Norwegian University
of Life Sciences

Master's Thesis 2019 30 ECTS
Faculty of Landscape and Society

The Use of Mobile Phones in the Extension and Advisory Service in Rwanda

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Declaration

I, Astrid Fuglesang Stokke, declare that this thesis is a result of my research investigations and findings. Sources of information other than my own have been acknowledged and a reference list has been appended. This work has not been previously submitted to any other university for award of any type of academic degree.

Signature: 

Date: December 15, 2019

Acknowledgements

First, I would like to thank NMBU for two meaningful years, for letting me expand my knowledge and grow as a person. A special thanks to my supervisor, Ruth Haug, for the guidance, patience and support throughout the thesis project. Thank you for sharing your knowledge and for always helping me out. I would also like to thank the InnovAfrica project for the financial support, which made it possible to conduct the fieldwork in Rwanda.

A special thanks go to the people I met in Rwanda. To Maurice Mugabowindekwe, for welcoming me in your beautiful country, your hospitality and for always helping me out. To Mupenzi Mutimura and Celestin Hitimana, for making fieldwork possible by taking care of logistics and local knowledge. And to all participants in the research, who have shared their time and insights. *Murakoze.*

I would also like to thank friends and family for the support and patience during this project.

Abstract

Agriculture plays a crucial role in most developing countries in sub-Saharan Africa, as it has an essential impact on the economy, food security and poverty. Extension and advisory service (EAS) is established as an important tool to improve agricultural development. The service aims to improve the agricultural production, income and well-being to farmers. However, the EAS is criticised for its limited reach of farmers, top-down approaches and ineffectiveness. Mobile phones are seen as a useful tool to overcome the existing barriers of the EAS due to its rapid growth in developing countries. This thesis assesses the use of mobile phones in the extension and advisory service in Rwanda. It examines farmers and extension service providers experience towards the use of mobile phones as a communication tool within the service. The study also examines barriers that led to the exclusion of certain groups of farmers. This qualitative research is based on twenty semi-structured interviews with respectively fourteen farmers, three extension service providers, one communication officer and two researchers. This study also uses secondary data such as reports and policy documents from Rwanda and the InnovAfrica project to ensure triangulation. The study found that the use of mobile phones has strengthened the EAS in relation to accessibility of the service, timeliness, two-way communication, being demand-driven and costs. However, these improvements only affect farmers with access to a mobile phone and exclude groups of farmers due to poverty and traditional gender roles.

Keywords: mobile phone, extension and advisory services, agriculture, Rwanda, digital divide, gender equality

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List of acronyms

AEAS	Agricultural Extension and Advisory Service
AICP	Agricultural Information and Communication Program
AIS	Agricultural Innovation System
AKIS	Agriculture Knowledge and Information System
CABI	Centre for Agriculture and Bioscience International
CIP	Crop Intensification Program
EAS	Extension and Advisory Service
FAO	Food and Agriculture Organization of the United Nations
FFS	Farmer Field School
FP	Farmer Promoter
GDP	Gross Domestic Product
GOR	Government of Rwanda
ICT	Information and Communications Technology
ICT4RAG	Information and Communication Technology for Rwandan Agriculture
MIC	Middle Income Country
MIGEPROF	Ministry of Gender and Family Promotion
MINAGRI	Ministry of Agriculture and Animal Resources
NAEB	National Agricultural Export Development Board
NGO	Non-Governmental Organisation
NISR	National Institute of Statistics Rwanda
RAB	Rwanda Agriculture and Animal Resources Development Board
RARDA	Rwanda Animal Resources Development Authority
ROR	Republic of Rwanda
SDG	Sustainable Development Goals
SMS	Short Message System
SNS	Smart Nkunganire System
UN	United Nations
UNECE	United Nations Economic Commission for Europe
USAID	U.S. Agency for International Development
WEAI	Women Empowerment in Agriculture Index
WFP	World Food Program

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1.0 Introduction

Agriculture is the backbone for most developing countries in sub-Sahara Africa. Agriculture plays a crucial role in economic development and other development goals, such as ensuring food security and poverty reduction (Aker, 2010; FAO, 2001). In Rwanda, economic development is dependent on the agricultural sector as it stands for one-third of the national GDP (NISR, 2018a). Furthermore, it is one of the leading export sectors and the main source of livelihood for 80% of the population (NISR, 2018a; FAO, n.d.a). The agricultural sector in Rwanda is essential for sustained economic growth, poverty reduction, and ensuring food security (MINAGRI, 2018a). However, the country's agricultural productivity faces challenges due to population growth, climate change and land scarcity (FAO, n.d.a).

Extension and Advisory Service (EAS) is well established as a key tool to improve agricultural development (Anderson, 2007; Christoplos, 2010; Birner et al., 2009). EAS aims to help farmers improve their agricultural production, livelihood and well-being by involving different actors to solve problems and obtain information (Christoplos, 2010; Birner et al., 2009). However, extension and advisory services have been criticized for its ineffectiveness, top-down approaches, restricted geographical reach and limited impact on female farmers and the poor (Anderson, 2007; Odame, 2013; Davis et al., 2010). EAS theory was previously seen as a transfer of knowledge from extension service providers to farmers but was further developed to involve several stakeholders in the agricultural sector, and more importantly, farmer participation (Röling, 1990; Taye, 2013; Leeuwis, 2004).

To overcome the existing barriers of EAS, the spread of mobile phones in developing countries creates new opportunities (Aker et al., 2016). In 2017, 67% of the households in Rwanda owned at least one mobile phone, and the 4G network is covering 95.1% of the country (NISR, 2018d; RURA, 2019). Rwanda has developed a strategy to implement ICTs in the agricultural sector, to increase agricultural productivity and become a knowledge-based economy (MINAGRI, 2016). However, the digital divide is present in Rwanda, where 43.6% of households living in isolated rural housing don't have access to a mobile phone (NISR, 2018d). The gender digital divide is also present as 54.3% of the female-headed households own a mobile phone, compared to 71.1% of the male-headed households (NISR, 2018d).

The purpose of this study is to assess the role of mobile phones in the agricultural extension and advisory service in Rwanda. More specifically, the study addresses the following research questions.

1.1 Research Questions

1. *What are the experiences of farmers and extension service providers towards the use of mobile phones in EAS in relation to accessibility of the service, timeliness, two-way communication, being demand-driven, and costs?*

2. *To what degree do certain groups of farmers such as women and small-holders in the poorest categories benefit from the use of mobile phones in EAS?*

1.2 Thesis Outline

The thesis consists of six chapters. The first chapter is the introduction and a presentation of the research questions. The second chapter explains the methodological approach, data collection and analysis, ethical considerations and limitations. The third chapter introduces the theoretical framework, where I will explain the Agricultural Knowledge and Information System, Extension and Advisory Service, Mobile Phones in EAS, the Digital Divide and Gender in Agriculture. Additionally, I will explain the analytical framework. Chapter four consists of relevant background information on Rwanda, its agriculture, extension and advisory service, its strategy of implementation of ICTs in the agricultural sector and the status of gender equality in the country. Chapter five presents and discuss the findings. Chapter six is the conclusion, which will sum up the findings and discussion.

2.0 Methodology

This chapter will give an overview of the research design and methods used to collect and analyse the data in this study. The first part of the chapter presents the two research areas where the study was conducted. In the second part, I will present the research design and describe the qualitative method. The third part presents the method for data collection, an explanation of how the informants were selected, an introduction of how I conducted the interviews, and how I collected the secondary sources. The fourth part will explain how I analysed the data and lastly, I will discuss the ethical considerations and limitations of the study.

2.1 Research Area

The data collection was conducted in two different districts in Rwanda; Kirehe and Nyamagabe (Figure 1). Selection of the study areas depended on the location of the InnovAfrica project. The two different districts were selected to examine if there were any dissimilarities in the respective districts, and with the aim to interview several informants. Details about the two areas are described below.

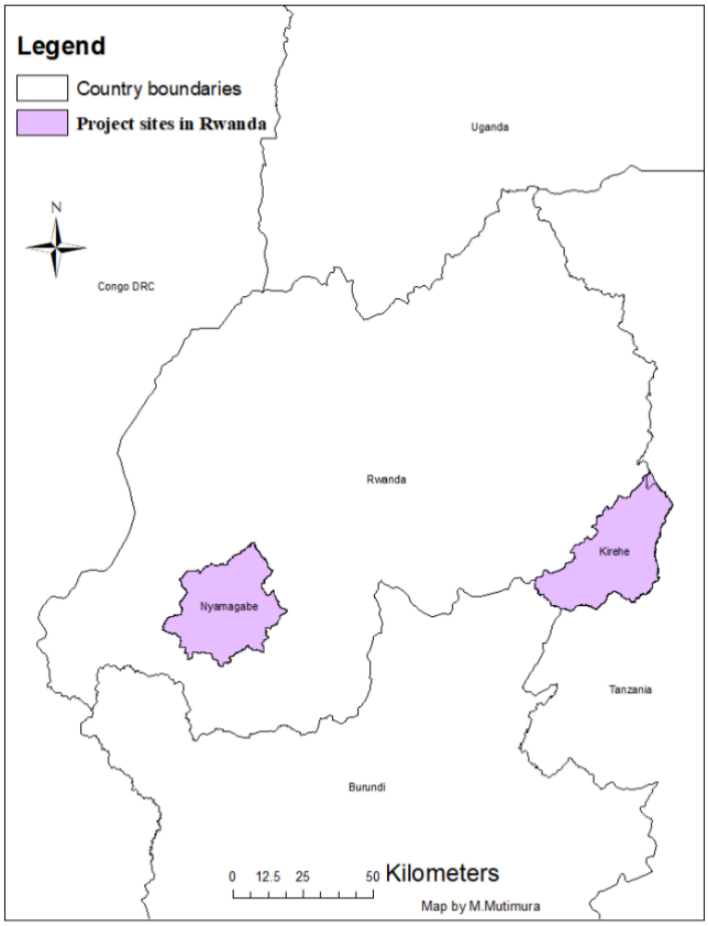

Figure 1. Map of Rwanda and, in purple, the two visited districts; Kirehe and Nyamagabe. Source: InnovAfrica, 2018

2.1.1 Kirehe District

Kirehe district is located in the Eastern Province, approximately 111 km from Kigali, bordering Tanzania. The districts population density is at 187 inhabitants per km2, with its population of 229,468 and an area of 1,225 km2 (InnovAfrica, 2018). Kirehe district is divided into 12 sectors; 60 cells and 612 villages. The district topography is generally flat land surrounded by low undulating hills separated of valleys. Kirehe receives an annual

rainfall at 750 mm and is considered the driest region of the country and has an average temperature at 21°C (InnovAfrica, 2018). Because of its topography and low rainfall, the district was the first in the country to implement irrigation schemes (The New Times, 2015). Agriculture and livestock are the main contributors to the district's economy, whereas 90% of the population is engaged in the agriculture sector (RAB, 2016c). The main crops grown in the district consist of maize, sweet potatoes, sorghum, cassava and beans, and their main animal species are cattle, sheep, goat, pigs, rabbit and poultry (InnovAcfrica, 2018). The district's average farm size is 0.7 ha, and 80 % of the farmers are smallholders (InnovAfrica, 2018). In 2012, 98.7 % of the households in Kirehe lived in *Umudugudu*, which is a clustered rural settlement (NISR, 2015b). The percentage of households with a mobile phone is 66.2 in Kirehe district, which is close to the percentage at the national level, which is 66.9% (NISR, 2018d).

2.1.2 Nyamagabe District

The second fieldwork area I visited was Nyamagabe District. The district is located in the Southern Province, about 153 km from Kigali. The district has a population of 333,587 and occupies 1,090 km2, and therefore a population density at 306 inhabitants per km2 (InnovAfrica, 2018). Nyamagabe district is characterized by hills, varying from 1500 to 2500 meters above sea level (InnovAfrica, 2018). Because of its altitude, the climate is considered as humid, with an average temperature at 16.5C and receives an annual rainfall at 1,636 mm (InnovAfrica, 2018). The majority of the district's total population lives on agriculture, where the average farm size is 0.5 ha, and the main crops consist of Irish potato, maize, tea, coffee and peas. 77.6% of the households in the district raise livestock, where the most common are pig, cattle, goats, chicken and rabbit (ROR, 2013; InnovAfrica, 2018). Compared to the average landholding size in Kirehe (0.7 ha), farmers in Nyamagabe own a smaller size of land with an average at less than 0.5 ha (InnovAfrica, 2018). In 2012, 47.8 % of the households in Nyamagabe lived in dispersed/isolated housing, followed by Umudugudu (44.3%) (NISR, 2015c). Households owning a mobile phone in Nyamagabe is 53.3 %, which is less than both the national level (66.9%) and Kirehe (66.2%) (NISR, 2018d).

2.2 Research Design

The research of this thesis is based on a qualitative research design. Qualitative research design is useful to understand a social phenomenon, individual or group experiences

or their meanings of *something* (Bryman, 2012). Berg & Lune (2012) further states that questions are answered by studying social settings and the individuals that interact with it. Through a qualitative research design, I was able to collect detailed information on farmers and extension providers experience and perceptions on the use of mobile phones in the EAS. These primary data made it possible to analyse the effectiveness, the communication flow, and challenges on the use of mobile phones as a communication tool in the EAS in Rwanda.

2.3 Data Collection Methods

The data collection includes primary data from semi-structured interviews and secondary sources. The use of two different data collection methods or sources ensures triangulation as the data is cross-checked when studying a social phenomenon (Bryman, 2012:392). The aim of triangulation is to ensure validity of the study (Bryman, 2012; Berg & Lune, 2012).

Primary data (interviews) were collected during fieldwork in August and September 2019, in Kirehe, Nyamagabe and Kigali. The secondary data were collected throughout the whole research process.

2.3.1 Selection of Informants

The sampling method of this research is purposive sampling. The selection of informants was based on several criteria: men and women farmers; small and big farms; poor and better-off; close and remote and extension service providers with a mobile phone. The purposive sampling method was used to assure that the informants had knowledge on my research topic and therefore help me answer my research questions (Bryman, 2012). The informants were selected by staff from RAB, so their willingness to participate and that they were available for interviews makes the method a purposive convenient sampling (Bryman, 2012).

I informed the RAB staff about my criteria of the informants, and they organized a meeting with the farmers and the extension service providers at the local village office in selected sectors. My original plan was to see every farmer and conduct interviews at their farm, but when we arrived at the sector level, the farmers were already gathered at the local office. I also planned to interview several extension service providers, but the extension agents under the local administration were the only one available (convenient sampling).

I interviewed people of different age, gender, income and diverse farm characteristics such as size, cultivated crops, various livestock etc. The aim of interviewing informants with diverse backgrounds was to see if there were any differences in the use of the mobile phone to demand and receive agricultural information. Although I interviewed farmers with different levels of income, I did not get the chance to interview farmers defined as the "poorest" that did not own a mobile phone. The interviewed extension staff were two sector agronomists and one sector veterinary that were extension agents under the local administration in the respective districts. The communication officer worked at the Agricultural Information and Communication Program (AICP) under MINAGRI, which runs the national extension service and call centre.

	Type of informant	**Characteristics**
Informants	Farmers Kirehe and Nyamagabe Total: 14 7 men and 7 women	Farmers that cultivated different crops, big and small farm size, all farmers had both livestock and crops (crop-livestock agricultural system)
Key Informants	Extension service providers Kirehe and Nyamagabe Total: 3 3 men	Two sector agronomists and one sector veterinary. Extension service providers under the local administration in Kirehe and Nyamagabe district
Key Informant	Communication Officer Kigali Total: 1 1 man	Communication officer at The Agricultural Information and Communication Program (AICP) under MINAGRI. The national extension service and call centre.

Key Informants	Researchers in RAB Total: 2 1 man and 1 woman	Researchers working with agriculture and EAS in RAB

Because of qualitative research method and the purposive sampling, I cannot generalize my findings to a larger population (Bryman, 2012).

2.3.2 Semi-Structured Interviews

The study is based on 20 semi-structured interviews with respectively 14 farmers, three extension service providers, one communication officer and two researchers from RAB. Three interview guides were developed before the fieldwork, and they were based on the different backgrounds of the informants. One was developed for the interview with farmers, one for the extension service providers and one for the communication officer and the researchers at RAB. The three interview guides included questions with themes I wanted to discuss with the informants, with the aim to analyse perceptions, attitudes and experience with the use of mobile phones in the EAS. During fieldwork, the interview guides were adjusted as questions were added and removed based on new information from the informants. This allowed me to further explore the new themes with the remaining informants. I chose the method of semi-structured interviews because I wanted information on the interview's point of view (Bryman, 2012). The difference between quantitative and qualitative interviewing is that qualitative is more flexible, and I was able to follow the informant's direction when they responded to my questions (Bryman, 2012). Semi-structured interviews allowed me to have conversations on topics outside the listed interview guide and to gain insight into the interview object's opinions and perceptions. In my case, I discovered new topics and issues that were valuable in my research, which I had not included in the interview guide. The use of semi-structured interviews also allowed me to adjust the language during interviews due to language limitations. Qualitative (semi-structured) interviews are less structured, which aim to result in detailed answers that depart from the interview guide (Bryman, 2012).

2.3.3 Secondary Sources

Secondary sources were used to gain knowledge and to fill the information gaps. Bryman (2012) refers to documents as secondary data as materials that are not produced

specifically for this research, but available to be analysed. When using documents as secondary data, it is important to evaluate the quality of the data (Bryman, 2012). The secondary sources are based on reports and policy documents from Rwanda, data from the InnovAfrica project and internet search. The secondary sources collected from the internet was mostly accessed from Oria and NMBU VPN. Statistics and official documents on Rwanda were retrieved from Rwanda's official websites such as NISR, MINAGRI, RAB and MIGEPROF, and from the World Bank and the UN.

2.4 Data Analysis

I have applied the thematic approach to analyse my interviews, where I used coding to search for themes (Bryman, 2012). The data was analysed thematically using Birner's Best-Fit framework.

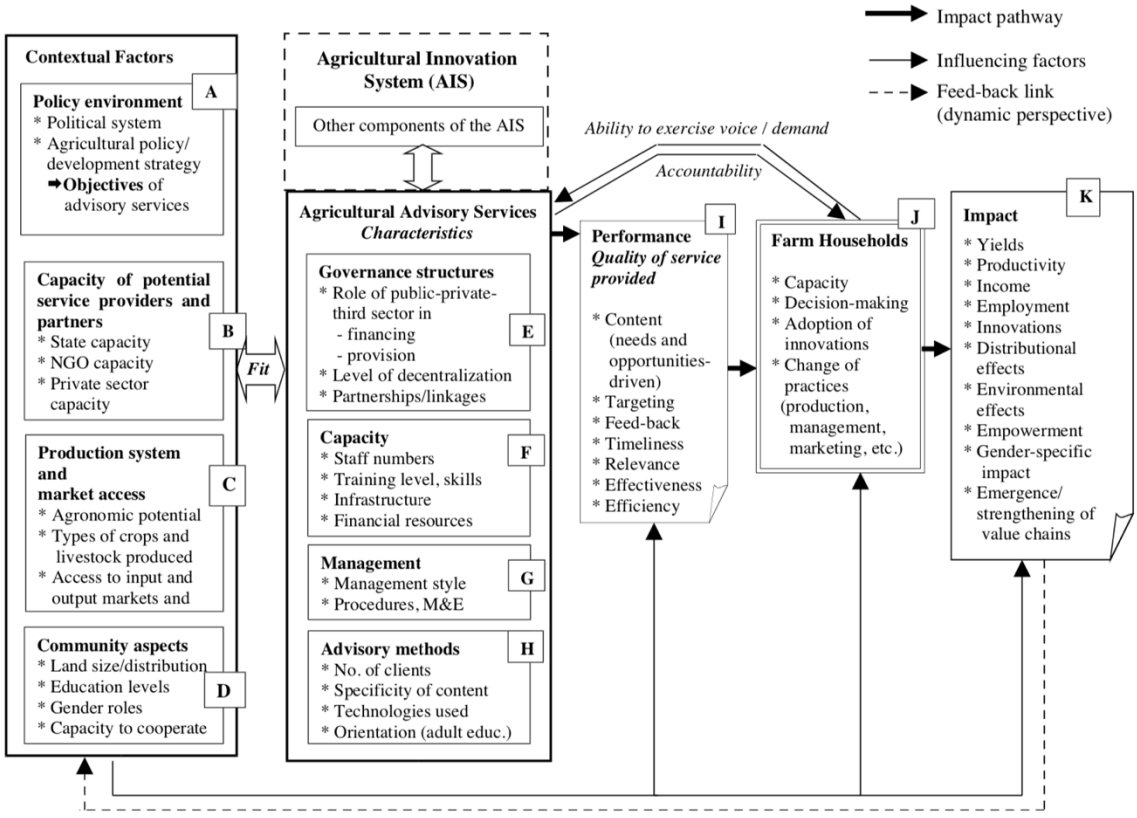

Figure 2. Framework for designing and analysing advisory services. Source: Birner et al., 2009

I manually transcribed the recorded interviews the day after they were conducted to make sure no information was missed. Bryman (2012) suggest that researchers should transcribe the interview immediately after it has been conducted to be aware of themes to ask about in the next interview. This was not possible, as we came back to Kigali at midnight and

had to get up early the next morning. However, I used field notes for the same purpose. When transcribing the interviews, I listened to the recordings several times to avoid misunderstanding or misinterpreting answers.

After I transcribed all interviews from both study areas, I started to colour code the data into different categories. For example, if the respondents told me that they saved time using the mobile phone, this was colour coded to the efficiency category. Some of the data were coloured in several categories as they were interconnected. Data from the respective areas were separated, to be able to analyse differences. The secondary data were grouped in folders according to the topic of the literature.

2.5 Research Ethics and Limitations

2.5.1 Ethical Considerations

There are four ethical principles to keep in mind when doing research. "a) Whether there is harm to participants. b) Whether there is a lack of informed consent. c) Whether there is an invasion of privacy. d) Whether deception is involved" (Bryman, 2012:135). The topic of the study has low sensitivity, but ethical considerations were done before conducting the research.

Before fieldwork, I prepared an information and consent letter to the participants of the study. The letter contained information about the research project, why they were asked to participate and their rights. They were informed that they could withdraw at any time and what would happen with the information after the completed project. The letter was translated to local language by a key informant in Kigali, to make sure the participant understood the information that was given. Before the interviews, I introduced myself and the purpose of the study in addition to the letter in case there was a low literacy level among the informants. The thesis proposal, consent form and the interview guides were approved by The Norwegian Centre for Research Data before I conducted the interviews.

2.5.2 Limitations

Interaction with the farmers required knowledge of Kinyarwanda, the local language in Rwanda. The fieldwork was carried out with the help of a translator, but I still faced limitations concerning language. The translator was not fluent in English, which caused language barriers between the translator and me. I experienced that I had to adjust my questions several times when the translator did not understand the language. Another risk is

that the translator misunderstood his role and made his own judgement instead of translating. The language barriers also created limitations due to in-depth information. There were informants who answered with several sentences and talked for minutes, that was translated into a simple sentence. When I asked for more details, I got the same answer in one sentence. If the informants actually gave me longer and supplementary answers, this was lost in the translation due to language barriers. Since the interviews were recorded, I tried to find a person in Norway that could help me translate the recordings. Unfortunately, no one was able to help me with this. Another limitation due to language barriers is that I had to edit misspellings when quoting the transcribed interviews. However, this was done carefully not to change the informants meaning or view of the topic.

Time was an issue regarding interviews in the fieldwork. Rwanda is a small country, so it was decided to drive from Kigali and use one day per district. This resulted in limited time spent with the respondents. Some of the interviews only lasted in 15-20 min, because the driver was in a hurry and we had to drive back to Kigali. I tried to ask if we could be there for several days to have more time with the farmers, but the driver and my translator did not have time.

Another limitation concerns the selection of the informants. The RAB staff chose the informants for me, as they were already at the local village office when we arrived. My goal was to find farmers and visit them at their farms, but the RAB staff had already organized a meeting in each district area. One advantage of this was that I was ensured that I got to do several interviews, but it might have affected the quality of the data. Because the translator worked in RAB, the interviews might have been inclined to share positive feedback on the use of mobile phones in the district. Because the RAB staff chose the farmers for me, I was not able to visit each farm to see the farm size, livestock and crops, close and remote etc. This was solved by asking several questions about their farm, such as how many they were in the family, what kind of crops and livestock they had, and how they travelled to the local office etc.

3.0 Theoretical Framework

The theoretical framework chapter will consist of six parts. First, I will give an introduction of the theoretical review, which is Agricultural Knowledge and Information System (AKIS), Extension and Advisory Service (EAS), Mobile Phones in the EAS, Digital

Divide and Gender Equality. Followed is the analytical framework, where I will explain how the study is analysed through Birner's Best-Fit Framework.

3.1 Agricultural Knowledge and Information System (AKIS)

Agricultural innovation approaches have been researched, discussed and developed over many decades. Rogers' (2003) *Diffusion of Innovation theory* was a linear model where the idea was that innovation was developed by scientists and disseminated through extension service providers to the end-users. In other words, knowledge was developed by agricultural scientists and the transfer of knowledge was brought to farmers through EAS. This linear model is criticised by several researchers (e.g. Leeuwis, 2004; Röling, 1990) saying that if the innovation were communicated through top-down models, the innovation was most likely not adopted, and the importance of a two-way flow of knowledge and information between farmers, research and extension service (Leeuwis et al., 2011). As an answer to the diffusion of innovation theory, Röling (1990) developed the *Agriculture Knowledge and Information System* (AKIS) in the 1990s. Röling defined AKIS as "a set of agricultural organisations and/or persons, and the links and interactions between them, engaged in such processes as the generation, transformation, transmission, storage, retrieval, integration, diffusion and utilization of knowledge and information, with the purpose of working synergistically to support decision making, problem solving and innovation in a given country's agriculture or domain thereof" (Röling 1990:1). The main purpose of the shift was not to look at innovation as a linear model, but rather a system with several actors. In more recent years, the concept has further developed to Agricultural Knowledge and *Innovation* Systems, or Agricultural Innovation Systems (AIS) (Klerkx et al., 2012).

Agricultural Innovation Systems (AIS) was developed as a parallel to Agricultural Knowledge and *Information* Systems and are defined as "a network of organisations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organisation into economic use, together with the institutions and policies that affect the way different agents interact, share, access, exchange and use knowledge as well as jointly learn" (Hall et al., 2006:vi-vii; FAO, n,d.b). The Agricultural Knowledge and *Information* Systems has been criticised for the limited focus on the role of markets, private sector, policy environment, and other regulations and sectors (Hall et al., 2006:25). This is included in the AIS where it is more focus on "the influence of formal institutions (defined as organisations like companies, public research institutes and governmental entities) and infrastructures on

learning and innovation, and its explicit focus to include all relevant organisations beyond agricultural research and extension systems" (Klerkx et al., 2012:463).

Research, education and extension are key elements in the AIS, but these three elements alone are not sufficient to the innovations process. Rajalahti (2012:4) states that "innovation requires a much more interactive, dynamic, and ultimately flexible process in which the actors deal simultaneously with many conditions and complementary activities that go beyond the traditional domains of research and development, and extension". In other words, outside actors in the agriculture sector have a key role in the innovation process. Rajalahti (2012) states that AIS principles are a combination of research, education and extension ("traditional interventions") and the consumers, producer organisations, exporters, input suppliers etc. ("complementary interventions"). Hall et al. (2006) also stated change in the growth of ICT as an important tool to generate and diffuse new knowledge between the actors. Because information flow is important in the AIS (and AKIS), ICT's are seen as an opportunity to connect the different innovation communities (Rajalahti, R, 2012).

When talking about innovation systems, it is important to define the term innovation. Through the development of agricultural innovation processes, the definition of innovation has changed as well. Rogers (2003:12) defines innovation as "an idea, practice or object that is perceived as new by an individual or group", and further explains that an innovation is either adopted or rejected by individuals. Innovation is no longer viewed as a one-dimensional aspect, but rather that building block comes from science, practice and intermediaries (Leeuwis et al., 2011:22-23). World Bank (2006:2) 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." Cambridge Dictionary (n,d) has defined innovation more simple as "a new idea, design, product or the development of it".

As mentioned earlier, both AIS and AKIS place emphasis on the interaction between different actors in the agriculture sector, and they both include farmers as important contributors to the collection of knowledge and information. Both systems also state that extension and advisory service is a key component in the systems, as they may function as a mediator between involved parties (Faure et al., 2012).

3.2 Extension and Advisory Service (EAS)

Extension and Advisory Service (EAS) is seen as a key element within a broader agricultural knowledge and innovation system (AKIS). The term extension and advisory service is for many synonymous as knowledge or technology transfer from an organisation (public, NGO) to farmers with the aim to improve farmers welfare and agricultural production (Christoplos, 2010; Anderson, 2007; Davis, 2008). However, because of the shift from technology/knowledge transfer to a two-way flow of information, Christoplos has developed a more descriptive definition; "Agricultural extension and advisory services (AEAS) refers to any organization in the public or private sectors that facilitates farmers' and other rural actors' access to knowledge, information and technologies, and their interactions with other actors; and assists them to develop their own technical, organizational and management skills and practices, so as to improve their livelihoods and well-being" (Christoplos, 2010:3). Birner (2009) has a simplified definition; "the entire set of organizations that support and facilitate people engaged in agricultural production to solve problems and to obtain information, skills, and technologies to improve their livelihoods and well-being" (Birner et al., 2009:342).

Due to changes in agricultural development and the knowledge and innovation systems, extension and advisory service approaches have changed likewise in the past decades (Taye, 2013). From what before was a linear top-down approach, to models with bottom-up approaches and ICT- based advisory services. This is a solution to the old approach, which has been criticised for reductionist perspectives and farmers passive role (Taye, 2013). With the diversity of EAS approaches and different institutional options providing the service, the term "pluralistic" has been coined (Birner et al., 2009). The institutional options vary from "...decentralization, deconcentration, contracting/outsourcing, public- private partnerships, embedded services, privatization, revitalizing of public sector advisory models, and provision of advisory services by non-governmental organizations (NGOs), farmer organizations and community-based organizations" (Birner et al., 2009:342). In other words, a pluralistic extension and advisory service is a cooperation between public and private sectors and farmers (FAO, n,d.c).

Regardless of definition and the evolution of it, the extension and advisory service is well established as a key tool to improve productivity in agriculture and to increase farmers income (Anderson, 2007; Christoplos, 2010; Birner et al., 2009). However, it is important to state that the outcome or the impact of extension and advisory services is hard to measure because it is affected by several factors, such as lagged and spillover effects, and because the variation in the models gives different results (Birner et al., 2009). Although extension has

resulted in positive impact, extension and advisory services face several challenges due to access and updated information, ethics and motivation of extension workers, coverage of geographical areas, farmer participation and farmers resistance to extension messages (Odame, 2013).

3.3 Mobile phones in EAS

The growth of mobile phones in developing countries has created an opportunity of using mobile technology for learning. M-learning (mobile-learning) is defined by Crompton et al. (2013:4) as "learning across multiple contexts, through social and content interactions, using personal electronic devices". From Brown's (2005) paper, we can define m-learning as the delivery of content and interaction through a mobile phone. Brown (2005:7) further explain that the mobile phones can be used with two approaches; content approach or communication approach. The content approach is where the individual is "providing content itself or have access to available content", and the communication approach is where the individual is "providing communication facilities or access thereto" (Brown, 2005:7). The benefits of m-learning are the interaction and communication between lecturers and learners, and that the access to learning is regardless of time and place (Brown, 2005:10).

Information and communication technologies (ICT) are seen as important tools to improve the information and communication process due to agricultural development and to overcome the challenges in the EAS. Information dissemination can expand with the use of ICTs due to the widespread of mobile phones in developing countries (Rajalahti, 2012; Aker and Mbiti, 2010). Mobile phones might also solve the problem of old ICTs in agriculture, as it can be used as a two-way communication tool, compared to radio and television that has limitations due to their ability to communicate only one way (Aker and Mbiti, 2010). This is supported by Brown (2005), which states that the communication approach in m-learning is its strengths. The ability of mobile phones to a two-way communication might make the service more demand-driven. In recent years the rate of mobile phone users in Sub-Saharan Africa has increased and therefore been implemented in EAS to improve the service. Gakuru (2009) states that the number of farmers has been growing, but the numbers of extension workers have declined, and that innovative information system has the ability to fill this gap.

The use of mobile phones in EAS is cost-effective in several areas. The costs of mobile phones have decreased, which gives people in developing countries greater access to information (Anderson, 2007; Aker, 2010). This leads to lower costs for the farmers when

they can make a phone call versus the cost of personal travel to an area where they can gain agricultural knowledge (Aker, 2011). The same expenses apply to extension workers, where the extension workers can reply to the farmers immediately without having the travel costs because of mobile phones geographical coverage (Aker, 2011). This applies to rural farmers with long distance to markets and knowledge centres and areas with poor infrastructure. However, Aker (2016) has stated the importance of projects without expenses for low-income farmers, as expenses can lead to rejection of the service.

Although mobile phones seem to be a solution to old problems with EAS, it has its challenges to be considered. Communicating complex information with a mobile phone is challenging because the text is limited, and it requires literacy (Aker, 2011; Gakuru, 2009). Aker (2011) further states that it is challenging to use SMS to provide and receive advanced information such as inputs but that it can be used to provide and receive short information such as market prices and weather reports. Aker (2016) also states the pros and cons of different mobile phones; old phones and smartphones.

	Pro	**Con**
Old Mobile Phones	Most people have it Cost effective	Only limited information
Smart Phones	Interactive Multimedia formats More detailed information	Not everyone has it Different smart phone models -> hard to develop an app that fits for all

Source: Aker (2016)

3.4 The Digital Divide

The digital divide is a popular term used to describe the gap between users and non-users of digital devices. The term was originally to describe the gap when computers became popular (Pearce, 2013), but as the technology changes, the term is now also used for new digital devices. The digital divide can occur on multiple levels, between or within countries, between rural and urban populations and poor and rich (World Bank, 2016b). The digital divide can be categorized into three social aspects; i) inequality of access to information technology, ii) inequalities due to capabilities to use the information technology, and iii) inequalities of the outcomes of using the information technology (Wei et al., 2011). In other

words, in the context of this thesis, a farmer needs to have access to a mobile phone (i), knowledge on how to use it (ii), and get an outcome of using the mobile phone due to knowledge on how to use it, and other contextual factors (iii).

The spread of ICT tools is seen as a solution to many development issues, especially agriculture, but not everyone is included in this evolution. Causes of the digital divide might be lack, or limitations of resources such as owning a phone, technical knowledge, access to a network and cultural resources (Van Dijk, 2012). Van Dijk (2012) further explains that these resources are distributed differently in society because of personal inequalities (age, sex, ethnicity, intelligence) and positional inequalities (level of education, occupation or role in the household). It is important to remember that access to a mobile phone, does not necessarily allow the person to use it due to the second social aspect, such as a person's capability to use the mobile phone (knowledge, airtime, literacy, network).

The importance of access and knowledge of ICTs is mentioned in several of the Sustainable Development Goals. The targets in SDGs number 4, 5 and 6 concern the knowledge of using ICT, women empowerment through increasing the number of women using ICT, and increasing the access to ICT (UN, n,d, a; b; c). These goals, targets and indicators are necessary to achieve to close the digital divide, and the digital divide is necessary to close in order to achieve sustainable development (UN, 2019).

Goal	**Target**	**Indicator**
4 – Quality Education	4.4 – *"... Substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship"* (UN, n,d,a)	4.4.1 "*Proportion of youth and adults with information and communications technology skills, by type of skill"* (UN, n,d.a)
5 – Gender Equality	5.B – *"Enhance the use of enabling technology, in particular information and communications technology,*	5.B.1 *"Proportion of individuals who own a mobile telephone, by sex"* (UN, n,d.b)

	to promote the empowerment of women" (UN, n,d.b)	
9 – Industry, Innovation and Infrastructure	9.C – *"Significantly increase access to information and communications technology and strive to provide universal and affordable access to the internet in least developed countries by 2020"* (UN, n,d.c)	9.C.1 *"Proportion of population covered by a mobile network, by technology"* (UN, n,d.c)

In this study, the digital divide refers to farmers who did not have access to a mobile phone, and to farmers who had a mobile phone but not the same access to agricultural information due to various challenges such costs and electricity to charge the phone. Further in this study, lack of access to a mobile phone is defined as not owning a mobile phone and not being able to borrow one. The digital divide was included in the theoretical framework because the study explored socioeconomic and cultural factors that can prevent farmers access to agricultural information due to access and availability of a mobile phone.

3.5 Gender Equality in Agriculture

Gender equality and women empowerment are seen as key for sustainable development (UN, n.d.b). The importance of gender equality is highlighted in the Sustainable Development Goals (SDGs) where goal number five is to "achieve gender equality and empower all women and girls", and the importance of the goal to make progress on all the other goals (UnWomen, n.d). Women empowerment is also included in targets of other SDGs, such as goal two, where one target is to *"(...) double the agricultural productivity and incomes of small-scale food producers, in particular women (...)"* (UN, n.d.d). According to FAO (2011) in order to increase agricultural productivity, achieve food security and reduce hunger, it is essential to focus on closing the gender gap.

When discussing women empowerment and gender equality, it is important to define the terms. The term gender equality means that both women and men have equal rights and opportunities (Eige, n.d). Equal rights and opportunities is a human right and are necessary

for sustainable economic growth, social development and environmental sustainability (Eige, n,d; Quisumbing et al., 2014; UNECE, 2012). Women empowerment is a widely used term, which the UN Commission on the Status of Women (2002:2) defines as a "Process by which women gain power and control over their own lives and acquire the ability to make strategic choices".

Women contribute to a large portion of the agriculture labour, and gender equality has a positive impact on food security at the household level and agricultural productivity (FAO, 2011; Sraboni et al., 2014; Quisumbing et al., 2014). The importance of gender equality in economic development and agriculture was first emphasised in 1970 and has since then been on the agenda for development (Quisumbing et al., 2014). However, women still tend to have limited access to productive resources and opportunities, which may result in difficulties in closing the gender gap (Quisumbing et al., 2014). Productive resources and opportunities are, for example, land, labour, capital, services, inputs, technology and markets (Quisumbing et al., 2014; Bezner Kerr, 2008). This also applies to the extension and advisory service where women tend to have less contact with extension officers than men (Quisumbing et al., 2014). This might be due to the service is being biased towards men, where the information is targeted to men and that most extension staff is men (Lecoutere, 2019). However, it is not clear if there is a different quality of the information given to men and women (Quisumbing et al., 2014)

Political and socio-economic elements must be considered in order to achieve gender equality in agriculture. Policies, strategies and laws have to address women empowerment to eliminate discrimination and to give women a greater voice (FAO, 2011). There is also a need to close the gap concerning elements as access to land, rural labour markets, financial service, social capital and technology (FAO, 2011). To research gender differences through the above elements, there is a need for data below the household level. A household has through early history been viewed as a unit (unitary model), where the behaviour of a household was viewed as a group of individuals with the same preferences (Quisumbing et al., 2014). The unitary model has been challenged by the collective model, where households are seen as a collective of individuals with different preferences and utility functions (Quisumbing et al., 2014). In agriculture, the view of households in a collective model means that *"men and women of different generations may have separate plots, animals or production activities, with varying degrees of independent control over the output, and varying degrees of claims on the land, labour, income, or other resources of other household members"* (Quisumbing et al., 2014:12). Because of challenges due to data collection of gender in agriculture, research

has focused on the comparison of female-headed and male-headed households as a gender indicator (Quisumbing et al., 2014). Using the sex of the household as a gender indicator is misleading when measuring gender relations (Quisumbing et al., 2014). Elements such as women's role and contributions in agricultural production in a male-headed household will most likely not be measured (Quisumbing et al., 2014). Additionally, female-headed households mostly lack the present of a husband, as adult men rarely live in female-headed households (Quisumbing et al., 2014:14). The challenges in measuring gender indicators may lead to an underestimation of agricultural productivity due to gender differences (Quisumbing et al., 2014; Peterman et al., 2011).

Gender roles have an impact on men and women at the household level, and the roles may be shaped by religion, economy, ethnicity and culture. Because gender and gender roles are socially determined, they can change over time if the society changes due to resources, policies and context (Quisumbing, 2014; Manfre et al., 2013). These socially determined gender roles influence the distribution of resources and responsibilities between men and women (Moser, 1989). Intrahousehold resource allocation is how time, money and other resources are allocated among individuals (Haddad et al., 1997). As an example, women tend to have the main responsibility for cooking, childcare, laundry, and cleaning combined with their high contribution to the agriculture sector (FAO, 2011; Bezner Kerr, 2008). Intrahousehold allocation and socio-cultural context shape the distribution of resources within a household, which further shapes the bargaining power of the assets (Meinzen-Dick et al., 2014b). Women's ownership of assets is therefore important to empower women and to promote gender equality, as it might function as an income and wealth generator as well as increasing women's bargaining power (Meinzen-Dick et al., 2014b).

3.6 "From Best Practice to Best Fit"

I have in this study used the best-fit framework (Birner et al., 2009) to guide my analyse of the extension and advisory service. The analytic framework can be used to analyse existing EAS by looking at the local context through an impact chain, or as a tool to design new services.

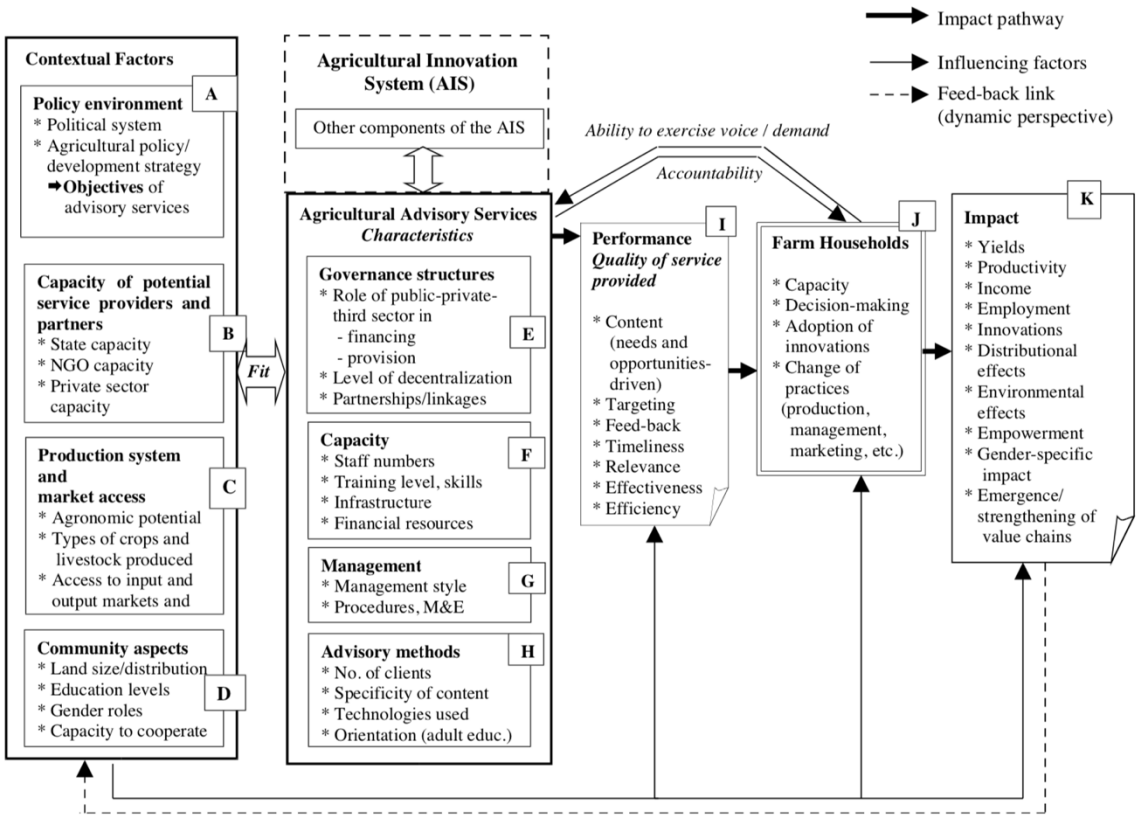

Figure 2. Framework for designing and analysing advisory services. Source: Birner et al., 2009

The framework considers variables of contextual factors (Box A-D) that has an impact on the characteristics of the EAS (Box E-H). The contextual factors serve as frame conditions for how the EAS is organized and structured, and they have to be considered when designing a new system (Birner et al., 2009). Birner et al. (2009) include the Policy Environment (Box A), Capacity of Potential Service Providers and Partners (Box B), Production System and Market Access (Box C) and the Community Aspects (Box D) as factors that influence the given EAS. This means that if you want to design a new EAS in a given country, you have to adapt it so it matches how the national level prioritise the agricultural development and to the community that will receive the service. The contextual factors influence how the EAS is designed and therefore has an impact on the quality of the service, Performance (Box I) (Birner et al., 2009).

Birner (2009) explains the remaining three boxes as an impact chain that makes it easier to analyse EAS's performance and impact. I have chosen to visualise the impact chain by adapt it to new boxes. The impact chain can be explained further by looking at the performance indicators (Box I) as "quality of the outputs of an advisory service" (Birner et

al., 2009:350). The outputs from the performance indicators lead to "immediate outcomes" (Birner et al., 2009:350), if farmers change their practice or behaviour based on the given advice. These changes will then lead to "intermediate outcomes" (Birner et al., 2009:350), results that benefit the farm household level. And then, the results that benefit the farm household level will further cause changes in the "impact" (Box K), which is broader development goals such as increased agricultural productivity and income (Birner et al., 2009).

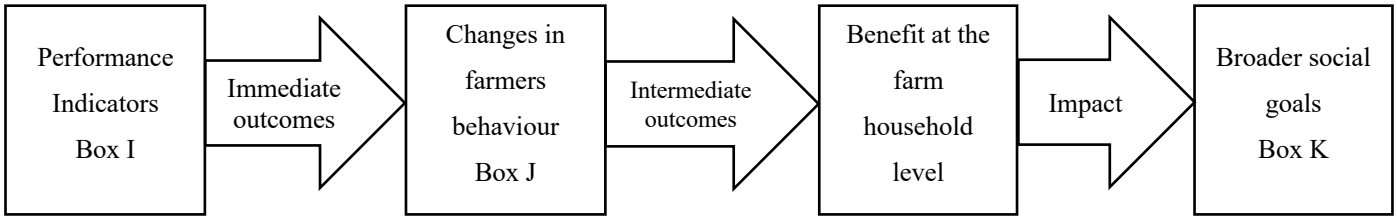

Figure 3. The impact chain in the best-fit framework. Source: Adapted from Birner et al., 2009

Performance (Box I) concerns indicators to measure the quality of the EAS. Birner et al. (2009) state that to measure the quality, you have to identify the goals of the service through the involvement of policymakers, extension workers and farmers to see if they have reached the goals. The framework includes indicators as; content delivered, the timeliness, relevance, effectiveness and efficiency (Birner et al., 2009).

In order for the EAS to work well enough to have an impact at the development level, they depend on Farm Households (Box J) and how the farmers use the service. Birner (2009) have listed indicators as *Capacity, Decision-making, Adoption of Innovations and Changes of practices*. If the EAS at the national and local level has made it possible for farmers to use an irrigation system that will help to increase the production, they depend on farmers to use the irrigation system to see a change in the Impact box. The framework also points out the importance of the opportunity farmers have to provide feedback and demand information from the EAS, and that it is important for the Performance of EAS (Box I). Birner et al. (2009) state that farm households are influenced by the contextual factors as well as characteristics of the EAS, as we can see from the long arrows at the bottom of the framework.

The last box, Impact (Box K), contains the variables you measure and compare with the policy objectives set for the service. Birner (2009) states that is it difficult to measure

these variables because there are many factors that influence the variables. For example, it is hard to measure whether EAS is effective by looking at yields because factors like weather have an impact on the outcome of the yield.

Birner's framework is designed to better analyse EAS by dividing the whole system into different parts and then analysing parts of it. Key for my study are some of the EAS characteristics; Advisory Methods (Box H), Performance (Box I), Farm Household (Box J) and Gender roles, which is included in Community Aspects (Box D).

4.0 Rwanda Background

Rwanda is a landlocked country located in East-Africa and is known as the country of thousand hills. Rwanda covers 26,338 square kilometres (BBC, 2018), and has a population of 12,374,397 people (NISR, 2019a), which make the country the second-most densely populated in sub-Saharan Africa (World Bank, 2018). 82.8 % of the population in Rwanda lives in rural areas (FAO, 2018). Rwanda has a decentralized political structure which has resulted in five provinces; Northern, Eastern, Southern, Western and Kigali. The provinces are then divided into 30 districts (*akarere*); 416 sectors (*imerenge*), 2148 cells (*utugari*) and then 14 837 villages (*imudungu*) (NISR, n.d)

Rwanda is a post-conflict country that has achieved impressive social and economic development since the 1994 genocide (World Bank, 2019b). The country has one of the fastest-growing economies in Africa (World Economic Forum, 2016), with its GDP growth rate at 8.6 % in 2018 (World Bank, 2019a). Economic development combined with political stability and low corruption compared to its neighbours is some of the reasons why the country is seen as a successful case in the region (Transparency International, 2018). Rwanda aims to become a Middle Income Country (MIC) by 2035 (World Bank, 2019b) and is often called "The Singapore of Africa" because of its aim of becoming a high-tech country with high focus on ICT (ROR, 2000).

Even though the country has achieved development improvements with a growing economy and a declining poverty rate, they still face challenges with poverty and food security (World Bank 2019b; WFP, n.d). Although people living under the poverty line has decreased recent years, still 39.1% is considered poor (NISR, 2015a) and 35 % of the children under five years old are stunted (WFP, n.d). Rwanda distinguishes between four categories of wealth. Citizens that fall into the first category is defined as the poorest in the country,

homeless and unable to provide food themselves (Ezeanya-Esibu, 2017). Category two are citizens that rent or own a house with low standard and can only afford to eat maximum once or twice a day (Ezeanya-Esibu, 2017). Category three concerns citizens that have a job or are employers of labour, for example, small-scale farmers that earn money on their agriculture (Ezeanya-Esibu, 2017). The rest of the population that are full-time employed and owners of other businesses fall under category four (Ezeanya-Esibu, 2017). The categories are used to target citizens into different social protection programs, with the aim to help the most vulnerable in the country and lift them out of poverty (Ezeanya-Esibu, 2017).

In order to achieve the goal of becoming a MIC as well as reducing poverty and increasing food security, Rwanda has to increase the agricultural productivity and make the agricultural production more market-oriented (World Bank, 2016a; FAO, n.d.a).

4.1 Agriculture in Rwanda

Agriculture is one of the main sources of livelihood for people in Rwanda, where 80% of the population is engaged in the agriculture sector (FAO, n.d.a). The country's economic development is depending on the agricultural sector, with its 31% of the national GDP and is one of Rwanda's main export sectors (NISR, 2018a). The agricultural sector is considered as the country's backbone for sustained economic growth and poverty reduction. Rwanda's agricultural policies acknowledge that the state of food security is dependent on increased agricultural production as well as increased incomes, access to markets and market information (Dusengemungu et al., 2018). Their National Agricultural Policy's mission is to "Ensure food and nutrition security, modern agribusiness technologies professionalizing farmers in terms of production, commercialisation of the outputs and the creation of a competitive agriculture sector." (MINAGRI, 2018a:5). The agriculture sector increased almost 6 % from 2013 until 2018 (World Bank, 2019a), but the country faces challenges due to population growth, climate change and land scarcity (FAO, n.d.a).

Because of the country's high population density and population growth, land is scarce. Most farmers are small-scale with an average cultivated area at 0.6 ha per household (NISR, 2016). The landscape in Rwanda has a great variety, from the highest mountains in the West to savannas, plains and swamps in the East. The country's typography consists of many hills and steep slopes which makes arable land scarce due to soil loss, erosion and declining fertility (Karamage et al., 2016. Most farming activities (70%) are arranged in slopes that range from 5 to 55% inclination (MINAGRI, 2013). To improve the agricultural productivity

in the slopes, Rwanda has invested in land management structures such as radical and progressive terracing to utilise land better, and to reduce soil loss due to rain (MINAGRI, 2018b). Rwanda has two rain seasons per year, which means that there are two agricultural seasons. The first heavy rain season is from March to May and the smaller rain season from September to November. The first cultivable season (season A) starts in September and lasts until February the following year, and season B that starts in March and end in June (NISR, 2018b). They also have a third season (season C) which is cultivated in the marshlands, that starts in July and ends in September. Two seasons per year is an advantage, as the farmers are able to grow two diverse sets of crops in one year.

Due to variation in climate and landscape, diverse crops are grown in different areas and seasons. The main crops grown in Rwanda are cassava, sweet potato, Irish potato, maize, rice, wheat, bean and banana (RARDA, 2006). Beans and sweet potato are grown in the whole country, while Irish potato is mostly grown in the Northern and Western Province. Cassava is grown in the southeast of the country and maize is concentrated in the Northern and Eastern Provinces (McNairn et al., 2018). Sweet potato, Irish potato, Beans, Pea, Soybeans and Vegetables are the crops grown in season C (NISR, 2018b). In 2007, the GoR developed The Crop Intensification Program (CIP) to increase the agricultural productivity and ensuring food security by, among other things, distributing improved seeds and fertilisers (MINAGRI, n,d.a). The program focused on crops namely maize, wheat, rice, Irish potato, beans and cassava (MINAGRI, n.d.a).

To increase income and food security, the main agricultural production in Rwanda is a mixed crop-livestock farming system (Mutimura et al., forthcoming). 12 % of the agriculture GDP comes from the livestock subsector, and it contributes with 3 % of the national GDP (NISR, 2018c). Livestock productivity is affected by poor quality and quantity in forage production due to the effects of climate change (Mutimura et al., 2015). Like the agricultural sector, livestock is important to reduce poverty and improve food security in the country. In 2006 the GoR launched the *"Girinka"* or "One cow per poor family" program to improve low-income households' welfare and malnutrition among children (RGB, n.d). Households are given a heifer which will provide the family with increased access to nutrition, employment and manure to their agricultural activities (MINAGRI, n.d.b). However, the high number of cattle in the country has led to pressure on land resources (Mutimura et al., 2015). Drought, land scarcity, diseases and limited quality and availability of feeds are some of the challenges in the livestock production in Rwanda (Bevi, 2016), which makes the veterinary service and EAS important for both agriculture and livestock.

The Ministry of Agriculture and Animal Resources (MINAGRI) is responsible for the development of the agricultural sector through the establishment and implementation of policies (Dusengemungu et al., 2018). MINAGRI has two implementation institutions, Rwanda Agriculture and Animal Resources Development Board (RAB) and National Agricultural Export Development Board (NAEB). RAB covers agricultural research and education and NAEB covers exports such as coffee and tea. One of RABs responsibilities is to "provide agricultural extension services in accordance with agricultural and animal husbandry needs", and they further explain the importance of a strong link between research and the EAS (RAB, n.d.a).

4.2 Extension and Advisory Service in Rwanda

After the genocide in 1994, Rwanda reorganised their extension and advisory service from before was a state-led "top-down" system, to the implementation of farmer-to-farmer extension "Twigire Muhinzi", with the support of FAO, Belgian Development Agency and others (MacNairn et al., 2018:15, RAB, 2016b). The Twigire Muhinzi model has four specific goals; maintain national food security, improve productivity, increase income and improve livelihoods (McNairn et al., 2018). The extension approach is a decentralised model which consist of two different Farmer to Farmer extension approaches; Farmer Field Schools (FFS) and Farmer Promoter (FP) (RAB, 2016a). Both approaches aim to make sure that all farmers have access to EAS and to increase the farm yield and foster solidarity (RAB, 2016b). The Farmer Promoter (FP) approach is based on the selection of one farmer promoter at the village level. The FP is selected through a participatory exercise in the village, and the FP receive training by the local sector agronomist and FFS facilitators (RAB, 2016b). The FP collaborate with agro-dealers to receive the right information on inputs for each farmer. At least three times during one season, the FP has demonstration plots in an organised group of 20 farmers, to show the local farmers the potential by using external inputs combined with improved agronomic practices (RAB, 2016b). The farmer promoter approach has the motto "seeing is believing", and the chosen farmer promoter is responsible for mobilising farmers to follow the agronomic practice advice (RAB, 2016b). In 2015, there were 14,200 farmers promoters, where only 20% were females (RAB, 2016b). The Farmer Field School (FFS) approach is based on that "the plant is the teacher", where the farmers are learning by doing (RAB, 2016b). The farmers are organised in groups where one FFS facilitator will offer experimental learning practice with in-depth knowledge. The group is organised based on

motivated farmers from an FP group, and the group meets on a weekly basis where they learn to identify and analyse agricultural problems at the local level (McNairn et al., 2018; RAB, 2016b). The goal of the FFS is that farmers are becoming progressive farmers by being able to take independent decisions based on the experience from FFS. In 2015, there were 2,300 FFS facilitators, where the majority was male farmers (72%) (RAB, 2016b). The Twigire Muhinzi model is developed and managed by RAB under MINAGRI, where RAB collaborate with districts and sectors where they have agronomists, trainers and field coordinators (RAB, 2016b).

The Rwandan EAS partners with local governments, NGOs and the private sector to provide multiple extension service methods to farmers, and for the policy implementation (Haug et al., 2018). Therefore, the extension and advisory system in Rwanda can be called pluralistic. This fits MINAGRIs extension strategy, where the Government of Rwanda (GoR) committed to developing a pluralistic extension system which concerns with the strengths of multiple approaches and methods that are participatory, demand-driven, process and result-oriented and to involve multiple actors to deliver extension service (MINAGRI, 2009:4). However, NGOs providing EAS in Rwanda is not taken into consideration because of the scope of this thesis; therefore my only focus is the public EAS.

4.3 Information and Communication Technology for Rwandan Agriculture (ICT4RAG)

In 2016, the Rwandan government developed a strategy for Information and Communication Technology for Rwandan Agriculture (ICT4RAG). The strategy is developed with an aim to implement ICT in agriculture to achieve an "information-rich and knowledge-based economy" (MINAGRI, 2016:8), which supports the country's development strategy; Vision 2020 (UN, 2017). The strategy also is also closely aligned to the SMART Rwanda Master plan, the fourth national ICT strategy, that focuses on investments in ICT to increase the country's productivity and efficiency (MINAGRI, 2016). The strategy's goal is to "make agricultural and rural development more effective and responsive to the farmers needs and expectations" (MINAGRI, 2016:8). Its main principles are a vision of modernization, an action plan for their agricultural and rural development and an evaluation plan (MINAGRI, 2016).

The strategy has identified the agricultural life cycle and when different information is required. In the time of pre-cultivation, there is a need for information on the selection of

crops and access to input and credit. During the season and harvesting, there is a need for information on the management of the cropping, and information on post-harvest techniques, marketing and transportation is needed in the post-harvest time (MINAGRI, 2016:23). The strategy further suggests several ICT solutions due to the different time in the agricultural life cycle, where ICT-enabled learning and knowledge exchange fits into all three stages (MINAGRI, 2016). They also state the importance of two-way communication where knowledge is shared as push information and that farmers can receive information on demand (MINAGRI, 2016).

The ICT4RAG strategy has developed objectives to reach the goal of using ICTs to increase agricultural productivity. The objectives focus on information for farmers and farming, skilled and knowledgeable farmers, include and encourage youth in the agriculture sector, improve the information and knowledge and increase access to it, and improve the agricultural financial services (MINAGRI, 2016). The objective four, "improve and increase access to agricultural information, knowledge and market" (MINAGRI, 2016:10) is of special interest for this research. They want to reach this goal by i) build ICT centres with computers at the district and sector level, to make the service affordable in the rural areas. ii) establish ESoko+, which is an improved version of the market price information system. iii) focus on the Agriculture Information Service Center, a centre that distributes agricultural information through channels like radio, video and the national call centre. And iiii) development of a mobile application that is functioning on the small mobile phones, that will provide farmers with location-specific fertilizer recommendations (MINAGRI, 2016).

4.4 Gender Equality in Rwanda

Along with agriculture development, poverty reduction and ICT in the agriculture sector, gender equality is highlighted as a cross-cutting area for Rwanda's development (ROR, 2000). In Rwanda, women participation is seen as a key for development as they make up 51.5 % of the population (NISR, 2019b). Gender equality is acknowledged by the president, Paul Kagame, who said that "Women and men are equal in terms of ability and dignity, and they should also be equal in terms of opportunities. As Rwandans, as a global community, we need every member of our society to use his or her talents to the fullest if we are ever to reach our development goals" (MIGEPROF, 2017:11). Gender equality and women empowerment are recognised in several of the laws and policies in Rwanda. For

example, the country has a law ensuring that women and men have equal access to land, and a policy against gender-based violence (MIGEPROF, 2017).

As of 2018, Rwanda was ranked as the sixth-best country in the world on the World Economic Forum's gender gap report and is ranked as the fourth-best considering closing the gender gap in the political empowerment (WEF, 2018). 61.3% of the representation in the parliament are women (IPU, 2019), and the constitution provides a minimum of 30% quota for women in decision-making positions (MIGEPROF, 2017). In 2014, Rwanda scored high on Women's Empowerment in Agriculture Index (WEAI), but women were more disempowered than men in 8 of the 10 indicators (Malapit et al., 2014). Women were more disempowered in relation to control over use of income, workload and speaking in public (Malapit et al., 2014).

Women are seen as key players in the agricultural economy in Rwanda, as the majority of the population involved in the agricultural sector are women (Mutimura et al., 2018). Women also have the main responsibility to feed the family, take care of the children and to manufacture household goods, and they spend almost 12 more hours than men on own-use production (NISR, 2019b).

Although gender equality and women empowerment are well established in laws and policies, socio-cultural perceptions and behaviours are still patriarchal (MIGEPROF, 2010). Additionally, literature (Randell and McCloskey, 2014; Burnet, 2011; Debusscher and Ansoms, 2013) have questioned the impact laws, policies and majority of women in the parliament, have on the current situation on women empowerment for the overall women population in the country.

5.0 Findings and Discussion

This chapter will introduce the relevant findings that emerged in the analysis of the interviews with farmers, extension service provider, communication officer and the researcher at RAB, as well as the secondary data. The chapter is divided to sub-chapters adopted from Birner's Best-fit framework (2009); Advisory Methods (Box H) in the respective areas; The performance of the EAS (Box I); Farm Households (Box J) and Gender roles (Community Aspects, Box D). The Advisory Methods sub-chapter aims to explain how the mobile phone was used to disseminate information and knowledge in Kirehe, Nyamagabe and from the ACIP. Secondly, the performance of the EAS is evaluated through the relevance of the

provided content, effectiveness and efficiency of the service. Further, the farm household sub-chapter is evaluated through examine farmers technological knowledge and their ability to demand information. The next sub-chapter concerns how gender roles influence the use of mobile phones in the EAS. Lastly, I will summarise my main findings.

5.1 Advisory Methods

This chapter presents box H in the best-fit framework (Figure 2), which is methods the extension service providers use to disseminate information and advice to farmers. The chapter consists of a presentation on how the extension service providers in Kirehe and Nyamagabe use the mobile phone in the EAS, and then a presentation of the service at the national level. Due to the scope of the thesis and the research questions, I will not discuss advisory methods such as the Twigire Muhinzi model. However, it has to be mentioned that the farmers and extension service providers reported that the main approach for learning was through Twigire Muhinzi. Further, this chapter will only consist of information on how the extension service providers used mobile phones, as I later will discuss how the farmers used the service.

5.1.1 Kirehe

Besides training and meetings, farmers and extension service providers in Kirehe reported that they communicated through mobile phones. Both the sector agronomist and the sector veterinary reported that they used the mobile phone to almost all tasks in their work, such as communicating with farmers, colleagues in other districts, researchers and staff working at RAB and MINAGRI. Both had been working in the district for approximately six years, and the mobile phone had always been a communication tool in their work. The sector agronomist and the veterinary had smartphones provided by the government, and they had no expenses due to the use of the mobile phone, as it was the district that paid the airtime of the phone. The sector agronomist reported that he mostly used the call function to communicate with farmers and that he never used the SMS function. The SMS function was never used because the information was communicated faster by calling. The sector agronomist used the mobile phone to inform farmers if there were new diseases in the area, time and date for meetings, the availability of equipment for the irrigation system and availability of seeds and fertilizer at the agro-dealer. This information was mostly given as a response to the farmers' demand, but it happened that the sector agronomist used it if he saw the importance of

disseminating the information. Concerning new diseases in the area, the sector agronomist would also give advice on how to avoid or treat the new disease.

As the smartphone had access to the internet, the extension service providers used WhatsApp to communicate with colleagues, RAB, MINAGRI and also with some farmers. The sector agronomist explained that the advantage of using WhatsApp was that they could send pictures explaining the problem the farmer was facing. The pictures often explained it better than talking on the phone, and they could forward the picture to colleagues in the WhatsApp groups. The sector agronomist reported that they had one WhatsApp group with all farmer representatives, secretary of the sector, agronomist and the leader of the cooperative. The leader of the farmers was able to suggest other farmers into the group, but the sector agronomist was the one to accept them or not.

The sector veterinary in Kirehe reported that they never scheduled meetings with farmers, so all his work with farmers was based on the calls he received. He received calls with questions about disease treatment, artificial insemination or general advice on livestock. He further reported that he could receive at least 14 calls per day during rainy season due to more cases of diseases. When he had too many farm visits, he would use WhatsApp to ask the private veterinary to help him. WhatsApp was also used to communicate with the private veterinary, the veterinary at local and district level and with a few farmers.
The extension service providers in Kirehe reported that they used the mobile phone as two-way communication between them and the farmers. However, the mobile phone was used differently in Nyamagabe.

5.1.2 Nyamagabe

The use of mobile phones in the EAS in Nyamagabe did not establish a strong link between the extension service provider and the farmers. The sector agronomist in Nyamagabe reported that he mainly communicated with the farmers in the district at meetings and training. Compared to the sector agronomist in Kirehe, he never used the mobile phone to call farmers directly. He called the president of the farmer group, and the president was responsible for making sure the other farmers received the information. The only time he called farmers directly was to make sure the farmer was home before the visit. The sector agronomist explained that farmers often called him during the preparation of the season to ask questions on fertilizer and seeds, and in the middle of the season if the farmers experienced diseases. If farmers called to ask questions about a disease, the sector agronomist would always visit the farmer to make sure he gave the right advice. If he didn’t recognize the

disease, he would take a picture and send it to different WhatsApp groups. The sector agronomist also used the WhatsApp group and the mobile phone to communicate with colleagues in other districts, RAB and MINAGRI. He also reported that even documents from MINAGRI were distributed through WhatsApp. However, he further explained that he did not use WhatsApp to communicate to farmers, as only a small number of farmers in the district had a smartphone.

5.1.3 The Agricultural Information and Communication Program (AICP)

The Agricultural Information and Communication Program (AICP) (previously Agricultural Information and Communication Centre (CICA)) were established by MINAGRI to ensure efficient communication flow in the agricultural sector (MINAGRI, RAB and NAEB) (MINAGRI, 2012:28). The aim of the program is to "regularly collect, produce, process, adapt, store, share and disseminate agricultural information" (MINAGRI, 2012:28). RAB, MINAGRI and NAEB provide AICP with technical input that the program further uses to produce content with agricultural information that is distributed throughout the country by using radio, TV, web and news outlets. The educative materials intend to educate farmers and extension service providers, as well as they train the local extension service providers. Beside the production of educative materials, ACIP also manages a call centre. The communication officer at ACIP reported that the telephone number to the call centre is promoted at all materials they produce and in media channels, such as the radio and TV. The call centre was developed to receive feedback and questions from farmers and other stakeholders in the agriculture sector. The communication officer reported that the call centre received all sorts of questions, but that the farmers were often linked with technical persons at RAB instead. If the call centre received a question they couldn't answer, they called the local RAB staff and asked him or her to call or visit the farmer. *"If an agent at the call centre can't answer the question, then he will forward it to the right person. We can answer general questions, but if they ask about the component of the fertilizer, we have to link the farmer to the technical person in RAB. Either we ask the technical person, or we connect them directly by giving the mobile number."*.

The communication officer reported that the call centre at the national level used to have a toll-free phone number farmers could call. During this period, they received many calls by farmers that didn't have any special problems. He said that *"Before when it was a toll-free number, people were not asking serious questions. They just wanted to make a call"*. However, they did not want to exclude farmers with limited airtime. *"We want to encourage*

farmers that tried to become a professional farmer. They have to get the help they need to become professional. We make sure all farmers that call, even if they are cut off because of limited airtime, receive information until they are satisfied.". He further explained that the cost of airtime had decreased and that farmers with limited airtime could "beep" them.

Beside the Twighire Muhnzi models and the agricultural content provided by AICP, mobile phones were mainly used to provide farmers with information that required fast response and short answers. The extension service providers reported that farmers still participated in the two Twighire Muhnzi advisory methods and that they received in-depth information at the meetings and training. Therefore, it seems like the mobile phone is used as a supplement and not a replacement of the existing advisory methods. The mobile phone was used as a two-way communication tool between the farmers and extension service providers, where the farmers demanded information. The next chapters will contain information on how the farmers used the service.

5.2 Performance

In this chapter, I will introduce the findings and discuss the performance of the EAS and the quality of the provided service (Box I). I will introduce findings from interviews, both farmers and extension service providers' perspective and then discuss it with existing literature. As Birner (2009) states, as a third party, there are challenges of measuring the quality of the given advice, because other factors influence its impact.

Indicators concerning the performance of the EAS are dependent on the goal of the service (Birner et al., 2009). Rwanda's strategy on the EAS is included in the National Agricultural Policy (NAP), where it highlights the importance of EAS to improve agricultural productivity (MINAGRI, 2018a). Rwanda's existing agriculture policies are aligned with the Malabo Declaration goals (The SDGs are integrated in the next development agenda: Vision 2050), with its mission "to ensure food and nutrition security of Rwandans by using modern agribusiness technologies, professionalizing farmers in terms of production, commercialisation of the outputs, and the creation of a competitive agriculture sector" (MINAGRI, 2018a:13). The strategy includes policy actions on how the EAS can contribute to improving the productivity by "Broaden the public extension services to include business orientation, nutrition, gender, and savings, using weather and climate information, integrated pest management and climate smart agriculture; Promote effective knowledge dissemination

and feedback mechanisms; Promoting private sector involvement in extension services; Upgrade institutional frameworks: enforcing a performance evaluation and incentive system to improve the level and accountability of the advisory services delivered" (MINAGRI, 2018a:24). In other words, the overall goal of the EAS in Rwanda is to ensure food security and reduce poverty by increasing the agricultural productivity by broadening the service, listen to farmers needs and response to the needs, including the private sector and ensure the service is accountable.

5.2.1 Content

All farmers in Kirehe and Nyamagabe reported that the use of mobile phone resulted in knowledge and information that met their needs. First, the farmers perceived the information as more helpful because the extension service providers had a connection to extensive knowledge through WhatsApp groups with RAB, MINAGRI and colleagues in other districts. This was also acknowledged by the extension service providers in both districts, reporting there was no longer an issue if they didn't know the answer on the farmers' question because they could easily get in contact with a person with the right knowledge. *"We have WhatsApp groups for RAB, MINAGRI and different forums depending on what people do. Like extension forums, irrigation forums, seeds, fertilizer. You will find these persons on these forums, but he is also in a big forum of RAB".* The use of mobile phones has therefore made it easier to receive and deliver accurate information that responds to the farmers' needs. One male farmer in Nyamagabe reported that before the use of mobile phones, he had to travel to the extension service providers office to ask the question. He further explained that he then risked not receiving an answer, either because the extension service provider was not present at the office or that he didn't have the right knowledge to answer the farmers' question. This is supported by Aker's (2011) suggestion that the use of mobile phones can help the research centres and extension service providers to connect in two-way communication, which in this case has benefited the farmers in Kirehe and Nyamagabe. Extension service providers are seen as the connecting link between research and farmers, and a strong link is beneficial for farmers (Anderson, 2007). Extension service providers are viewed as translators of information from research to farmers, and as conveys so the research receives information on the problem's farmers are facing (Anderson, 2007). These interactions are also described in the Agricultural Knowledge and Information System (AKIS) (Röling, 1990). The important factor in the AKIS is the inclusion of farmers (and other actors) to produce knowledge and support innovation (Röling, 1990:1). In this case, the farmers

received information that met their needs and reported that they were able to use the information, which might be crucial for productivity.

When discussing the content of given advice, literature (Aker, 2011; Nakasone et al., 2014) on the use of mobile phones in agriculture focus on market price, weather information and other short information. This is also one of the stated goals of the EAS in Rwanda. When talking to farmers in Kirehe and Nyamagabe, only one farmer reported that he used the mobile phone to get information on the weather. The oldest farmer (with the largest farm) in Nyamagabe said he dialled a number to get weather information on his mobile phone. He used the weather information to make decisions on when to sow and harvest. Because Kirehe is a drought-prone area, irrigation systems have been implemented. Two female farmers and three male farmers in Kirehe reported that they used the mobile phone to ask for the availability of the irrigation system. Concerning information on market price, farmers were asked if they used the mobile phone to receive market prices. All farmers, in both sites, reported that they received market price information at the meetings. One female farmer who cultivated sugar cane reported that the price was set, so she did not need price information. Literature states that the use of ICT solutions to provide information on the market price will make the farmers increase their income and in the long run increase their agricultural productivity (Nakasone et al., 2014). In 2010, MINAGRI and the Rwanda Information Technology Authority developed eSoko, a tool to increase the accessibility of market prices (Esoko, n,d). However, there is no information available on the number of eSoko users, and farmers in Kirehe and Nyamagabe reported that they did not use it due to lack of knowledge of the service. The ICT4RAG strategy includes a plan for eSoko+, which has the same description as the old eSoko. eSoko+ will also be developed with the aim to provide market price information, but there is no available information about the service, and it is probably not launched. As the EAS has the goal to make the agriculture sector more commercial, it is important to inform farmers on market prices so they can make competitive choices and increase their profit.

5.2.2 Effectiveness

The mobile phone was used to disseminate and receive information that could have an effective impact on agricultural production. During one agricultural season, different information is needed in the three stages of the cropping cycle; i) pre-cultivation, ii) crop cultivation and harvesting and iii) post-harvest (Zyl et al., 2014:4; MINAGRI, 2016:23). The same goes for livestock production, as diseases often occurred during the rainy season.

Availability and Selection of Seeds

During pre-cultivation, farmers used the mobile phone to receive information that helped them make decisions that could improve their production. The sector agronomists in both districts reported that they received most calls from farmers during the preparation of the season. All farmers in Kirehe said that they called the sector agronomist to get information on the availability of seeds and fertilizer at the local agro-dealer. One male farmer further explained that he often asked the sector agronomist on the recommended inputs, with the aim to increase the productivity. Some male farmers in Nyamagabe also used the mobile phone to get information on seeds, but several preferred to get the information in meetings so they could see the seeds.

Diseases

The use of mobile phones enabled farmers to receive an immediate response when facing crises, which could be crucial to the outcome. All farmers in both sites reported that they called the extension service provider if they experienced pests or diseases on their crops or livestock. They used the mobile phone to inform the veterinary or the agronomist about the problems they saw and to ask if they could visit the farm to see the problem. If the veterinary or the agronomist recognized the disease on the farmers' explanations, they would give advice on which medications they should get. The extension service providers reported that if they gave the advice on the phone, they would visit the farm to see if they were right about the disease or not, or to see if the medications helped. If they didn't recognize the disease on the phone, the extension staff had to visit the farm to see it themselves to make sure the problem was solved. The sector agronomists in both districts reported that they would most likely go to see the disease the same day as the farmer called. In Kirehe, the mobile phone was also used to inform the farmers of disease and pests' outbreaks, both from the agronomist and the veterinary. The extension service providers in Kirehe would then inform the farmers of what actions they could take to prevent transmission of the disease. Several farmers in both districts reported that access to this kind of information and the fast response was improved after the use of mobile phones. More timely information may lead to immediate response and treatment of the disease and can have a positive impact on the production of both crops and livestock. However, this only applies if they actually receive the information, which will be discussed later.

Access to a smartphone could provide both farmers and extension service providers with more precise information. Three male farmers, one in Nyamagabe and two in Kirehe owned a smartphone. The farmers in Kirehe with a smartphone reported that they used WhatsApp to send photographs to the extension service providers. Both extension service providers and the farmers explained that it was easier to see the symptoms of a disease or pests at photographs. *"I receive information from a WhatsApp group with other members that also have a smartphone. In the group there are several agronomists, progressed farmers, local leaders and some local farmers, we are 60 people in the WhatsApp group. The WhatsApp group is used to give information on pests and diseases. I can either send the group a picture or just a question, and I will receive an answer less than one hour later.",* the male farmer in Kirehe explained. Another male farmer in Kirehe that didn't hold a smartphone also said that the use of a smartphone would give them more detailed information with the possibility of taking photos. Only one young male farmer in Nyamagabe owned a smartphone, and he had never used WhatsApp to communicate with the extension service providers.

As smallholder farmers are more vulnerable to pest or disease outbreaks, early warning and treatment might be crucial for agricultural production (Harvey et al., 2014). A major disease outbreak will affect a large number of the population, as 80 % are engaged in the agricultural sector and its importance on the country's economy. Yields loss due to disease outbreaks is therefore a huge threat to food security and farmers income. Unfortunately, there is no available data on yield loss in Rwanda (ROR, 2011). However, aving pictures of diseases or pests on both crops and livestock contributes to the researchers "farm-level knowledge". Researchers can use the pictures and information to monitor diseases and develop a control system (Lynam, 2012).

5.2.3 Efficiency

With a poor extension to farmer ratio, the use of mobile phones increases the opportunity to reach more farmers. The extension service providers in Kirehe and Nyamagabe reported that they were able to help several farmers through a mobile phone, which was both cheaper and timelier. The sector agronomists in Nyamagabe reported that it was an advantage that they could stay anywhere when making calls and that they could even help farmers after working hours. All farmers interviewed also reported that the most positive effect of using the mobile phone was that they saved both money and time. They explained that the cost of a mobile phone had decreased in recent years, it was, therefore, cheaper for them to call than to go by a moto-taxi. Several farmers reported that before using mobile phones, they could

spend time and money travelling to seek information they did not get if, for example, if the extension staff were not present at the local office. This low-cost factor of using mobile phone is well established in the literature. Several authors (Aker, 2011; Aker et al., 2010; Courtois and Subervie, 2015) states that obtaining information by personal travel, costs in both money and the individual's time. The use of a mobile phone reduces the costs and therefore enable more farmers to access information (Aker, 2011). Literature (Aker, 2011; Cole and Fernando, 2012) states that this also applies to costs of the public EAS, which may result in increased geographical scope. Although the use of mobile phones may result in reduced costs and increased information dissemination, other financial barriers prevent extension service providers from reaching all farmers such as farmers access to a mobile phone, airtime and electricity.

The use of mobile phones made it easier for farmers to get in touch with the extension service providers, but the extension service providers had trouble getting in touch with the farmers. The sector agronomist in Kirehe explained how farmers with limited airtime would reach the extension service providers; *"There are three possibilities if a farmer doesn't have enough airtime. First, the farmer can beep me, and I will call him or her back immediately. Second, the farmer can call and ask me to call back. The third option is that the farmer goes to see the leader of the cell and use his phone because the leader of the cell's mobile phone is paid by the government".* One male farmer in Nyamagabe reported that they also could send an SMS to the extension service providers and tell them to call. All farmers reported that they never had problems getting in touch with the extension service providers and that they would always call the farmers back. However, the extension service providers reported that they often faced problems when reaching out to the farmers. The sector veterinary in Kirehe reported that he often experienced that farmers did not answer when he called. He further explained that he went to see farmers twice a week, where he planned to see farmers that were in the same area. He explained that *"When we are on our way to help him or here, I am calling for directions and they don't pick up the phone. Then I have to go back or to another farmer because I don't know which house they live in.".* He stated that this could be due to lack of network coverage in the villages or that the phone was switched off. Switched off phones was apparently an issue in Kirehe district. When a male farmer in Kirehe was demonstrating how he used his smartphone, I observed that his smartphone was switched off. Wyche and Steinfeld (2015) observed the same issue when they did a study on the use of mobile phones in Kenya. They experienced farmers with mobile phones switched off, low battery, or that their phone was at a charging kiosk. This may be the case in rural areas where

there is lack of electricity, so that rural users have limitations due to costs constraints, and therefore switch off their phone to "preserve the charge" (Wyche and Steinfeld, 2015). In 2017, 65% of all households in Rwanda did not have any form for electricity, and only 5.7% of the households living in isolated rural housing had access to electricity (NISR, 2018d). In both Southern and Eastern province, the main source of home lighting is batteries. By turning off the mobile phone to save power, farmers risk missing important and urgent information or visits by extension service providers. The veterinarian in Kirehe reported that he had many visits and that the time he spent looking for directions could be spent on another farmer. This may reduce the efficiency of the EAS due to the reach of farmers and time spent looking for directions.

Another challenge due to the reach of farmers was people without access to a mobile phone. 66,2% of the households in Kirehe own a mobile phone, and the percentage is lower in Nyamagabe with only 53,3% (NISR, 2018d). The sector agronomist in Nyamagabe mentioned that most families had at least one mobile phone, but that there were still farmers that did not own one. A review of the statistics shows that only 56.4 % of households living in isolated rural housing have access to mobile phones (NISR, 2018d). The sector agronomist in Kirehe said that *"One challenge with the use of mobile phones is that the poorest farmers don't have money to buy a mobile phone or airtime. Also, the oldest farmers don't have a mobile phone".* He further explained that the farmers without access to mobile phone had to participate in the meetings to receive the same information. However, when I asked the extension service providers how the farmers were informed on the time and date for meetings, the sector agronomist in Nyamagabe reported that he called the president of a farmer group, and the president had to inform the farmers which was mostly done through a mobile phone or to the neighbours in person. In Kirehe, the sector agronomist explained that the village had a plan for all meetings which he assumed everyone knew. If farmers age or financial status results in limited access to mobile phones, there is a reason to assume that not everyone receives the information on when the meetings were held. This may prevent them from attending the scheduled meetings and reduced access to the EAS, which affect both the efficiency and effectivity of the service. The implementation of mobile phones in the EAS is seen as a solution for creating a more efficient service (Aker et al., 2016). The use of mobile phones might result in more farmers reached, but findings show that they don't reach everyone, and possibly not those who need it the most. The problem that not everyone has equal access to the service due to lack of technology and the disparities it makes is often referred to as the digital divide (Kensinton, 2004). In this case, the digital divide concerns

people without or limited access to a mobile phone, and therefore limited access to EAS. The digital divide also applies to limitations in infrastructure such as network coverage and in this study, the lack of electricity. Even though the number of mobile phones has increased recent years, there is still 33% of households in Rwanda without a mobile phone, and the number is higher in the rural areas (NISR, 2018d). As seen in the digital divide theory, the digital divide can occur on multiple levels, between rural and urban populations and between poor and rich (WorldBank, 2016b).

Farmers with limited or no access to mobile phones might be excluded from the agricultural knowledge and information system. The transfer of technology model was criticized for only benefitting the progressive farmers that already had the resources and better conditions, and that an AKIS would be more inclusive for all farmers (Chambers, 1983; Röling, 1988). However, if farmers don't have access to mobile phones and therefore limited access to the EAS, they are most probably excluded from the AKIS. If rural farmers without access to mobile phone and EAS are excluded from AKIS, there is likely to assume that innovations that meet the rural farmers' needs are not developed. This is also stressed in Birner's framework, where it is stated that the performance of the EAS is influenced by farmers ability to exercise demand (Birner et al., 2009).

The main goal of the agriculture sector is to increase agricultural productivity and income, to fulfil their commitment to halve poverty and end hunger by 2025 (MINAGRI, 2018a). However, 39,1 % of the population in Rwanda is considered poor, and these are most likely the individuals with limited access to mobile phones (ref only 56.4% of households living in isolated rural housing have access to mobile phones). The country's development and poverty reduction strategy place emphasis on the EAS service and improved infrastructure to connect rural communities with relevant information. Since the population with less access to mobile phones lives in isolated rural housing, there is a need to ask a question of why they don't have access. If the reason is lack of money to buy a mobile phone, it is likely to assume that they have limited access to the EAS, as farmers reported that it was more expensive to visit the extension service providers at their office than by using the mobile phone to call. However, these are just assumptions as I were not able to interview farmers without access to a mobile phone, and there is a need to study this further.

5.3 Farm Households

This chapter will introduce findings and a discussion of the Farm Households (Box J) in the Best-fit Framework. As Birner et al. (2009) states, the farm households are key when looking at the impact of the EAS as one can see how the farmers use the service. Further, Birner et al. (2009) state the importance of farmers ability to "exercise voice and formulate demand". In other words, to improve agricultural production and increase the farmers' income, farmers need to exercise voice and demand information, so the service meets the farmers' needs. As the farmers use of the EAS is discussed in the above chapters, this chapter will discuss farmers capacities to use the mobile phone and to demand information.

5.3.1 Technological Knowledge

Farmers' capacity to use mobile phones varied due to age and knowledge on new devices. The oldest farmer in Nyamagabe reported that he lacked knowledge on the use of the mobile phone. The male farmer in Kirehe with a smartphone reported the same problem. He did not have any problems using the small phone, but the smartphone was more difficult to use. Lack of technical knowledge is seen as one social aspect of the digital divide and might be due to personal and positional inequalities such as age, sex, and level of education (Wei et al., 2011; Van Dijk, 2012). The oldest farmer probably had challenges using the mobile phone due to his age, as the younger people thought him how to use it. This was also reported by the sector agronomists in Kirehe and Nyamagabe as they said that they experienced that the oldest farmers had challenges using the mobile phone. Thy further reported that they did not provide farmers knowledge on how to use the mobile phone, as it was not their responsibility and that farmers thought it from friends and family. However, inequalities in technical knowledge might lead to inequalities of outcome from using the mobile phone (Wei et al., 2011). Lack of technical knowledge has been an issue with other implemented technological innovations. Smart Nkunganire System (SNS) is a supply chain system where farmers receive information on seeds, fertilizer and pesticides (RAB, n.d.b; Smart Nkunganire System, n.d). Rwanda Today reported that only a limited number of farmers used the system due to lack of technical skills and that farmers rather used the old Twigire Muhinzi approach (RwandaToday, 2019).

Extension service providers ability to cope with broader tasks, other than communicate messages to farmers, affect farmers ability to adopt innovations (Anderson, 2007). One of the goals in the NAP is to "broaden the public extension service to include business orientation,

nutrition, gender, and savings…" (MINAGRI, 2018a:24), and the ICT4RAG strategy states that ICT solutions should be included in field activities to promote the use of ICTs (MINAGRI, 2016). The importance of an increased number of individuals with technological skills is also stated in SDG number 4 (SD, n,d.a). Therefore, it should be a greater emphasis on increasing farmers capabilities to use the promoted ICTs to avoid the digital divide gap in technological knowledge. This is especially necessary for Rwanda, as they focus on becoming a high-tech country with a focus on the use of ICT's.

5.3.2 Ability to Demand Information

When looking at the Farm Household (Box J) in the framework, Birner et al. (2009) explain the importance of the farmers' ability to formulate demand. This is important as farmers need information about the challenges they are facing, and if they manage to demand this information, they will benefit more from the service. All male farmers reported that they mostly used the mobile phone to demand information. The extension service providers distributed their phone number to farmers at the end of all meetings and encouraged farmers to call if they faced any challenges or had questions. Rwanda has a decentralized governance structure which influences farmers ability to formulate demand (Birner et al., 2009). The communication officer explained that they worked to establish trust between the local agents and the farmers by providing the local staff with the necessary knowledge and increasing their capacity. As mentioned, farmers reported that they didn't face any problems reaching the extension service providers, which is also important when demanding information (Birner et al., 2009). The trust in local agents is well established as all farmers reported that they rather called the local extension service agents than the national call centre. How farmers demanded information was discussed in chapter 5.2.

5.4 Gender Roles

This chapter will discuss gender roles, which is an indicator in Community aspects in the Best-fit Framework. As seen in Birner et al. (2009) framework, Community aspects (Box D) are influencing the Performance (Box I), Farm Households (Box J) and Impact (Box K). Gender equality and women empowerment are seen as a key for agricultural productivity, ensuring food security and increase income (FAO, 2011; Sraboni et al., 2014). Different EAS approaches is criticized for the lack of focus on the gender perspective, and mobile phones are seen as a tool to close the gender gap due to its ability to disseminate information targeted to

women (Mbo'o-Tchouawo et al., 2014; Manfre and Nordehn, 2013). Gender equality is important in the agricultural sector in Rwanda as women are key in the agricultural economy.

The use of mobile phones is seen as a solution to close the gender gap in access to EAS, but the women farmers in Kirehe and Nyamagabe only indirectly benefited from it. During interviews in both Kirehe and Nyamagabe, women farmers reported that they used mobile phones to get information about agriculture and livestock. Further into the interviews, everyone explained that even though they had a mobile phone, they never used it themselves to communicate with the extension service providers. Previous research (Mbo'o-Tchouawo et al., 2014; Kansiime et al., 2019) have found that access and the use of mobile phones in the EAS is lower among women than men. A study on the use of mobile phones by smallholder farmers in Malawi shows that 9.5% of the women, compared to 37.5% of the men, stated that they called the extension officer (Steinfield et al., 2015). A similar finding was done by Blumenstock (2012) in a study on access and use of mobile phones in Rwanda. Blumenstock (2012) found that 27.2% of the men used their phone to get advice on farming, compared to 20.7% of the women. The same study found that 34.6% of the women had used the phone to find a doctor, compared to 29.3 % of the men (Blumenstock et al., 2012). Mbo'o-Tchouawo (2014) suggest the low number of women's access and use of ICTs is due to barriers such as literacy, control of mobile phones, low technological skills and socio-cultural factors.

Two women farmers in Kirehe and Nyamagabe reported that it was their husband or their oldest son who called the extension service providers. One woman in Kirehe told me that her son would make the call and forward the information. She said that; *"I have no husband. My son is the leader. (...) My son is in charge, but we share information with each other".* One woman in Nyamagabe explained she never used the mobile phone because she had a problem with her eyes, and another said it was because she was shy. The others explained it was because a woman cannot be in charge of the farm, and therefore the man (husband or son) had to make the call. With the country's high rank on the World Economic Forum's Gender Gap Index, higher than several western countries, Rwanda is often set as an example when it comes to gender equality. Rwanda has established gender equality in their development policies and strategies (Vision 2020), and legal frameworks are established to empower women in society (MIGEPROF, 2017). Although GoR has made commitments to achieve gender equality through the constitution, laws on land rights, gender-based violence, etc., socio-cultural factors and patriarchal attitudes still exist. In Rwanda's Gender Strategy, the government states that the country's socio-cultural perceptions and behaviours are still patriarchal (MIGEPROF, 2010). Patriarchy is defined as a "system of social structures, and

practices in which men dominate, oppress and exploit women" (Walby, 1989:214). As one women farmer in Kirehe reported, "the man is in charge and is therefore the leader at the farm". As stated in the theory chapter, women's ownership of assets is important for the bargaining power of the assets (Meinzen-Dick et al., 2014b). Men and women have had equal rights over their land properties since 2013, which have improved women's access to finance and control over productive resources (MIGEPROF, 2017). Nevertheless, the decision-making power of agricultural products and control of income is mainly for men (Mutimura et al., 2018; Malapit et al., 2014). It is therefore likely to assume that women empowerment and gender equality is yet to be implemented at individual, household and community level.

The implementation of gender equality and women empowerment at the household and community level might be crucial for women's ability to demand information. As seen in the best-fit framework, the household ability to demand information is influenced by the characteristics of the household, the community and characteristics of the advisory service (Birner et al., 2009). The socio-cultural perceptions and behaviours in Rwanda are still patriarchal (MIGEPROF, 2010), which influence women's ability to demand information. Ragasa (2014) states that a community's perception of women's role in agriculture might affect women's participation in the EAS. If women don't use the mobile phone to take part in the EAS, and the extension service providers are the link between farmers, research, markets in the AKIS, this might result in limited access to information on women's needs and therefore not help women improve their agricultural productivity. Meinzen-Dick also states the importance of including women in the AKIS, in order to increase research that meets the woman's needs and "ensure greater gender equity in the adoption of innovations" (Meinzen-Dick et al., 2014a:375). Meinzen-Dick et al. (2014a) also state the differences in roles in a farm household, where men often are responsible for the market-oriented production and women are in control of the production and processing of the family food. Although the tradition in Rwanda is that both men and women can own any type of livestock, there are some areas the ownership of livestock is based on gender (Mutimura et al., 2018). This might also affect the available information as men are the ones to demand information using the mobile phone.

Rwanda invests in ICTs for agricultural development, but lack strategies on how to include women farmers. Development and implementation of gender-responsive policies are important to gender equality in agricultural development (Ragasa, 2014; Quisumbing et al., 2014). The ICT4RAG strategy states that the use of ICTs is important to empower women,

but it does not state how they are going to do it. The word "women" appears only five times in the strategy document of 69 pages. Not having a strategy on how to target women in the use of ICTs in agriculture might lead to a higher gap in the digital divide between men and women.

If Rwanda is going to meet their goals on increased agricultural productivity, secure food security and increased incomes, there is a need to empower women at household and community level. As women play a key role in the agricultural sector, the country is dependent on women's productivity, as they now still remain in subsistence agriculture (Mutimura et al., 2018). If the use of ICTs is implemented to increase information dissemination, the service needs to make sure women also have access and benefit from the service. It is likely to assume that the use of mobile phones in extension and advisory service don't increase women's access to the service as they did not use the mobile phone themselves.

5.5 The use of mobile phones in extension and advisory service in Rwanda

The use of mobile phones in EAS have generally strengthened the service in relation to accessibility of the service, timeliness, two-way communication, being demand-driven and costs. However, certain groups do not benefit from the use of mobile phones in the EAS. Limited or no access to a mobile phone or its functions, lack of electricity, and traditional gender roles are contextual factors that have an impact on the benefits of using mobile phones in EAS.

5.5.1 Mobile Phones Strengthen EAS

Findings from this research indicate that overall, the use of mobile phones has strengthened the EAS. Farmers who owned a mobile phone experienced that they had better access to the extension service providers. The mobile phone reduced the costs and time for receiving or demanding information due to its ability to connect farmers and extension service providers regardless of time and place. This is supported with what has been acknowledged in the literature, due to the lower cost of mobile phones versus personal travel to receive information on agriculture (Aker, 2010; Anderson, 2007), and the expansion of information dissemination (Rajalahti, 2012; Aker and Mbiti, 2010). However, the mobile phone was mostly used to demand information.

It appears that the use of mobile phones as a tool in EAS has resulted in a more demand-driven service, which allows for two-way communication between farmers and

extension service providers, and involvement of other agricultural stakeholders. The use of mobile phones is perceived as a tool to demand information rather than a tool to disseminate information. In both districts, the mobile phone mostly used by farmers to demand information and by extension service providers to communicate this demand to other actors in the agricultural sector. This resulted in more timeliness information that had an impact on farmers' decisions. This fits the theory of Agricultural Knowledge and Information System, which states the importance of a two-way flow of knowledge between farmers and extension service providers in order to create innovations that meet the farmer needs and therefore increase the possibility of farmers implementing or developing the innovation (Röling, 1990). This is also stated in the best fit framework, as farmers ability to demand information that meets their needs is crucial in order to see an impact on the agricultural development (Birner et al., 2009).

As a result of my findings, I would argue that two-way communication, demand-driven, accessibility, timeliness information can be accommodated where mobile phones are used. This creates the opportunity to go beyond the old approach, where it is a one-way technology transfer. However, there is a need to place emphasis on certain groups of farmers that do not benefit from the use of mobile phones in EAS.

5.5.2 Mobile Phones, EAS and exclusion of certain groups

Although the use of mobile phones has strengthened the EAS regarding accessibility, relevance and being more demand-driven, not everyone benefited from it. As viewed in the best-fit framework, contextual factors influence the EAS, its performance, the immediate and intermediate outcomes (Birner et al., 2009). Contextual factors, such as poverty and age, were reported as reasons to lacked technical skills and limited access to a mobile phone. Poverty was stated as one reason why some farmers did not own a mobile phone, limited ability to buy airtime and to charge the phone due to lack of electricity. As the older farmers lack technological knowledge, this affects their use of the mobile phone. Additionally, Rwanda has earlier tried to implement mobile phone-based apps to improve access to market information, but it has been rejected due to lack of knowledge. This is supported by the first and second social aspect of the digital divide, the access divide and capability divide. The digital divide poses challenges in terms of who can access the service and not, and it seems like the most vulnerable are excluded in the digitalisation of the EAS. As Rwanda is aiming to become a high-tech country and to improve the agricultural sector by implementing ICTs, there is a need to bridge the digital divide in order to make it beneficial for everyone.

Besides the digital divide, gender roles at household and community level is also a contextual factor that challenges the use of mobile phones in the EAS. Throughout history, studies show that women tend to have less access to EAS compared to men, which results in gender inequalities in agriculture (Ragasa, 2014). In Rwanda, there is still a gap in the gender digital divide, and my findings show that gender roles at the household and community level are creating a hinder for women due to the use of mobile phones in EAS. As a result of a patriarchal society and traditional gender roles, women do not call the extension service providers, even if they own a mobile phone. The man in the family was the one communicating with the extension service providers through the mobile phone, as the man was in charge of the farm. Community aspects, in this case the patriarchal attitudes and traditional gender roles, influence women's ability to demand information. Women's lack of ability to demand information will also affect their use of the information they receive, as the information probably don't meet their needs. The knowledge and information are influenced by gender roles and the gender digital divide. As seen in the best fit framework, this will influence the performance of the EAS, the immediate and intermediate outcomes, which influence the broader development goals, such as the agricultural productivity, income and food security (Birner et al., 2009).

6.0 Conclusion

The purpose of this study is to assess the role of mobile phones in the extension and advisory service in Rwanda. The study assesses farmers and extension service providers experience on the use of mobile phones in relation to improved access to the service, the communication flow, time and costs. Additionally, it assesses the (lacked) benefits of mobile phone use in the EAS for women farmers and small-holder farmers.

My findings demonstrate that overall, the use of mobile phones strengthened the EAS by making it more accessible, timelier, demand-driven, improving the two-way communication, and reduced the cost of accessing the service. The benefits of using the mobile phone in the EAS has most likely an effect on the broader development goals such as improving agricultural productivity and income, as well as ensuring food security. However, these benefits appear only to affect farmers with access to a mobile phone. Due to the digital divide and gender inequalities, women and (probably) the poor do not benefit from the use of mobile phones in the EAS. Access to a mobile phone, electricity to charge the phone and

knowledge on how to use the device are factors for the digital divide, as well as traditional gender roles that leave the men in the household to communicate with the extension service providers. In order to make the use of mobile phones in EAS beneficial to everyone, there is a need to bridge the digital divide and empower women at community and household level. If the digital divide is bridged, and women are empowered at household and community level, the use of mobile phones in the EAS in Rwanda will most likely improve all farmers' access to knowledge that meet their needs. It is likely to assume that improved access to knowledge that meets the farmers' needs have a positive impact on agricultural production, income and food security.

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