answer the questions of 10 years ago as well.

	Present	*10 years ago
Men (Full-time)		
Women (Full-time)		
Children –below 18 (Full-time)		
Men (Temporary)		
Women (Temporary)		
Children –below 18 (Temporary)		

G3-5: Are there any dependant youths (above 16-30 years old, except HH head and Spouse) within your household who are farmers and independently manage farming activities?

G3: Yes or No	G4: How many Boys?	G5: How many Girls?

G6-9: Do/did you use external labour for farming activities in present and 10 years ago? What was the mode of payment/arrangement for the external labour?

	1-Yes, always, 2-Yes, sometimes, 3-No, rarely, 4-Never	Mode of payment/arrangement (select all) [1-Paid in Cash, 2-Paid in Kind (e.g. food…etc), 3-Free, 4-Group work (rotational)]
Present		
10 years ago		

H: Crop Management

Crop Management (Present)

H1: 3 major crops	H2: Land size	H3: Who decides to grow this crop and how to grow? [below]	H4: Who pays for inputs? [below]	H5: Cultivation method [below]	H6-9: Who mainly does the work? (Tick the matrix below)	H10: Where to sell? [below]	H11: What is the major transportation means for this crop? [below]	H12: Who manages profit? [below]	H13: Contribution to household income [1-Not at all, 2-very little, 3-somehow, 4-good, 5-greatly]	H14: Contribution to household food [1-Not at all, 2-very little, 3-somehow, 4-good, 5-greatly]
1.										
2.										
3.										

H3: Who decides to grow this crop and how to grow?: 1-Mainly Husband, 2-Mainly Wife/Female-head, 3-Husband and Wife jointly, 4-Others (specify)
H4: Who pays for inputs?: 1-Husband, 2-Wife, 3-Husband and Wife jointly, 4-Others (specify)
H5: Cultivation method: 1- hand-digging by family labour, 2-hand-digging by paid labour, 3-own ox-plough, 4-paid ox-plough, 5-own tractor, 6-paid tractor, 7-other (specify)
H10: Where to sell?: 1- internal trader at farm gate, 2-external trader at farm gate, 3-market within village, 4-local market, 5-district market, 6-out of district, 7-others (specify), 8-no selling
H11: What is the major transportation means for this crop?: 1-walking, 2-bicycle, 3-motorbike, 4-pickup, 5-lorry, 6-others (specify)
H12: Who manages profit?: 1-Husband, 2-Wife/Female-head, 3-Husband and Wife jointly, 4-Others (specify)

Crop1:

	Family labour (Tick one)					External labour (Tick if work done by Hired labour)
	Husband	Wife/Female-head	Both	Children	No one	Hired Labour
Ploughing						
Planting						
Weeding						
Mulching/irrigation						
Spraying						
Harvesting						
Post-harvest processing						
Marketing						

What is the % of work done by Hired Labour for this crop? ……………………………..%

Crop2:

	Family labour (Tick one)					External labour (Tick if work done by Hired labour)
	Husband	Wife/Female-head	Both	Children	No one	Hired Labour
Ploughing						
Planting						
Weeding						
Mulching/irrigation						
Spraying						
Harvesting						
Post-harvest processing						
Marketing						

What is the % of work done by Hired Labour for this crop? ……………………………..%

Crop3:

	Family labour (Tick one)					External labour (Tick if work done by Hired labour)
	Husband	Wife/Female-head	Both	Children	No one	Hired Labour

Ploughing						
Planting						
Weeding						
Mulching/irrigation						
Spraying						
Harvesting						
Post-harvest processing						
Marketing						

What is the % of work done by Hired Labour for this crop? ……………………………..%

Crop Management (10 years ago) *This section should be asked if the household exists more than 10 years. (check the answer B3).

H15: 3 Major Crops	H16: Land size	H17: Who decides to grow this crop and how to grow? [below]	H18: Who pays for inputs? [below]	H19: Cultivation method [below]	H20-23: Who mainly does each work?	H24: Where to sell? [below]	H25: How do you transport? [below]	H26: Who manages profit? [below]	H27: Contribution to income [1-Not at all, 2-very little, 3-somehow, 4-good, 5-greatly]	H28: Contribution to food [1-Not at all, 2-very little, 3-somehow, 4-good, 5-greatly]
1.										
2.										
3.										

Crop1:

	Family labour (Tick one)					External labour (Tick if work done by Hired labour)
	Husband	Wife/Female-head	Both	Children	No one	Hired Labour
Ploughing						
Planting						
Weeding						
Mulching/irrigation						
Spraying						
Harvesting						
Post-harvest processing						

Marketing						

What is the % of work done by Hired Labour for this crop? ……………………………..%

Crop2:

	Family labour (Tick one)					External labour (Tick if work done by Hired labour)
	Husband	Wife/Female-head	Both	Children	No one	Hired Labour
Ploughing						
Planting						
Weeding						
Mulching/irrigation						
Spraying						
Harvesting						
Post-harvest processing						
Marketing						

What is the % of work done by Hired Labour for this crop? ……………………………..%

Crop3:

	Family labour (Tick one)					External labour (Tick if work done by Hired labour)
	Husband	Wife/Female-head	Both	Children	No one	Hired Labour
Ploughing						
Planting						
Weeding						
Mulching/irrigation						
Spraying						
Harvesting						
Post-harvest processing						
Marketing						

What is the % of work done by Hired Labour for this crop? ……………………………..%

I: Livestock Management

Livestock Management (Present)

I1: Livestock (Answer for max.3 types of animals)	I2: Breed [1-local, 2-cross, 3-exotic]	I3: Number	I4: Who decides whether and when to sell or consume the animals? [below]	I5: Who pays for the inputs? [below]	I6-9: Who takes care of the animals? (Tick the matrix below.)	I10: Where to sell? [below]	I11: What is the major transportation means for this animal? [below]	I12: Who manages the profit? [below]	I13: Contribution to income (rate) [1-Not at all, 2-very little, 3-somehow, 4-good, 5-greatly]	I14: Contribution to food (rate) [1-Not at all, 2-very little, 3-somehow, 4-good, 5-greatly]
1. Cows										
2. Goats										
3. Chickens										
4. Pigs										
5. Rabbits										
6. Sheep										
7. Guinea pigs										
8. Ducks										
9. Others (specify)										

I4: Who decides whether and when to sell or consume the animals?: 1-Husband, 2-Wife, 3-Husband and Wife jointly, 4-Others (specify)
I5: Who pays for inputs?: 1-Husband, 2-Wife/Female-head, 3-Husband and Wife jointly, 4-Others (specify)
I10: Where to sell?: 1-not sold. only for own consumption, 2-internal trader at farm gate, 3-external trader at farm gate, 4-village market, 5-local market, 6-district market, 7-out of district, 8-others (specify)
I11: How do you transport?: 1-walking, 2-bicycle, 3-motorbike, 4-pickup, 5-lorry, 6-others (specify)
I12: Who manages profit?: 1-Husband, 2-Wife/Female-head, 3-Husband and Wife jointly, 4-Others (specify)

Animal1: …………………………………..

	Family labour (Tick one)					External labour (Tick if work done by Hired labour)
	Husband	Wife/Female-head	Both	Children	No one	Hired Labour
Construction of sheds						
Cleaning of sheds						

Feeding						
Grazing						
Growing fodder						
Spraying/deworming						
Marketing						

What is the % of work done by Hired Labour for this animal? ……………………………..%

Animal2: ……………………………………..

	Family labour (Tick one)					External labour (Tick if work done by Hired labour)
	Husband	Wife/Female-head	Both	Children	No one	Hired Labour
Construction of sheds						
Cleaning of sheds						
Feeding						
Grazing						
Growing fodder						
Spraying/deworming						
Marketing						

What is the % of work done by Hired Labour for this animal? ……………………………..%

Animal3: ……………………………………..

	Family labour (Tick one)					External labour (Tick if work done by Hired labour)
	Husband	Wife/Female-head	Both	Children	No one	Hired Labour
Construction of sheds						
Cleaning of sheds						
Feeding						
Grazing						
Growing fodder						
Spraying/deworming						
Marketing						

What is the % of work done by Hired Labour for this animal? …………………………..%

Livestock Management (10 years ago)

I15: Livestock	I16: Breed [1-local, 2-cross, 3-exotic]	I17: Number	I18: Who decides whether and when to sell or consume the animals? [below]	I19 Who pays for the inputs? [below]	I20-23 Who takes care of the animals? (Tick in matrix below)	I24: Where to sell? [below]	I25: How do you transport? [below]	I26: Who manages the profit? [below]	I27: Contribution to income (rate) [1-Not at all, 2-very little, 3-somehow, 4-good, 5-greatly]	I28: Contribution to food (rate) [1-Not at all, 2-very little, 3-somehow, 4-good, 5-greatly]
10. Cows										
11. Goats										
12. Chickens										
13. Pigs										
14. Rabbits										
15. Sheep										
16. Guinea pigs										
17. Ducks										
18. Others (specify)										

Animal1: …………………………………..

	Family labour (Tick one)					External labour (Tick if work done by Hired labour)
	Husband	Wife/Female-head	Both	Children	No one	Hired Labour
Construction of sheds						
Cleaning of sheds						
Feeding						
Grazing						
Growing fodder						
Spraying/deworming						
Marketing						

What is the % of work done by Hired Labour for this animal? ……………………………..%

Animal2: ……………………………………..

	Family labour (Tick one)					External labour (Tick if work done by Hired labour)
	Husband	Wife/Female-head	Both	Children	No one	Hired Labour
Construction of sheds						
Cleaning of sheds						
Feeding						
Grazing						
Growing fodder						
Spraying/deworming						
Marketing						

What is the % of work done by Hired Labour for this animal? ……………………………..%

Animal3: ……………………………………..

	Family labour (Tick one)					External labour (Tick if work done by Hired labour)
	Husband	Wife/Female-head	Both	Children	No one	Hired Labour
Construction of sheds						
Cleaning of sheds						
Feeding						
Grazing						
Growing fodder						
Spraying/deworming						
Marketing						

What is the % of work done by Hired Labour for this animal? ……………………………..%

J: Source of Income and Food

*Questions about 10 years ago should be asked only if the household exists for more than 10 years. (Check answer –B3).

Please make sure that the total for each question is 100%.
J1-6: What are the major income sources for your household?

	Crop production (%)	Livestock production (%)	Agricultural casual labour outside of holding (%)
Present			
*10 years ago			

J7-10: What are the major food sources for your household?

Seasons	Own production (%)	Bought (from market) (%)
Present		
*10 years ago		

J11-14: Household Expenditure?

Seasons	Food (%)	Education (%)
Present		
*10 years ago		

SECTION II: INDIVIDUAL HOUSEHOLD MEMBERS
<u>***This section will be asked to Household Head and Spouse separately**</u>

Is the respondent Household Head or Spouse? …………………………………..

K: 3 Key Innovations
What are the 3 key new changes in what you do and how you do in your farming activities (innovations) have you made in last 10 years?

	K1-4: Innovations (Describe briefly) AND [enumerator adds code from list]	K5-7: Which Crop /Animal? [enumerator select code from	K8: Which year did you start? (year)	K9: Why did you make the change? [below]	K10: Key information source (direct)? [below]	K11: Who was the first one to know about it within your household?	K11-1: When (which year) did you first	K12: Who decided to make the change within	K13: Key source for getting inputs. [below]	K13-1: Where did you source/purchase the inputs for the innovation?	K14: Did the PRODUCTION of the respective crops or animals	K15: Still continuing? [Y/N]	K16: Which year did you stop?	K17: Why stopped?

		list]				[below]	know about the innova tion?	your househol d? [below]		[below]	increase, compared to without the innovation? [1-Not at all, 2-very little, 3-somehow, 4-good, 5-greatly, 6-Not sure]			
1														
2														
3														

K1-4: Code for Innovations

Crop-related innovations	Livestock-related innovations
1- New crop 2- New variety 3- Expansion in area planted 4- Reduction in area planted 5- Change in planting timing 6- Pests and diseases control 7- Improved farming tools 8- Soil management 9- Irrigation/Water-harvesting 10- Land preparation and Planting method 11- Weeding method 12- Post harvesting method (storage, processing, marketing) 13- Other (specify)	1- New animal 2- New breed 3- Expansion in no. of animals 4- Reduction in no. of animals 5- Grazing method 6- Feeds/fodder 7- Breeding method 8- Animal disease control 9- Animal house 10- Other (specify)

K5-7: Code for Crops/Animals

A. Cereal and general crops	1-maize, 2-cassava, 3-sweet potato, 4-irish potato, 5-banana (matooke), 6-rice, 7-sorghum, 8-millet, 9-other(specify)
B. Leguminous and oil crops	1-bean, 2-cowpea, 3-soya bean, 4-pigeon pea, 5-simsim, 6-g/nuts, 7-other (specify)
C. Vegetables	1-tomato, 2-cabbage, 3-eggplant, 4-onion, 5-okra, 6-greens (e.g. amaranth, kale…), 7-pumpkin, 8-other (specify)
D. Fruits	1-mango, 2-citrus, 3-avocado, 4-pawpaw, 5-pineapples, 6-watermelon, 7-sugarcane, 8-banana (sweet), 9-other (specify)
E. Cash crop	1-tea, 2-coffee, 3-cotton, 4-tobacco, 5-other (specify)

K9: Why did you make the change?: 1-higher profit, 2-higher yield, 3-coping with weather/drought, 4-coping with water scarcity, 5-because recommended, 6-higher social status/social responsibility, 7-education for children, 8-curiosity, 9-coping with pests and diseases, 10-quick maturity, 11-Labour-saving, 12-coping with theft, 13-improving soil fertility, 14-improving soil moisture, 15-high market demand/marketability, 16-Better taste, 17-others (specify)

K10: Key information source (multiple): 1- Government (select from District office, S/C extension staff, NAADS extension staff, NARO/ZARDI, other (specify)), 2-NGO, 3-District Farmer Association, 4-Private sector (Select from Agro-input shop, Trader, Market, Company/factory, Other(specify)), 5-School, 6-Local leader, 7-farmer group, 8-Other farmers outside village, 9-Other farmers within village, 10-Family (Specify Husband/Wife, Parent, Child, Other (specify)), 11-Mass-media (Select from newspaper, Radio, TV, internet, Mobile phone), 12-Own idea, 13-Other (specify)

K11: Who was the first one to know about it within your household?: 1-Myself, 2-My Husband/Wife, 3-Myself and Husband/Wife together, 4-children, 5-parents, 6-others (specify)

K12: Who decided to make the change?: 1-Myself, 2-My husband/wife, 3-Myself and Husband/wife jointly, 4-children, 5-parents, 6-others (specify)

K13: How did you acquire inputs?: 1-selling agro-produce (specify), 2-casual labour at someone's gardens, 3-casual labour for non-farm work, 4-Charcoal-burning, 5-Profit from own business, 6-salary, 7-Given (by who?), 8-No extra resource required, 9-others (specify)

K13-1: 1-Own, 2-Agro-input shops, 3-Market, 4-Government, 5-Research Institute, 6-NGO, 7-District Farmer Association, 8-Farmer Group, 9-Other farmer out of village, 10-Other farmer within village, 11-Other (specify)

L& M: Pre-Selected Innovations

Innovations	L1-32:	L1-32:	M5-7:	M8:	M9:	M10:	M10:	M11:	M11-	M12:	M13:	M13-1:	M14:	M15:	M16:	M17:

(skip if the innovation chosen above already.)	Have you tried? [Y/N]	Why not tried? [choose max. 3 answers from below]	Which crop /animal?	Which year did you start? (year)	Why did you make the change? [select from above]	Key information source (direct)? [select from above]	Specific name of the person/ organization. Relationship. (if within village, record HH number.)	Who was the first one to know about it within your house hold? [select from above]	1: Which year did you first know about the innovation?	Who decided to make the change within your household? [select from above]	Key source for getting inputs. [select from above]	Where did you source/purchase the inputs for the innovation? [select from above]	Did the PRODUCTION of the respective crops or animals increase, compared to without the innovation? [1-Not at all, 2-very little, 3-somehow, 4-good, 5-greatly, 6-Not sure]	Still continuing? [Y/N]	Which year did you stop?	Why stopped? (write briefly)
Inorganic Pesticide																
Manure application																
Mulching																
Forking of Banana																
Introduction of Dairy cows																
BBW measures (Ryantende)																

L1-32: Why not tried?: 1-never heard of the innovation (lack of information), 2-Not interested/No need, 3-lack of money, 4-lack of land, 5-lack of skills/know-how, 6-lack of labour/manpower, 7-lack of farming tools, 8-afraid of pests and disease, 9-afraid of wild animals, 10-drought or unsuitable weather pattern, 11-lack of family's consent/agreement, 12-afraid of theft, 13-jealousy, 14-lack of market, 15-not profitable, 16-other (specify)

N: Future Innovation Drivers and Constraints

N1: Please think about 1 innovation/change you want to make in your farm in future (in next 3 years)?

N1: Future Innovation	N2-4: Code for innovation (see Section K.)	N5-7: Which Crop/Animal (breed)

: N10What are the expected constraints when trying to make the innovation? (1-Not constraining at all, 2-Not constraining, 3-Somehow, 4-Constraint, 5-Major constraint)

Constraints	
1. Lack of information	1-2-3-4-5
2. Land shortage	1-2-3-4-5
3. Limited labour/manpower	1-2-3-4-5
4. Lack of credit/capital	1-2-3-4-5
5. Difficult access to inputs (seeds, tools…etc)	1-2-3-4-5
6. Lack of market	1-2-3-4-5
7. Theft	1-2-3-4-5
8. Jealousy from community	1-2-3-4-5
9. Difficult to get family's consent	1-2-3-4-5
10. Lack of knowledge/skills	1-2-3-4-5
11. Unfavourable weather pattern (e.g. drought)	1-2-3-4-5
12. Pests and diseases	1-2-3-4-5
13. Wild animals	1-2-3-4-5

O: Agricultural Information Sources and Services

*Please ask about 10 years ago, even if the household does not exist more than 10 years.

	O1:	O2:	Ask only when answer to O2 question is "Yes".			
Info source	Did you have access to their information for your innovations,	Do you currently access their information for your	Do you seek for their information from YOUR SIDE	What type of information from them do you receive for your innovations? (select all applicable) [1-weather, 2-crop varieties,	Is their information reliable?/Do you trust their information? (rate) [1-not at all, 2-not, 3-	How much did you apply the information for your innovations? (rate) [1-not at all, 2-not, 3-somehow, 4-yes, 5-very

	10 years ago? [Y/N]	innovations? [Y/N]	actively? [1-Yes, always, 2-Yes, sometimes,3 -No]	3-new agriculture practices, 4-farm machinery/tools, 5-credit facilities, 6-plant diseases and pests, 7-marketing, 8-animal health]	somehow, 4-yes, 5-very much]	much]
District government office						
S/C Extension Staff						
Research Institute (e.g. NARO/ZARDI)						
Extension staff from Private company (e.g. tea company, seed company…)						
Agro-input shops						
Market						
Trader						
Schools						
District Farmers' Association						
Local leaders						
NGO						
Farmers group						
Model farmers						
Neighbours/Friends						
Mass-media	If yes, please select 1 major source. 1- radio 2- TV 3- Newspaper 4- Internet 5- Mobile	If yes, please select 1 major source. 1- radio 2- TV 3- Newspaper 4- Internet Mobile phone				

	phone (service)	(service)				
Select all Credit Services you have used 10 years ago and Present (last 12 months)	1- Commercial bank, 2- Micro finance institutes 3- SACCO 4- NGO 5- VSLA/farmer group 6- Friends/relatives 7- Not used at all.	1- Commercial bank, 2- Micro finance institutes 3- SACCO 4- NGO 5- VSLA/farmer group 6- Friends/relatives 7- Not used at all.				

P: Public Agricultural Extension Services

P1-11: Have you heard of the following programme? What is your satisfaction level?

	Heard?[Y/N]	Benefited? [Y/N]	(only for those who have heard of the programme) Level of satisfaction [1-Not satisfied at all, 2-Not satisfied, 3-A little bit satisfied, 4-Satisfied, 5-Very satisfied]	How important for your innovation? [1-Not important at all, 2-Not important, 3-A little bit important, 4-Important, 5-Very important]
NAADS (before restructured in 2014)				
Operation of Wealth Creation (OWC)				
S/C Extension staff (after NAADS restructure in 2014)	N/A			

P12: Do you feel that government (public) extension services have improved or become worse last 3 years?

Select from [1-Severely deteriorated, 2-Deteriorated, 3-Same, 4-Improved, 5-Highly improved]

Appendix 10: Manual for Household Survey

- All respondents have to be given "Information Sheet" prior to the interview (distribute one sheet per household). And each respondent has to sign on "Consent Form".
- Definition of Household Head – Head of the household (The person is not only a man, but can be female, if she is heading the household.)
- Estimated time per interview: Section I -40minutes to 1 hour. Section II -40 minutes to 1 hour per respondent. If there are both Household Head and Spouse to answer Section II, the required time is doubled.
- Please do not try to play with the allocated mobile phones, in order to avoid any inconveniences and data depletion. (This once resulted in losing data in the phone as one of the enumerators erased the KoboCollect programme from the phone by mistake!)
- At the end of the interview, please give 1 Bar Soap (per household) as compensation/appreciation for their time spent for this interview.

HOW TO OPERATE KoboCollect

How to open form:

1. Open KoboCollect app in the phone.
2. Select "Fill Blank Form".
3. Select the latest form from the list (you will see only one form in the folder).

How to save form:

1. Try to save the form frequently by clicking "file" icon at upper screen.
2. If you want to save and exit from the form, click "dot" icon at upper screen, select "Go to Prompt", then select "Go to End" at the bottom of screen. Unmark "Mark form as finalized" then select "Save Form and Exit". The saved form can be found in the folder "Edit Saved Form".

How to edit form:

1. Go to "Edit Saved Form".
2. Select relevant form, then continue editing.

How to save finalized form:

1. At the end of the interview, tick "Mark form as finalized", then select "Save Form and Exit".

Add New Group? Options:

- This appears when "repeated" or "looped" questions are necessary. For example, 3 crops they grow (for example, Section H.)
- Please do not skip the group by selecting "Do not add" when answers are expected.
- If "Add Group" is mistakenly selected, long-push in any answer in any question in the loop/group, then select "Remove group". Screen says "Remove group….?", then select "Remove group". *Please be careful not to erase the entire section which you have already entered necessary data.
- When you don't need to repeat, select "Do not Add" group.
- If "Do not Add" was mistakenly selected, swipe back to the previous page, then select "Add Group" instead.

*Single selection is Round-shaped. If answer needs multiple selections for this type, please try to stick on "major" answer.
*Multiple selection is Square-shaped. This means that all applicable answers should be marked.

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Section I: HOUSEHOLD

Ask either Household Head or Spouse, depending on the indication in the List of Households.

→If the household is without Spouse, ask the Household Head.

→If the household is with Spouse, ask the person which is highlighted in the List.

A. Identification

- For GPS, please check “Accuracy”. This should be at least less than 10m.

B. Basic Household Information

- B2: “Did your household exist 10 years ago?”. Please be precise. If YES, questions about 10 years ago in following sections appear.
- B5: Be precise especially on the difference between “No” and “No one ages 6 to 12”.
- B6: Be precise especially on the difference between “No” and “No female head/spouse”.
- B10: Toilet type. Take care of definition of “slab”.
- B15: Definition of “shoes”. No sandals.

C. Details of Respondents (Household Head and Spouse)

- C7: What is ???’s main activities? (multiple selection) –Please make sure of selecting all applicable.
- C8: Definition of “Resident” –Resident means that the person is living in the village. It doesn’t matter whether the person is FROM the village.

F: Land

- Please be accurate in simple fraction. 3/4 acre = 0.75 acre, 2/4acre = 1/4 acre = 0.5 acre, 1/4 = 0.25 acre.
- F5: Please make sure all crops grown are selected.
- Do not mix up “crops grown on their OWN land” and “crops grown on RENTED land”, as the questions come separately.

G: Family and Hired Labour

- G1: How many HOUSEHOLD MEMBERS work at your farm including yourself?: Please do not include “Hired Labour” or “Extended Family labour” here.
- G6: Do you use EXTERNAL LABOUR?: This can include any other labour apart from Household labour. This can include “Hired Labour”, “Extended Family labour”, “Group

work"…etc.

H: Crop Management

- 3 major crops for the household are asked. Enter crop detail by "Add group" for EACH crop. Please make sure all 3 crops are captured. (You will see number in bracket at upper screen), unless any exceptional cases.
- H6: Who (within your household) mainly does each work for this crop?: If the work is not done by any family members, select "No one". Only one selection is possible, so select major answer (if weeding is practised by both Husband and Wife, but if it is mainly by "Wife", select "Wife". "Both" means "Husband" and "Wife".
- H9: What % of work is done by Hired labour for this crop?: The percentage should be out of entire work necessary to manage the crop. Not out of a particular type of work. This is difficult to estimate the percentage, but please assist farmers to estimate.
- Add a new "Crop Management (10 years ago)" group: You will see this if the household exists more than 10 years. Please "add group" in this case.

I: Livestock Management

- Please "Add Group" if the household has any livestock. Please repeat this for 3 major animals for the household.
- I5: If there is no payment involved in taking care of the animal at all, please select "Other (specify)", then type "No payment".
- Add a new "Livestock Management (10 years ago)" group: You will see this option if the household exists more than 10 years. Please "add group" in this case.

J: Source of Income and Food and Expenditure

- This section is a bit tricky. Please try your best to assist respondents to estimate percentages.
- What % of household income comes from…? J1 (Crop Production) + J2 (Livestock Production) + J3 (Agricultural Casual Labour)… This should not exceed 100%. Same for the rest of questions.

Section II: INDIVIDUAL HOUSEHOLD MEMBERS

- Please select "Add Group" to continue for Section II.
- Please ask each of Household Head and Souse separately by repeating "group".
- Again, if the respondent is female head of household, select "Household Head", not

"Spouse".

- In this section, my interest is their opinion, view and experiences as an individual, not as a household as a whole.
- In Section II, there are some questions about 10 years ago (Section O). It doesn't matter whether the household exists for 10 years or not, because this section is about the respondent himself/herself, not about household.

K: 3 Key Innovations

- It is important for the respondents to understand correct definition of "Innovation". Therefore, please do not create your own definition but just follow/translate what is written in the screen. (Innovation is a new change or improvement you made in your farming activities.)
- Also, in this section my interest is to capture 3 key innovations that the respondent was directly involved in making the innovations. The scope in my survey is the innovations which happened within 10 years (from 2007 until now). Please do not be confused with "innovation of 10 years ago", but my question is "innovation WITHIN 10 years". So, please do not include innovations which he/she implemented more than 10 years ago.
- Also, 3 key innovations can include those ones which are started within 10 years but stopped for some reasons.
- "Add group" for each innovation and repeat for 3 innovations. If the respondent claims that he/she does not have any innovations despite your thorough explanation about "what innovation is", please skip "group" to continue to next section.
- K1: What is one of the 3 key innovations you made/adopted last 10 years? (write briefly): Please write this as comprehensive as possible (for example, not just "new crop" but "introduction of grafted mango").
- K2-K5: This is the part that enumerator himself/herself has to categorize the innovation mentioned by the respondent.
- K8 and K11-1: "Which year did you start this innovation?" and "Which year did you first know about the innovation?": Please do not get confused by those two similar but different questions.
- K14: Did the PRODUCTION of the respective crops or animals increase, compared to without the innovation?: If it is either "new crop" or "new animal", please select "Not Applicable" as there is no previous comparison.

L: Pre-Selected Innovations (Yes or No)

- If NO, the following question is "Why not?" Please select all applicable answers (max.3).

- Definition of “Inorganic pesticide” and “Organic pesticide”.
- I recommend that you should take a note which innovations were answered YES. The note will be useful for Section M.

M: Pre-Selected Innovations (Details)

- Please enter the details for any YES answer for 6 pre-selected innovations (L section).

N: Future Innovation and Constraints

- Please be as specific and clear as possible for what future innovation is.

O: Agricultural Information Sources and Services

- Select all types of information which are applicable.

P: Public Agricultural Extension Services

- P12: Do you feel that government (public) extension services have improved last 3 years?: Please make sure that the respondent is not confused with private/NGO’s extension services.

Appendix 11: Research Protocol for Phase III

12 days per village x 4 villages

3. In-Depth Farmer Interviews (4-5 Days)

- The following questions will be asked to the respondents who are randomly selected from each socioeconomic category.
- Respondents -3 farmers x 9 categories =27 farmers per village
- Duration -1 hour per interview
- 6 farmers per day
- Transcripts will be made.

	Husband	Wife	Female-head
Poor	3	3	3
Moderate	3	3	3
Rich	3	3	3

Questions to be asked	Issues to be investigated	Target respondents
1. For which enterprise do you make innovations the most? Why? How do you choose which enterprise that you make innovations on? Any changes last 10 years?	• Why do the Poor make innovations on cereals and the Rich on vegetables/leguminous crops?	All
2. Why do you innovate? Income or Food? Any changes last 10 years?	• The Rich & Men –High market demand. The Rich –Education for children, Wives-Social responsibility/Food for family, Men-Soil management.	All
3. Why did you count on that particular information source for your key innovations? Why don't you count on other information sources? Is it because of easy access or more trust?	• Why do the Poor count on Community Actors, more than other wealth groups? • Why do Women count on Community actors? • Why do Wives count on government less than Men? • How does 'trust' in the information source influence your usage of information? • Why are Market actors less trusted than public/government actors, especially for the Poor farmers? • Why do Wives trust 'Neighbour' more than other gender categories?	All
4. (If the key information source is other farmers,) How do you select that particular farmer among all farmers?	•	All
5. Did you seek for the information from your side? How did you interact with them? Why do you actively	• What does it mean that the Poor claim to be proactive to obtain information more than other wealth categories of farmers?	All

seek for information from particular actors and not from some other actors?		
6. Did the information sources that you count on change last 10 years? How? Why?	• Why is the information access of poor farmers and wives to 'Neighbours' increasing last 10 years?	All
7. What do you mean by "Own idea" as the information source?	• What does it mean that the Rich farmers count on 'Own idea' for innovation? Is it accumulated knowledge or information based on their previous experiences?	Only for the farmers who answered "Own idea"
8. Which individuals or organisations provide the best support to your needs (in terms of Income or Food)? Why are they the best?	• Why are the key innovations sourced from Government, Local leaders, and other farmers within the village made on the crops which are not important for household income? • Why are the key innovations sourced from the Government made on the crops which are not important for household food?	All
9. Do you have to seek for approval from your husband when introducing innovations? (Does your wife have to seek for approval from you?) For what kind of innovations and what kind of enterprises, do wives have or do not have more say?	• Why is decision-making for innovation weak for wives (especially for Rich wives)? What are the implications for this? For what kind of innovations, do wives have or not have more say?	Only for Husbands and Wives
10. How are the benefits of innovations shared between wife and husband?	• Why do the crops rated "Greatly" contributing to their household income have highest male dominance in profit-management? • Why do the Richer households have stronger tendency in the male-dominance in profit-management for the crops rated "Greatly" contributing to household 'income'. • Why, is there less male-dominance in profit-management for key crops for 'Food', compared to the key crops for 'Income'?	Only for Husbands and Wives
11. You mentioned that … ('land shortage' and 'lack of capital') are the major constraints for your future innovations. How do you think you can overcome the constraints?	• How the difference in resource endowment (land, capacity to hire external labour, farming tools) of farmers affect the way they innovate? • Major future innovations are land expansion and introduction of livestock for the Poor, however how are these materialized, given their major constraints of lack of land and lack of credit? • How much does the 'difficult to get family consent' for their innovations matter for Wives?	All

12. Why haven't you tried "specific innovations"? Any constraints?	• Nave village –Nase14, Line-planting, Inorganic pesticide	All applicable
13. Why do you think that government extension worsened recently?	• Why is the proportion of the Poor who consider that the public extension services either 'severely deteriorated' or 'deteriorated' higher than the one of the Moderate and the Rich?	All

2. Innovation Network Case Study Workshop (2 Days)

- 6-8 participants (who are purposively selected from each socioeconomic category of farmers who have made the specific innovation) will be invited for each of 3 case studies per village.
- Male farmers and female farmers will have separate sessions. 6 sessions per village.
- Innovation History and Network Analysis will be conducted.
- 1.5 hours per innovation

Village	Pre-selected Innovations
Nave	Improved Cassava Variety (n=55), Inorganic pesticide (n=51), Onion (n=62), Line-planting (n=139), Vaccination of animals (n=63)
Elema	Change of simsim planting season (n=53), Improved maize variety (n=45), Line-planting (n=93), Ox-ploughing (n=21), Inorganic pesticide (n=15), Organic pesticide (n=13)
Ryantende	Mulching (n=53), Manure (n=57), BBW (n=81), Inorganic pesticide (n=24), Dairy cows (n=8)
Rushasha	Mulching (n=80), Forking of banana (n=95), Manure (n=78), Inorganic pesticide (n=8), Dairy cows (n=3)

Nave Village

Innovation	SE category	Poor	Moderate	Rich
New Variety of Cassava (Nase 14)	Male	2 (0)	8 (3)	5 (0)
	Wife	0 (0)	12 (5)	5 (1)
	Female-head	0 (0)	1 (2)	0 (0)
Line-planting (Multiple crops)	Male	11 (2)	29 (5)	14 (3)
	Wife	4 (1)	42 (7)	15 (1)
	Female-head	7 (3)	16 (5)	1 (0)
Inorganic Pesticide (Beans, Vegetables)	Male	3 (1)	20 (2)	6 (0)
	Wife	0 (0)	12 (4)	6 (2)
	Female-head	0 (0)	4 (3)	0 (0)

Rushasha village

Innovation	SE category	Poor	Moderate	Rich
Mulching (Banana)	Male	22 (11)	13 (7)	1 (0)
	Wife	19 (9)	8 (2)	2 (1)
	Female-head	9 (4)	2 (0)	1 (0)
Forking (Banana)	Male	23 (9)	18 (4)	2 (0)
	Wife	27 (6)	14 (1)	2 (1)
	Female-head	6 (3)	3 (0)	0 (0)
Manure (Banana)	Male	18 (8)	12 (4)	3 (1)
	Wife	20 (7)	10 (0)	3 (0)
	Female-head	6 (1)	4 (0)	1 (0)

Elema village

Innovation	SE category	Poor	Moderate	Rich
Change of simsim planting season	Male	3 (1)	15 (3)	4 (1)
	Wife	0 (0)	15 (3)	5 (0)
	Female-head	2 (0)	9 (4)	0 (0)
Improved maize variety	Male	0 (0)	12 (6)	5 (0)
	Wife	0 (0)	13 (6)	5 (3)
	Female-head	2 (1)	8 (2)	0 (0)
Line-planting	Male	4 (0)	30 (4)	8 (6)
	Wife	0 (0)	23 (6)	8 (3)
	Female-head	4 (0)	16 (6)	0 (0)

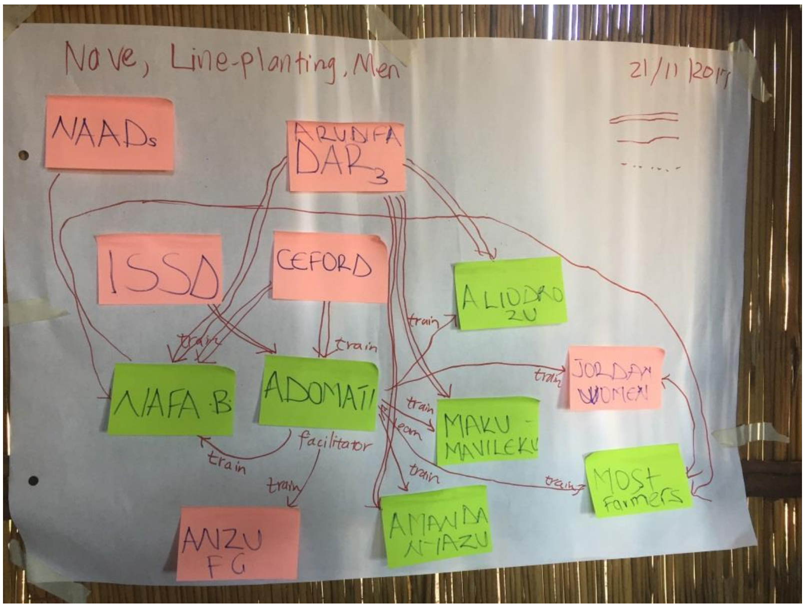
Number – identified as Pre-selected innovations
(Number) –identified as Key innovations

Information to be collected	Key questions to be asked
Innovation History (timeline)	• When and from where did the innovation come from? • What are other major events related to the innovation?
Innovation Network Analysis	• Which organisation brought it in? How? • Which other individuals or organisations were involved? What roles did they play? How are they connected to each other? • Which farmers are the ones who started the innovation first? How did they start? • How did the innovation spread? From who to who? In which way? • Intra-household communications?

Innovation History

Source: Author (2017)

Network Analysis



Source: Author (2017)

3. Innovation Effects (Participatory Budgeting and Effect Diagram) (3 Days)

- Select 1 out of 3 pre-selected innovations per village.
- Target respondents will be randomly selected from each socioeconomic category of farmers who have tried the particular innovation.
- 2 farmers x 9 categories = 18 farmers per village. (2 farmers from the same category will pair up for a session.) 9 sessions.
- Participatory Budgets are gross margin analysis which includes input (cash, labour and other resources) and output (consumption, sale, given). The gross margins before and after the innovations will be compared.
- Effect Diagram will capture more multidimensional effects (both positive and negative) of the innovations. *Transcripts will be made.
- Intra-household decision-making to be inquired (e.g. who decided to sell/consume, who controlled the profit…etc).
- 1.5 hour

Participatory Budgeting

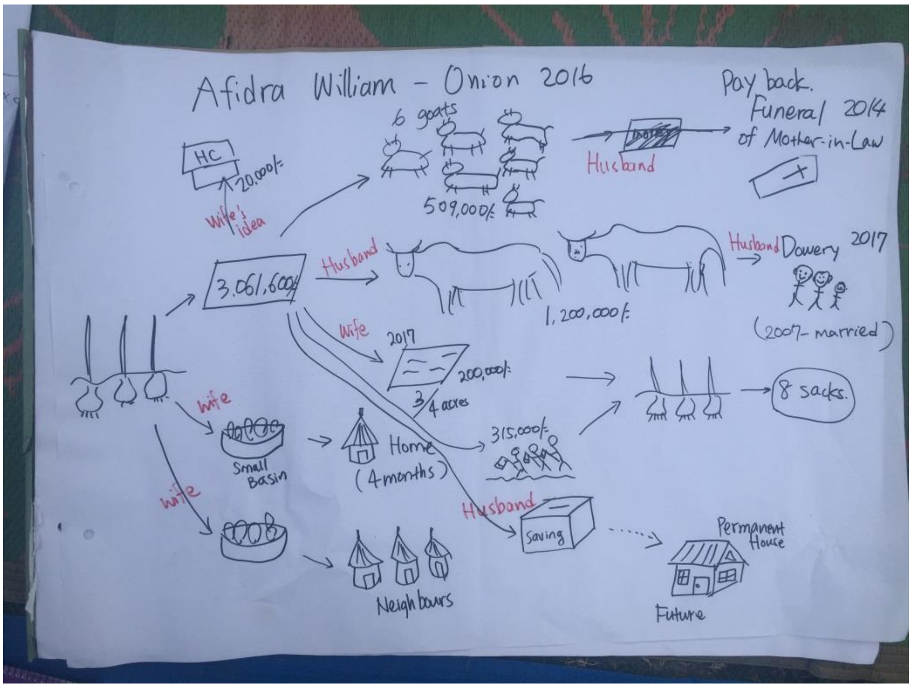
Enterprise…………………… Change………………………… Scale / area / units………………… Year……………………… Ref…………………						
	Period 1	**Period 2**	**Period 3**	**Period 4**	**Period 5**	**Period 6**
Activities						
Cash Inputs (incl. hired labour)						
Family / in-kind Labour						
Cash outputs						
Consumption outputs						
Balance / profit (cash and consumption)						

Source: PICSA (2016)

	Cash balance	Produce for consumption (e.g. litres or bags or KGs)
(a) Post-changes		
(b) Pre-changes		
(c) Difference (a-b)		

Source: PICSA (2016)

Effect Diagram



Source: Author (2017)

4. Farmer Interview for Transformational Innovations (1 Day)

- The households identified by Dynamic Wealth Ranking as transformational will be visited to find out whether or which innovations are transformational. *Key Informants (e.g. Village Chairman) to confirm the transformational cases only related to agricultural-related innovations.
- Case study for the transformational innovations (innovation characteristics, innovation process, innovation effect).
- 30 minutes
- Transcripts will be made.

Village	Transformed farmers
Nave	5 farmers
Elema	6 farmers (reasons to be confirmed)
Ryantende	6 farmers (reasons to be confirmed)
Rushasha	6 farmers (reasons to be confirmed)

Key questions to be asked
1. Which innovations improved your wealth status? How? 2. What AIS actors were involved in the process? How were they involved?

5. AIS actor Interviews (1 Day)

- Key AIS actors who were identified during other activities will be visited for interviews.
- 30 minutes

Village	AIS actors to be visited
Nave	• S/C Extension Officer • District • District Farmer Association (ARUDIFA)

	• CEFORD • ISSD • NARO/ZARDI • OWC
Elema	• S/C Extension Officer • District • OWC
Ryantende	• S/C Extension Officer • District • Tea Factory (Igara) • Agro-input shops
Rushasha	• S/C Extension Officer • District • OWC

Information to be collected	Key questions to be asked
Innovation Types and support	• What type of innovations do you support? Food crops or cash crops? Which commodities/enterprises? • Why do you promote the innovations? • How do you identify which enterprises and which innovations to support? • How do you confirm whether the expected outcomes are met? • How do you support innovations? (e.g. training, input distribution) • Have the ways you support innovations changed over the last 10 years? How?
Targeting and Dissemination	• Who is your target group? • How do you actually identify the target group? • How do you expect the supported innovation would disseminate to non-target members in the community?
Progress of Extension Reform (To be asked to District)	• How is the Extension Reform (Single-spine Extension System) going on in your district? • What are the implications for farmers? • How do you think the farmers are benefited before NAADS, with NAADS, and after NAADS?
Identification of gaps in innovation system	• Do you work with other Innovation Support actors? With whom? How? • Do you think that the current agricultural innovation system support farmers' innovations? How? • If not, what are the gaps?