DIGITAL TOOLS AND SMALLHOLDER AGRICULTURE: THE ROLE OF ICT-ENABLED EXTENSION SERVICES IN RURAL SMALLHOLDER FARMING IN NORTHERN GHANA

A Research Paper presented by:

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(GHANA)

in partial fulfilment of the requirements for obtaining the degree of

MASTER OF ARTS IN DEVELOPMENT STUDIES

Major:

AGRARIAN, FOOD AND ENVIRONMENTAL STUDIES

(AFES)

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December 2018

Disclaimer:

This document represents part of the author's study programme while at the International Institute of Social Studies. The views stated therein are those of the author and not necessarily those of the Institute.

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Contents

List of Tables

List of Figures

List of Appendices

List of Maps

List of Acronyms

ISS - International Institute of Social Studies
ICT - Information and Communication Technologies
ITU - International Telecommunication Union
ICT4D - ICT for Development
ADVANCE - Agricultural Development and Value Chain Enhancement
USAID - United States Agency for International Development
ACDI/VOCA – Agricultural Cooperative Development International/ Volunteers in Overseas Cooperative Assistance
ACDEP - Association of Church-based Development
OBs – Out-grower Businesses
OGs – Out Growers
NFs - Nucleus Farmers
GAPs – Good Agricultural Practices
GLSS – Ghana Living Standards Survey
BSO – Business Service Officer
BOP - Bottom of the Pyramid
PCs - Personal Computers
NGOs - Non-Governmental organizations
SMS - Short Message Services
D4D - Data for Development
WTP - Willingness to Pay
GPS – Geographic Positioning System
MDGs - Millennium Development Goals
WSIS - World Summits on the Information Society
ANT - Actor-network Theory
UN - Unite Nations
FBO – Farmer Based Organizations
IFAD – International Fund for Agricultural Development
FAO – Food and Agriculture Organisation
DFS – Digital Financial Service
VSLA - Village Savings and Loans Association

Acknowledgement

I wish to express my gratitude to all persons who have contributed in diverse ways to the successful completion of this academic document. My initial gratitude goes to my creator (God) for granting me life, health and the sense of commitment to go through this academic endeavor. I wish to also thank my supervisor Dr. Oane Visser and second reader, Dr. Tsegaye Moredo Shegro for providing me with the required technical expertise and guidance throughout this study. God richly bless you all. I would not be exhaustive without appreciating friends and family like Mr Yussif Abdul Rauf, Mr Yakubu Yoyibu, and Mr Mohammed Yushawu who in diverse ways have either encouraged me or assisted in many ways during this study.

Dedication

I wish to dedicate this academic document to my lovely wife Suweiba and daughter Emaan, who have been very supportive during this entire period.

Abstract

This study was conducted on ICTs and smallholder farming, assessed the accessibility, extent of use, challenges as well as potential effects of information communication technologies (ICTs) on smallholder agriculture in northern Ghana. This assessment was done considering the age, gender, farm size and literacy levels of smallholder farmers. Based on a survey and some additional interviews, the study found that among the various types of ICT services provided in the ADVANCE II project, the price information and market information options were the least used by farmers. It also found that access to, and use of mobile phone was very high among farmers in the project. On the extent of usage or application of the information delivered to them via mobile phones, nearly half (48%) of farmers indicated that they always apply the information in their farming process with males dominating in this category. Young people were the dominant in the use of the ICTs within the study area as about three-quarters (74%) of respondents were within the age category of 20-39 years. Also in the category of farmers with larger farm size 4 acres or above, it was found to be predominantly males. In terms of the challenges that confront farmers in the use of the ICT services, the prominent ones include: difficulty in using phones; loss of information when call is missed; system do not allowing for interaction or feedback; low literacy levels of farmers; shorter forecast period (48 hours) as well as information delivered as call rather than a voice SMS. These challenges can be categorized in to two main ones, namely: low capacity /skills of farmers and weaknesses in the ICT system or package as an intervention.

Relevance to Development Studies

The research contribute to the search for alternatives to enhance productivity of smallholder farmers in Ghana. In essence, the outcome of the study will facilitate better understanding among academics and development actors who operate in the crop production sector particularly in e-agriculture. In addition, the study findings will be a source of information that will further contribute to body of knowledge on smallholder farmers' use and adoption of digital technologies in their farming activities. Finally, the thesis report is significant to the extent that it serves as a partial requirement for award of a Master of Arts degree in Development studies. Though there is some research conducted around the area of ICTs in agriculture, this study is among the few in Ghana that investigates smallholder farming and use of digital technologies for weather forecasting especially the northern part of the country. The study will therefore contribute to knowledge as such.

Keywords

Digital tool, ICT-enabled Services, Smallholder agriculture, Northern Ghana

Chapter 1 : Introduction

1.0. Background to the study

According to Aker et al., (2016) 75% of the rural poor – for whom agriculture plays a significant role - survives on less than US$1 a day (Aker et al., 2016). This notwithstanding, rural smallholder farmers face a lot of challenges including access to physical infrastructure and financial services. These challenges according to them, in turn, limits farmers' ability to make decisions on production, harvesting and marketing (ibid). The explosive increase in coverage and adoption of information communications technologies (ICTs), particularly mobile phones over the last two decades (Duncombe 2014) is, therefore, encouraging giving the challenges faced by rural smallholder farmers. The spread of digital technologies especially mobile phones comes with new opportunities for households in rural settings to achieve a varied set of development goals such as; access to information, markets and financial services (Aker et al., 2016) which are key in ensuring an improved rural socioeconomic life supported by agriculture. The International Telecommunication Union (ITU) cited in Duncombe (2014) points out that even the poorest countries have extended telecommunication service coverage to its rural poor with the help of mobile cellular technology to support livelihoods through agricultural extension, information and marketing. Within the past decade several public and private initiatives in ICT for agriculture have been developed and rolled out, with over 140 of them deployed worldwide in 2015 according to Aker et al., (2016). However, studies on the impact of these initiatives on agriculture are 'mixed' with suggestions that they are successful only to the extent that they are targeted at a key information need -that is where there are information asymmetries (Aker et al., 2016). Although these studies have shown an improvement in farmer knowledge attributable to ICTs in agriculture initiatives, "… this has not necessarily translated into higher yields, output prices or profits" (Aker et al. 2016:36).

Poor people in the global south are at the receiving end of most problems including climate change, conflict, disease and resource depletion (Heeks 2009: 2). It is also identified that the interests of both global North and South are the reason for the '4D' part ICT for Development (ICT4D) framework arguing that what affects the poor today could have serious future consequences on the rich, hence an improvement on the poverty situation of at the bottom of the pyramid (BOP) will have a positive economic impact on the rich as they will

consume more of the products and services from the rich and industrialized countries creating a 'win-win' scenario for all (Heeks, 2009: 2). In his view, the reason for the 'ICT' part of the ICT4D is that economic, social and political issues are anticipated to be digital in nature in the 21st century, hence the need to take ICT serious in order to avoid exclusion of some category of people (Ibid). In most African economies, agriculture remains the largest sector hence the application of ICT to that sector offers huge opportunities for economic growth as well as the alleviation of poverty within the continent (Van Zyl, et al., 2012). To ensure the survival of individuals, families and nations at large, issues of food security, therefore, need to be given serious attention. Yet, the agricultural sector in Africa has over the past four decades seen a declining trend, with poor farmers getting poorer according to them (Ibid). Agriculture in Africa just like any other sector, generally suffers from many setbacks including: low investment (particularly in rural settings); lack of access to markets; high cost of production and transportation; gender-based variation/unequal access to assets and services among others as identified by Van Zyl et al. (2012). They point out that African agriculture is largely 'traditional,' 'rain-fed' and predominantly smallholders, with challenges such as low productivity, poor access to critical information, lack of market facilitation and inadequate financial intermediation services (Van Zyl et al., 2012: 3).

With smallholder farmers worldwide numbering close to a billion according to Asenso-Okyere and Mekonnen, (2012), there is the urgent need for adequate extension services in the form of information, advice and technology for these farmers in other to support and empower them. Mobile telephony, community radio programs, information kiosks, farmer call centres, innovative television and video shows etc. are some of the ways ICT can be used to promote agricultural transformation according to Asenso-Okyere and Mekonnen, (2012). Embedded within ICT-enabled agricultural extension in their view is the potential of empowering farming communities (Ibid). ICTs can be good tools through which agricultural extension can reach out to a large number of farmers if properly harnessed. With rising availability and usage of ICT devices such as mobile phones, tablets, personal computers and radio, ICT can potentially play a very vital role in addressing some of these challenges of agriculture in Africa by bridging critical knowledge gaps (Van Zyl, et al., 2012).

Due to the critical role digital technologies play in agriculture, especially smallholder agriculture, there has been increased attention in that industry geared towards harnessing the potentials therein to ensure that the agriculture sector, particularly in developing countries, is improved. To this end, there has been the emergence of innovative approaches to agricultural extension services across various parts of the world including Ghana.

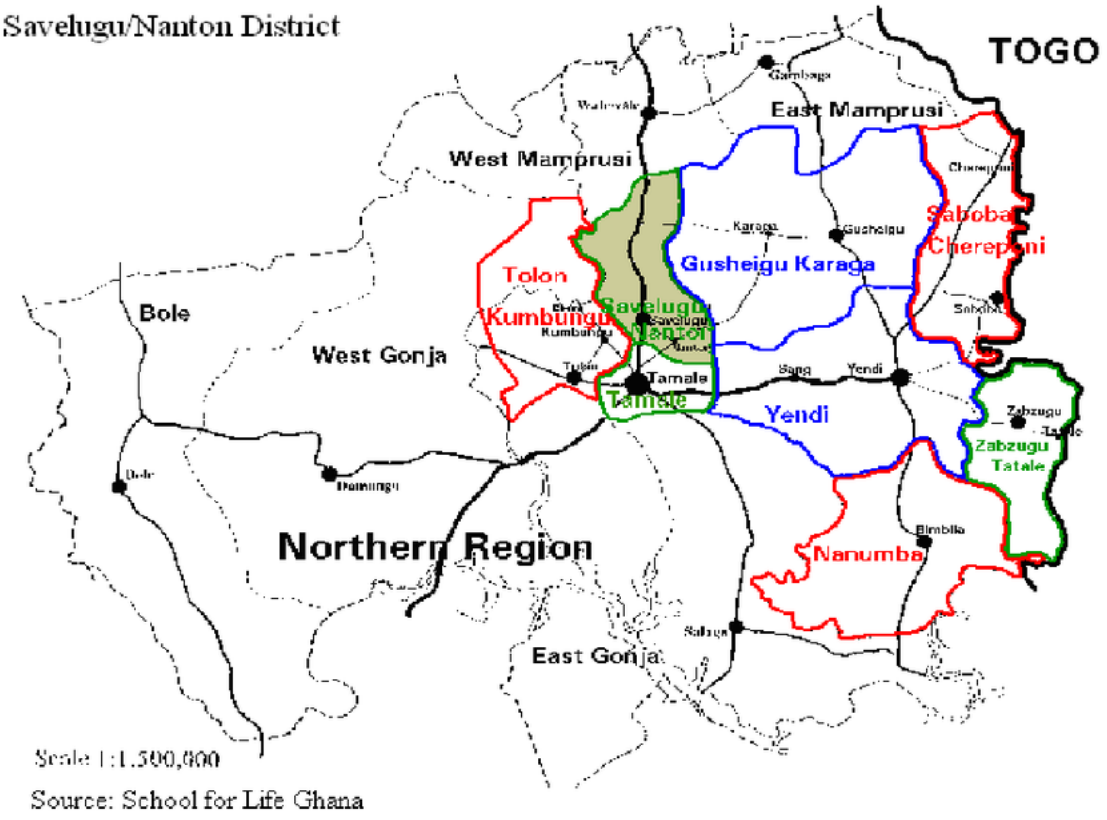
1.1. Study Area

The study was conducted in two districts of the Northern Region, namely Savelugu-Nantong Municipality and Tamale Metropolis. The two districts were selected first of all because of the presence of the ADVANCE II project in the districts. A community was selected from each of the two districts for the study. One community- Gushie – in the Savelugu-Nantong Municipality, is located on the fringes of the district capital, Savelugu, about 20km away, and on the main Tamale to Bolgatanga road. It, therefore, has some characteristics of both urban as well as rural communities. The second community- Labariga – which is about 38km away from Tamale, the capital city, is also considered by many as a farming community due to its location and poor accessibility to certain basic social amenities. Also, the major road to the Labariga community is not asphalted making it difficult to travel on particularly during the peak of the rainy season.

Svelugu-Nanton municipality is a creation of the former Western Dagomba District Council by a law in 1988 (GSS 2014). It is located north of the Northern region and share boundaries with Karaga, East Mamprusi, Tamale Metropolis, and Kumbungu districts. The district which is predominantly occupied by Dagombas, has a total population according to the 2010 Population and Housing Census of about 139238, with an estimated land area of 2022.6 square kilometres. It has a rainfall pattern that is enough to support a single season of farming, with a maximum temperature of 34 degrees Celsius. The vegetative cover of the area is good for livestock farming and the cultivation of crops such as maize, sorghum, rice, groundnuts, yam cassava and cowpea (GSS 2014).

The Tamale metropolis on the other hand which shares similar climatic, vegetative and natural resource characteristics, has a population of about 233,252 according to the 2010 Population and Housing Census (GSS 2010). It is located in the centre of the region sharing boundaries with the Savelugu-Nanton, Mion, East Gonja, and Sagnarigu districts or the Northern region. It has an estimated land size of 646.9018 square kilometres (GSS 2010).

Figure 1: Map of Northern Region displaying Tamale Metro and Savelugu-Nanton Districts where the study was carried out.



Source:https://www.researchgate.net/figure/Map-of-Savelugu-Nanton-District_fig2_238115150

1.2. Brief background of ADVANCE II

The Agricultural Development and Value Chain Enhancement II (ADVANCE II) project under Feed the Future, **(is a**) the US Government Global Hunger and Food Security Initiative. It is a four year USAID funded project targeted at improving livelihoods of smallholder farmers by enhancing their productivity in rice, maize and soya value chains. ADVANCE II seeks to achieve three main objectives; an increase in productivity, an increase in incomes as well as improvement of food security of smallholder farmers within the selected regions in Ghana. The project is implemented by ACDI/VOCA (an international NGO based in Washington) in partnership with Technoserve, the Association of Church-based Development NGOs (ACDEP), and a private consultancy firm, PAB Consult. The Grameen Foundation also partnered with the ADVANCE II project to deliver training and support to OBs and their field agents on a tablet-based application, "Smartext" that will enable them to provide interactive extension service to smallholder farmers under

them. This was specifically targeted at training farmers on good agricultural practices (GAPs).

Feed the Future in Ghana is investing more in the Northern, Upper East and Upper West regions because of the incidence of poverty in those part of the country. According to the Ghana Living Standards Survey round 6 (GLSS6), the incidence of poverty stands at 44.2%, 45.9% and 69.4% respectively for the Northern, Upper East and Upper West regions.

1.2.1. Out-grower Businesses (OBs)

The ADVANCE II project operates using an out-grower business (OB) model which seeks to promote commercially driven linkages between actors within the value chain of smallholders at both the input and output sides. These OBs connect service providers with stallholders farmers (who under the project are also referred to as out growers- OGs), or serve as service providers themselves, rendering services such as tractor services (ploughing), short-term financing for inputs, post-harvest shelling and basic extension services. The aim is to enhance and build their skill and capacity to help smallholder farmers to increase their productivity while they (OBs) increase their profits and ultimately promote the business side of farming (Brand. 2017). The OBs who could be farmers and business operators in the agribusiness sector,

These farmers and/or businesses in the agri-food value chain who must have an existing business relationship with smallholder farmers are identified and supported by way of logistics, training/capacity building to equip them to support more smallholder farmers within their reach.

Out-grower businesses (OBs) previously known in the ADVANCE model as nucleus farmers (NFs), are often farmers and farm businesses who are selected based on their capacity to deliver some specific services for smallholder farmers within their reach. Such individual or businesses according to the criteria set for selection as indicated by the field staff of ADVANCE II must have a farm size of at least 12 acres and should be rendering at least one or more of services such as ploughing, spraying, combine harvesting etc. It may also include the distribution of certified seeds, fertilizer and other inputs to smallholder farmers on credit basis as well as short-term financing. These farmers and/or businesses in the agri-food value chain who must have an existing business relationship with smallholder farmers are identified and supported by way of logistics, training/capacity building to equip them to support more smallholder farmers within their reach. Farmers are required to pay back these facilities after harvest using their farm produce and based on agreed terms. The

criteria for inclusion of smallholder farmers is based on the capacity of the OB to reach out to the farmers with these services. According the Business Service Officer (BSO) of ACDI/VOCA, men and women smallholders are given equal chances of been selected on to the project, although in his view there are more men than women in the project probably due to issues of availability of agricultural land for women within the regions where the project is implemented. The OBs are made to select a literate worker who is trained as a field extension agent to assist farmers under his/her OB according to the BSO.

Some of the logistical support given to OBs include tractors, combine harvesters, and motorbikes (for agents field monitoring). The OBs are made to identify the type of logistics they need to be able to expand their services to more farmers in the various farming communities within their reach. Upon a satisfactory report on the various due diligence checks about the OB's operations and capacity, the farmer or business operator (in this case OB) is asked to make a commitment of 30% of the cost of the particular equipment, whiles the project pays for the remaining 70%. This is, however, done under the strict condition that, the OB is required to serve all the farmers registered under him on credit bases payable only after harvest and on agreed terms.

1.3. Problem Statement

The role of digital technologies in agriculture, especially smallholder farming has gained increased attention in Ghana. Over the past decades, actors in the agriculture sector have recognized digital technologies as a means that can be used to improve agriculture extension especially to smallholder farmers who require expert services to enhance their production and livelihoods. In line with that, there has been the emergence of interventions on the use of digital technologies for agriculture extension service delivery in the Northern Region of Ghana. Some of these local corporate organizations are into the provision of different services within the broader spectrum of ICT-enabled agricultural extension and market services. The digital service providers in Ghana include; Esoko, Farmerline, Ignitia, Votobobile among others. In collaboration with telecommunication companies and sometimes Non-Governmental organizations (NGOs), these ICT companies deliver information on weather alerts, prices, crop advice, market access and financial services. These services are delivered to farmers on their mobile phones via various media including Short Message Services (SMS), Voice/audio and video messages. Others include innovative radio and television programs where farmers can listen and call in to ask questions and share their problems and experiences with experts.

Stone (2011), in a case study of the e-agriculture project (e-Sangu) in Hyderabad, India, argue that the eulogy for such projects is reflective of the vested interests of various actors

in e-agriculture that goes beyond reality. He found that the project which was designed to link farmers to expert advice using ICT was premised on the belief that lack of skilled knowledge and information was to blame for the agrarian distress which led to cases of suicide in India. Rather than delivering on the main reason for its existence as was stated at its inception, e-Sangu became agents for the "commodification of agricultural information" (Stone 2011: 764).

Mann, (2018) writing on the political economy of Big Data revolution in development points out that many projects in collaboration with organization based in Africa are engaged in extracting data from farmers in Africa for purposes of expert analysis in advance countries, with the justification that is used for humanitarian purposes (2018: 3). This concentration on humanitarian development rather than economic development according to Mann (2018) is an emerging governance structure which is carved in line with the interests of advanced counties. Laura Mann notes that, "the poor have been treated as beneficiaries, rather than as potential economic producers" (Mann 2018: 7). These cases raises concerns about the role of such projects that rides on the back of employment and livelihoods improvement through e-agriculture in developing economies including Ghana. With most of these projects in Ghana being funded by donors from the advanced countries, there is a potential of similar motivations of actors with vested 'interests' and agents of information commodification as Stone (2011) puts it, the emission of data in the 'Big Data' revolution disguised in Data for Development (D4D) discussions. There is, however, not very much done in terms of research on the area of digital technologies and rural smallholder agriculture in the wake of these digital innovations for agriculture extension services that are gaining currency in Ghana. The need for studies on the use, appropriateness and diffusion of these technologies becomes imperative. This gap in research evidence on the role of ICT-enabled extension services in rural smallholder farming in Northern Ghana underscored this study.

1.4. Research Objectives

This section presents the objectives of the study. In order to remain focus to the study problem, the following objectives were set out as guide upon which data is generated for the study.

1 To find out the level accessibility of the digital technologies to smallholder farmers.

2 To assess the extent of use/application of digital technologies/ICTs by smallholder farmers across age, gender, farm size and literacy divides.

3 To identify challenges faced by smallholder farmers in the use/application of digital technologies/ICTs.

4 To assess the potential effects of digital technologies/ICTs services on smallholder farming in terms of performance and independence.

1.5. Research Questions

In order to focus on the problem of the study, the main research question bellow was used to investigate the problem.

1.5.1. Main Research question

How accessible are digital technologies/ICTs to various groups of farmers, and what are the effects on performance and independence?

1.5.2. Sub-questions

To answer the broad question above, the following sub-questions were asked in order to ascertain appropriate responses.

1 How accessible are the digital technologies/ICTs to smallholder farmers?
2 To what extent are digital technologies/ICTs in agriculture applied by various smallholder farmers across age, gender, farm size and literacy divides?
3 What are the challenges facing smallholder farmers in the use of digital technologies?
4 What are the potential effects of digital technologies on Smallholder farming in terms of performance (productivity) and independence?

1.6. Organization of the study

Chapter one contains a general introduction and background to the research, chapter two broadly contains the literature review. Chapter three will be devoted to the analytical framework of the study as well as in-depth discussions on the methodology for data collection and analysis. Chapter four is reserved for the presentations of discussions of results and findings. Chapter five is the conclusions of the study.

Chapter 2. Theoretical/Conceptual Framework

2.0. Introduction

This chapter presents the reviewed literature on digital technologies and smallholder farming. The relevance of the literature review takes stock of existing information on the subject matter and to establish what others have written on the subject matter. The review also reveals the extent of research around the digital technologies and smallholder farming. It addresses digital technologies as tools for agriculture extension. It covers issues such as; types of technologies used by smallholder farmers, accessibility of such technologies, effects of the technologies, smallholder farmers' perceptions about the technologies, and challenges facing smallholder farmers in the use or application of such technologies and other relevant literature in the area of digital technologies and agriculture. Some of the theories and concepts to engage in this study include; ICT for development (ICT4D), agricultural treadmills farmer-expert relations, precision/smart/digital farming as well as youth and gender studies. These theories and concepts are relevant to the study because they help in drawing attention to the alternative side of the over 'romanticized' views about new technologies in agriculture which obscure the harsh realities about them. This then leads to the discussions of the way forward to these realities

2.1. Conceptualizing Digital technologies and smallholder farming

As part of the review of relevant information, the study gleaned some knowledge on the types of digital technologies used by the smallholder farmers. The intent is to identify the types of digital technologies and to subsequently assess smallholder farmers' use and adoption of such technologies. A World Bank Group study found that digital technologies are capable of overcoming information problems that serves as barrier market access for many small-scale farmers, improves knowledge, and provide novel ways for enhancing agricultural supply chain management (Deichmann et al. 2016). According to them digital technologies are increasingly adopted as innovative ways of enhancing agriculture production across the world especially the developing economies of Africa. They also established that digital technologies are not all inclusive panacea to agriculture challenges and has recognized the persistent challenges of digital technologies and how issues of access and sustainability of such facilities remains a challenge especially in developing countries. They equally stressed

the need for ICT policies and broader regulatory environment of countries to be strengthened to enhance impact on agriculture development using digital technologies (Deichmann et al., 2016). In a research on ICT for agriculture in Africa, argued that growing knowledge and access to digital technologies has a potential for enhancing agriculture development and mitigating instances of poverty. They further notes the persistent constraints that hold back most developing countries in particular from taking advantage of the available opportunities to cause positive changes in the production systems using ICT. These constraints includes; under-investment, low access to markets and unfair market conditions, poor access to advanced technologies, inadequate infrastructure, high cost of production and transportion, gender asymmetry in access to assets and services, conflicts, natural disasters, deforestation, environmental degradation and loss of biodiversity (Van Zyl et al., 2012).

In terms of ICT infrastructure, Ghana in 2001 was one of the earliest African countries to effect reforms of her ICT sector particularly the legal and regulatory frameworks. This move according to Frempong and Atubra, (2001) was to support and create enabling infrastructure and legal frames for growth and development of rural areas through ICT. Prior to this move by Ghana, the telecommunication sector was liberalized by the government of Ghana to enable the private sector participate effectively in the services provision, access, and coverage and also to cause value addition to services and consumption of state of advance technology in the country (Frempong and Atubra 2001). In a related study, conducted by Alemna and Sam, (2006), it is indicated that the use of ICT for rural development in Ghana is a great potential and highly feasible because, Ghana has an ICT policy with governments' commitment to support ICT programmes as means of rural development. The study however recognized the need for best approaches of implementation of technologies to impact the lives of people. As part of review of ICT for agricultural extension in developing countries, the failure of formal systems of extension by agricultural institutions across most parts of the world was recognized and also noted the emergence of interventions piloted in many countries. The review also noted that the ICT-based agricultural extension risks becoming unsustainable, due to limited impact on knowledge, adoption and welfare of poor households. For this reason, pilot programs need to be assessed using rigorous impact evaluations, which not only assess the causal impact, but also its mechanisms; determine whether such approaches are complements or substitutes for traditional extension; identify the types of information which are best suited for these programs; ascertain the demand for such services and hence their potential sustainability; and their cost effectiveness (Aker 2010). In another study that explored the possibilities and limita-

tions of digital technologies and big data in agriculture, Visser and Sippel (unpublished), emphasizes the trends and increasing scale of corporatization supported by the capital intensive nature of digital technologies in agriculture. They raise critical concerns relating to "principles, values and power structure" that shapes how food is produced in the 21st century. They also point out limitations of technology as well as issues of "data ownership and privacy" as some of the critical concerns regarding digitalization (Visser and Sippel, unpublished: 2). Also of importance to them is what they describe as "unintended consequences" that could potentially lead to a worsening of the inequalities that already exist within the agri-food system (Ibid). They argue based Crow and Longford, (2000) view on digital restructuring, that new technologies are 'ambivalent' as they seek to illuminate the limitations, risks and potential opportunities therein in the upsurge of smart farming technologies and big data (Visser and Sippel, Unpublished: 4). They add that techno-economic structures of digital farming have not yet crystallized and that there is an urgent need to study the rise of digital farming including its risks (Ibid).

Mann (2018) points out that data will soon become a powerful tool in economic governance, explaining that, as economies continue to improve their digitalization drive, "data will increasingly become a source of power in economic governance" (Mann 2018: 28). According to her, data for development (D4D) projects in their quest to deliver experts solutions to current development challenges, also generate data of huge commercial value which can be a useful potential for future bureaucratic control and economic power (Ibid). As stated by Murphy and Carmody (2015) in Mann (2018), there is a 'double movement' of profits, to producers and global corporations resulting from digital technologies. This could be the reason big corporations (like Facebook, IBM, Google etc.) are putting in place infrastructure and lobbying African governments for regulatory regimes that will enhance their extraction of maximum profits and strategic advantage (Mann 2018: 28-29). It could also be the reason according to Mann (2018), for the design of mobile tools for farmers by agribusinesses like Monsanto and Syngenta aimed at collecting data about markets and distribution chains (2018). These actions of multinational corporations are usually disguised in the form of humanitarian services and hence seek to encourage emissions, personalization and centralization of data. Laura Mann call for the need to shift focus of D4D from humanitarian services towards economic development, taking into cognizance the "revenue, knowledge and power" that African economies stand to gain from this move (Mann 2018: 3). Stone (2011) in the e-Sangu project, concludes that agricultural skilling in rural communities of India is a 'sociocultural process' where farmers see invention and adoption of

scientific agricultural knowledge as an integral part of everyday productive activities and 'sociocultural' behaviors (Stone 2011: 759-760). The project which was designed to help cotton farmers by linking them not only to the internet but also to agricultural experts who would "tell them how to farm" (Stone 2011: 762). Projects like e-Sangu often serve the interests of various actors and hence has a hyped enthusiasm regarding their impacts (Stone 2011). The complex mix of science and culture as well as the undeserved hype attached to new technologies are clear from the above. It also shows the role of unequal power relations in the agri-food industry.

In Ghana, a study by Palloni et al., (2018) in an assessment of farmers' willingness to pay for digital agriculture and nutrition services in the country found that, farmers were willing to pay a maximum of three Ghana Cedis for digital services monthly. It also found that farmers' willingness to pay (WTP) for digital services is high at low prices, and reduces as price goes up. According to them, however, there is further indication that farmers are more likely to abandon usage of the services because of the service fees (Ibid), which is a critical factor in discussing issues of sustainability. A study by Gwaka (2017) revealed that digital technologies have affordances which can be exploited to contribute towards the sustainability of the livestock system. However, there is the need for the presence of supporting institutions and improvement of digital infrastructure. These findings confirm the need for context based studies on digital technologies. In some African countries including Ghana, smallholder farmers can sign up to receive a package of weekly advisory services. This typically consists of current market prices, matching bids and offers, weather forecasts, agricultural tips. In other countries, advice may be sent by voice messages with live call center of agricultural experts available to complement data alerts with voice support (World Bank Group 2012). A study by Masuka et al., (2016) revealed that out of a survey of 131 farmers in Svosve-Wenimbi, Marondera district of Mashonaland East Province in Zimbabwe, it was established that there is high literacy and mobile phone use of 95.32% and 94.45% respectively. The study also found that 16% are already accessing advisory services over mobile phone with another 51.1% signed on to various mobile phone services including accessing market information on inputs and produce, advisory services, weather data, mobile phone money transfer for transaction and crop insurance. By using mobile phones farmers made informed decisions and saved time and transport cost (Masuka et al. 2016). The study therefore largely suggest that mobile phone-enhanced ICTs can promote better production, marketing, food security and livelihoods and more farmers may adopt the technology. A study conducted in rural Mozambique on an assessment of ICT use by

smallholder farmers revealed that characteristics of ICT tools influences the level of diffusion of that technology, and that mobile phone use was widely adopted by rural farmers (Freeman and Mubichi 2017). In view of the literature gleaned above, it is clear that ICTs have received recognition as means through which agricultural production could be enhanced. Also, ICT for farming is a contemporary alternative approach increasingly adopted to provide extension in particularly in developing countries including Ghana.

2.2. Theories and Concepts used

The theories and concepts that will be used in this study include smart/digital//precision agriculture; ICT4D; farmer-expert relations; agricultural treadmills; as well as youth and women studies in agriculture. These are relevant to the study because the help in understanding the nuances involved in digital agriculture.

2.2.1. Precision Farming/Smart Farming

Digital technology in agriculture was introduced around the 1980s when personal computers and geographic positioning system (GPS) were first introduced (Visser and Sippel unpublished). They argue however that "precision agriculture" has different meanings depending on the period of time concerned, since decisions such us which part of a farmland is good for growing what particular crop, existed long ago (Visser and Sippel, unpublished). The terms smart farming, digital agriculture and precision agriculture are often used interchangeably to mean the same, even though there is some difference. According to Zhang and Kovacs, (2012) precision agriculture is

> the application of geospatial techniques and sensors (e.g., geographic information systems, remote sensing, GPS) to identify variations in the field and to deal with them using alternative strategies." (Zhang and Kovacs 2012: 963).

They add that the use of satellite imagery common in precision agriculture helps in determining soil conditions (2012: 693). Visser and Sippel (unpublished) on their part argues that precision farming is targeted at "… recognizing and managing variation within fields based on the assumption that with improved understanding inputs can be applied exactly where and when they are needed."(Visser and Sippel, unpublished: 6). The idea of meas-

urement of the spatial or temporal variability of the field makes precision farming more of a purely scientific act, hence suitable only for a particular category of farmers.

Schrijver (2016) defines precision agriculture as "a modern farming management concept using digital techniques to monitor and optimize agricultural production process" (Schrijver 2016: 4). Fraser (2018) following Schrijver (2016) definition, describes the concept of Precision agriculture as:

> techniques that monitor and optimize production processes by advising farmers and/or remotely adjusting machinery to optimally apply fertilizer or chemicals to the land and feed to animals, thereby conceivably increasing yields and outputs and improving the efficiency and effectiveness of inputs (Fraser 2018: 1-2).

These definition all point to the optimal use of inputs and machinery geared towards increasing productivity.

The fundamental questions however are; what are the modalities in measuring this variability? And what determines the accuracy of this measurement? Farmers who have worked their field for a couple of seasons are often able to tell the various parts of the field and its productivity without the help of yield mapping, since they become very familiar with the field, as pointed out by Tsouvalis et al., (2000).

Smart farming on the other hand refers to the use of information and communication technologies in the entire farming process. It is described as "… a development that emphasizes the use of information and communication technology in the cyber-physical farm management cycle." (Wolfert et al. 2017: 69). In their view, recent inventions such as the 'Internet of things' as well as 'cloud computing' has leveraged this situation to introduce even more advanced innovations like robotics and artificial intelligence which is revolutionizing agriculture. According to them smart farming which involves serious management is not only location-based, but data supported by context and real-time occurrences.

2.2.2. ICT for Development (ICT4D)

In his article, 'The ICT4D Manifesto,' it is stated stated that, "economic, social and political life in the 21st century will be increasingly digital, and those without ICTs will be increasingly excluded" (Heeks 2009: 2). This statement is true to the extent that digital technology viewed as a preserve of the affluent in society has become a thing of the past as it is affecting everyone regardless their economic or social status (Ibid). ICT4D provides a perfect example of how digital technology is affecting lives across global south. This situation call

for "…new technologies, new approaches to implementation and … a new view of the world's poor" (Heeks 2009: 1), in order that the potential of digital technology is fully ripped. He adds that, ICT4D which started in the 1990s is a product of a combination of an emerging internet technology and the International Development Goals of 1996 which later became the Millennium Development Goals (MDGs) by the year 2000 (Ibid). Several publications, events, programmes and project funding (including: The World Development Report, 1998 of the World Bank; the Digital Opportunities Taskforce in 2000; and the World Summits on the Information Society WSIS, in Geneva and Tunis in 2003 and 2005 respectively) became key points of learning and policy formulation for ICT4D. With improvement of the lives of poor people as its main priority, ICT4D attracted funding from international development agencies, private sector actors as well as some governments of global south (Heeks 2009: 16). These international development agencies included: the UK's Department of International Development; the World Bank; The US Agency for International Development, Japan's International Cooperation Agency. Literature had it that, any initiative aimed at addressing the needs of the poor should be inclusive, enabling and focused on their aspirations and interests (Heeks 2009: 3). These global south digital initiatives have been heralded as the solution to the pressing challenges of poverty, hunger and disease which these third world countries have been battling for long. However, this is a naïve mind-set as witnessed in the failure of most of these initiatives which neglects to consider the local socio-cultural context during implementation. Again it is not accurate to attribute increased productivity to only newly introduced digital technologies because, several factors other than technology contribute to the production process. Also the commodification of agricultural information (Stone 2011) and the global shift from a labour intensive agriculture to one predominantly dependent on chemicals and machinery, as well as the current trends in agriculture where information is very key (Cash 2001) remains a huge challenge to rural agriculture. These situations makes ICT4D far less a complete solution to the challenges of poor communities in global south.

2.2.3. Farmer-expert interface

There has been an over reliance on a top-down approach to agricultural technology in global south for many years with researchers questioning this approach as there is little evidence of a long-term improvement in Agriculture and the environment as claimed by these innovations. Halbrendt et al., (2014) in a study in Nepal on farmer-expert beliefs and its perceived impact on conservation agriculture, cautioned against the universal application of

agricultural practices. Rather practitioners and local communities should begin to engage in "a two-way learning" process in order to tap into "locally situated knowledge" (Halbrendt et al. 2014: 50). They indicate that technical experts often ignore the ecological and cultural beliefs of the localities where they seek to promote these new technologies or practices (2014). In their view, a lot of agricultural programs promoted globally do not take in to account farmers' existing beliefs and the perceived impacts of these new innovations on productivity (Halbrendt et al., 2014). They suggest that there is disconnect between researchers and rural farmers on how they conceptualize the role of these new technologies and their integration into the existing decision-making process of farmers. This disconnect according to them is traceable to the various 'Mental models' of scientific experts and rural farmers in relation to the impact of these practices (Halbrendt et al. 2014: 50). It is also the reason in the view of some researchers that some innovative interventions by governments, NGOs and research institutions are often abandoned for local practices after projects are completed (See Bunch, 1999; Cochran, 2003; Yadav, 1987). A bottom-up approach is therefore recommended when introducing new agricultural development programmes to encourage community participation at the project design stage to ensure that the goals and objectives will be in the interest of famers and other related stakeholders and groups (Chambers, 1994; Pretty 1995). They point out that, technologies which are usually expert-driven, rarely considers the local ecology, culture, norms and beliefs of the targeted people and their compatibility with local situations and recommends that new technologies should not be applied in a universal way, rathe a two-way learning process with local communities and farmers is encouraged to gain benefit from "locally situated knowledge" (Halbrendt et al., 2014: 50). They add that local context and perceptions of both farmers and experts must be considered in planning for agricultural development to ensure trust and mutual understanding.

In a study that explored Knowledge–cultures and expert-farmer inter-face in the English counties of Lincolnshire and Suffolk, Tsouvalis, et al., (2000) argued that Knowledge-cultures as a social gain provides people with enlightened understanding of issues shaped by multiple forms of knowledges taking farmers experience with precision-farming technique in Lincolnshire as acase study. According to them Knowledge-cultures "are the result of a contingent flow of continuous communicative interactions between human beings" (Tsouvalis et al. 2000: 912). They further argue that knowledge-cultures enables people to realize the "constantly negotiated" nature of reality which in their view affects both the interpretation and understanding of reality and creates a pervasive moral view and "power

relations" that defines group and individual Identities (Tsouvalis, et al., 2000: 922). Also related to the concept of knowledge-cultures is Thomas Kuhn's idea of a 'neutral, objective and universal scientific knowledge.' Kuhn, (1970) was of the view that rather than seeing society as a "scientific community" with similar norms, the debate about scientific knowledge should be seen as inherent and routine to scientists, resulting from "incompatible modes of community life" built upon the idea of "paradigm" (Kuhn 1970: 94). Mendelsohn, (1987), makes the claim that scientific activities are social constructs which has a linkage with various social interests. This claim propelled some studies which established that science is not neutral, but rather a negotiated set of practices (Tsovalis etal., 2000). Closely related to the concept of knowledge-cultures is actor-network theory (ANT), propounded by Michel Callon, Bruno Latour, and John Law (Law and Hassard 1999). Fauccult, (1988), also believe that the dominance of scientific knowledge is as a result of the imposition of ordered procedures to produce, regulate and operate the system. According to him, scientists compel people to say things which are used later to make a judgement about particular situations (Fauccult 1988).

The assumptions that experts know better than farmers is very problematic. This is because, as pointed out by Tsouvalis et al., (2000), farmers and experts have different forms of knowledges. Farmers "know what they are looking for" as expressed by a farmer in a field interview in the English county of Lincolnshire: "If you are working the farm, it's programmed in your head anyway" (Tsovalis etal., 2000: 916). Farmers sometimes hold the view that they have a better appreciation of the technologies designed by the experts after a considerable period of using them which brings to mind the question of 'other' forms of knowing or knowledges which for long have been seen as myths, not realistic and subjective (Tsouvalis et al., 2000). However, there has been a shift in recent years from expert to what is loosely called 'lay people' knowledge, highlighting how this form of knowing continuously evolves (Clark and Murdoch 1997).

2.2.4. Agricultural Treadmills

The concept of treadmills to demonstrate the effect of new technologies in agriculture particularly on late adopters of these technologies (Cochrane 1958). According to him, the in elastic nature of agricultural products implies that farmers need to continuously increase in production which leads to decreasing prices for farmers as explained by the principle of elasticity in economics that when supply exceeds demand of a particular product, price will reduce (Ibid). These technologies leads to increased yields for early adopters, but as more

farmers adopt the technology, overall production increases forcing prices to reduce. Hence in order to keep up, farmers have to continue using these technologies creating what is referred to as technological treadmills (Cochrane 1958). Farmers who are unable to stay on this treadmill loses their lands to other farmers, a situation which promotes accumulation (Cochrane 1993). Howard, (2009), identifies off-farm input treadmill as another form of agricultural treadmill. He breaks it in to three types: pesticide treadmill; synthetic fertilizer treadmill and Commercial seed treadmill (Howard 2009: 1269). All these technologies once adopted yields positive results in terms of production, but puts farmers in a fixated position as they have to continue using these off-farm products or stand the risk of being kicked out of the business of farming. This according to him makes farming more expensive as farmers are inclined to spend more on the farm albeit declining revenue (Howard, 2009). In the end, farmers become the losers while multinational input dealers continue to make increasing profits (Weis and Weis 2007).

2.2.5. Youth and women in ICTs for agriculture

Agriculture is the single biggest employer in the developing world, and the agri-food sector needs to grow in order to meet the world's increasing demand for "food, feed, fuel and fibers" (White 2012: 11). In his view agriculture has the potential to provide decent work for people, especially the young, if it is given the needed support (White, 2012). He also argues that about one-fifth of young people across the world are unemployed, with several millions of others underemployed (White 2012). The International Labour Organization have been battling with the issue of youth unemployment since 1935, just as the Unite Nations (UN) have been doing for the last few decades through the Millennium Development Goal (MDGs) goal 8 which is targets at developing and implementing strategies that will create decent work for young people (White 2012: 11). However, in its current state, agriculture according to Ben White appears unattractive to young people to an extent that they are turning away from it as a carrier or 'rural futures' (Ibid). There is evidence supported by research, of the lack of interest of young people (particularly in developing counties) to take up agriculture as a carrier or a source of employment despite the despite its huge employment potentials. Many researchers and academic writers (see: White, 2012; Sumberg et al., 2012; Anyidoho et al., 2012; Tadele and Ayalew, G., 2012) have pointed out this lack of interest and assigned various reasons to it. These reasons include; a lack of prestige (Tadele and Gella 2012), the mismatch between policy and the expectations or aspirations of young people (Anyidoho et al. 2012) and lack of research that is grounded in theory and history as

well as conceptually and contextually appropriate (Sumberg et al. 2012). There is also the arguement that access to farmland and other opportunities related to agriculture resulting from agrarian inequality, gerontocracy and corporate penetration into the agri-food sector are some reasons for the lack of interest (White 2012).He further notes three key problems that needs to be examined in order to understand the reasons for young people's turn away from agriculture, which include: "the deskilling of rural youth and the downgrading of farming and rural life; the chronic government neglect of small-scale agriculture and rural infrastructure; and the problems that young people increasingly have even if they want to become farmers, in getting access to land whiles still young" (White, 2012:11).

Chapter 3: Study methodology

3.0. Introduction

This section addresses the methods that were used during the study. It covers research design, types and sources of data, study population, sampling procedure, methods of data collection and data analysis, instruments for data collection, presentation of data, ethical considerations and limitations of the study. This section explains how the entire study was carried out.

3.1. Research Design

The validity of research findings depends on the relevance of the research design employed for the study since the design provides for how data will be generated and analysed for the study. This study employed a mix methods research design as basis upon which data was collected and analysed to address the objectives of the study. This research design is appropriate for the study because it facilitates the description and explanation of conditions of the present by using mix methods to describe a situation and/or phenomenon. In addition, this design is suitable for purposes of generalizability and transferability of results to a wider population. The use of this design involves a systematic collection of both primary and secondary data that enables the researcher to identify and describe the role of digital technologies in smallholder farming in the Northern Region of Ghana.

3.2. Study Population

The population of interest for this study includes smallholder farmers who have benefitted from the ADNANCE II project in the Northern Region of Ghana. In this context, the study interviewed project staff as key informants, beneficiary smallholder farmers under the project as well as out-grower business operators (OBs). These constitute the unit of analysis of the study.

3.3. Sampling Procedure and Techniques

O'Leary (2004) argues that, for purposes of generalization, a sample should meet the requirement of both appropriateness and representativeness or should be able to 'relate' to a

bigger population. Out of 45,200 beneficiary farmers on the project across the 18 districts of the Northern Region where the project operates, about 1361 were from the Savelugu-Nantong and Tamale Metropolis combined, from which 140 respondents were selected for the survey. Two out-grower businesses (OBs) and two project staff were also interviewed. Non-random sampling methods, specifically a combination of both snowball and volunteer sampling techniques were used to identify and interview farmers after using purposive sampling to select communities. These two methods were used because the research timing coincided with the peak of farming activities making respondents quite difficult to access due to their busy schedules. Also the researcher had no access to a list of respondents. These reasons made the two sampling techniques most appropriate to use. According to O'Leary (2004), Snowball sampling is often used when dealing with population that are in-accessible or difficult to identify. Also, purposive sampling technique was used to identify and interview stakeholders like the project staff as well as out-grower businesses (OBs).

3.4. Sources of Data

Data was gathered from both primary and secondary sources. This took the form of review of existing literature from documents, websites and media publications relating to the topic and the ADVANCE II project. The primary source involved data from the field including survey and interview of the sampled respondents.

3.5. Methods of Data Collection

Basically, the study used questionnaire and interview guide to collect data from farmers and field staff of the ADVANCE II project (Workers of ACDI/VOCA who are the implementers of the project). Both open and closed questions were used elicit information.

3.7. Methods of Data Analysis and Presentation

Both qualitative and quantitative data gathered during the study were analysed. Data gathered through survey questionnaires were analysed using SPSS computer software. The verified data was then entered into SPSS. Prior to data entry, all questionnaires were numbered to aid tracking for errors and routine quality checks. The data was then cleaned by going through the data set to correct all errors of omissions and commissions including wrongly entered codes and entries left blank where there should be a code or an entry. This was

then analysed using SPSS. The analysed data was presented graphically and in tabular forms using basic statistics (i.e. percentages, averages, and frequencies). Specifically, descriptive statistical tools such as graphs, charts and percentages were used during data presentation. The data were edited by correcting any omissions and errors, non-responses, appropriateness and accuracy to ensure that there was consistency in responses. These analyses and presentations were done based on the thematic areas of the study objectives.

3.8. Ethical Considerations

For purposes of ensuring objectivity, demonstrating responsibility, competence and propriety; ethical issues were taken as one of the top priorities in the data collection process. According to Sarantakos, (2012), ethical consideration in social research enhances the quality of research by eliminating fabrication and falsification. Researchers hold the view that, as producing knowledge requires 'responsibility', the 'power relations' that exist between the researcher and the researched equally requires responsibility to guarantee the dignity and wellbeing of the people that are studied (O'Leary 2004: 50). To this end, I ensure that respondents gave informed consent as one of the key ethical pillars in every research. Respondents were voluntarily involved and made aware of the right to discontinue if they so wish. Confidentiality and where necessary anonymity of respondents were ensured. The essence of the study and its objectives were also explained to the respondents.

3.9. Scope, Limitation and Challenges of the study

The study investigated digital technologies in agriculture extension service delivery and how those services are used, its effects, and appropriateness to smallholder farmers of Northern Region of Ghana. In terms of scope, the study addresses accessibility, extent of use, the challenges and potential effects of ICTs or digital technologies among smallholder farmers. Geographically, the study was carried out in the Northern Region of Ghana. Two districts (Savelugu Nanton district and Tamale metropolis) were selected for the study. One community each was selected from districts where the Agricultural Development and Value Chain Enhancement II (ADVANCE II) project was operating.

The study faced a number of challenges which need to be pointed out. One of such challenges is the fact that the study was limited to only smallholder farmers who were on the ADVANCE II project. The study therefore, may not be reflective of the use of ICTs in general, but only those under the project in the northern part of Ghana.

The timing of the research which coincided with the peak of the rainy season also made it difficult to select districts following standard procedures in research. This was due to the bad nature of the roads in most districts of the region, which often gets worse during the peak of the rains making them difficult and unsafe to ply. Journeying on motor bikes from Tamale (the regional capital) to each of the communities (Labariga and Gushie) which are within a distance of about 39km and 50km respectively, researchers had to defy the incessant rains to go for the data in rain coats.

Again, in one of the selected communities, it turned out that only a homogeneous unit of female participants in the project existed. This therefore does not meet the criteria of heterogeneity for that community in terms of gender in the sample selected as it will lack the views of males on the subject under study, making it a serious challenge.

Another challenge is the fact that the selected districts were very close to each other. This however was the result of other difficulties including language barrier, poor road network and financial/resource constraints. These had an influence on the selection of the districts.

Also worth highlighting is the fact that no input from the service providers (ICT companies) is incorporated in the study. This is strictly due to non-response for interviews on the part of the companies. The Ghanaian ICT –provider for agriculture, Farmerline for example responded to the emails sent to them requesting for an opportunity for an academic research interview, after two reminders. But indicated in their reply that they had no ongoing projects in Northern Ghana. Esoko did not respond to two mails suggesting a lack of interest in participating in the research. However, information gathered from secondary sources on the role of the service providers has been duly incorporated into the research.

Lastly, it is also worthy pointing out that there was some level of non-responses by the survey respondents in the sense that some of the participants did not answer some of the questions. One key reason for this could have been fatigue on the part of respondents as the days for survey in both communities coincided with heavy rainfalls. Also in the local language words like 'effects' and 'impact' as well as 'perception' and 'general assessment' are almost interpreted to mean the same, hence some of the respondents felt such questions that had this perceived similarity were previously answered. This implies that for some questions, responses fell short of the sample of 140 respondents. This could have been avoided if measures were put in place to discuss adequately with research assistants the various terms or words used in the survey in order to come out with a uniformed understanding of these words and context within which they are used. Since the snowball

method was employed in sampling respondents, and because their personal detail such as names and contact numbers were not taken (for ethical reasons), it made tracking of non-response a serious challenge. For those questions therefore, conclusions can only be drawn strictly based on the responses provided.

The research tools for this study were not adequately pretested before actual field data collection. Future research will therefore require a rigorous pretesting of the tools in the field to ensure that the potential challenges are detected and solutions found to them before actual data collection is done.

Chapter 4: Discussion of Results and findings

4.0. Introduction

This chapter presents the results and findings of the study. The findings are discussed and presented on the themes of the study objectives. The results and findings covers types of digital technologies available for smallholder farmers, accessibility of the digital technologies, the use of these technologies by farmers, as well as some of their effects, and the challenges facing smallholder farmers in the use/application of these digital technologies in farming.

4.1. Socio-Demographic Characteristics of Smallholder Farmers

This section discusses the background characteristics of smallholder farmers who participated in the study. The section describes the demographic features of the smallholder farmers as in age, sex, educational status, and acreage of land cultivated.

4.1.1. Age Distribution of Respondents

This section describes the age distribution of smallholder farmers who participated in the study. The results from fieldwork as presented in table 4.1 below, indicates that close to about three-quarters of the respondents (74%) representing an aggregate of two age ranges (20 – 39years) were within the very (working age) bracket. This suggests an encouraging youth participation in ICTs for agriculture within the study area. Although these findings appears contradictory to existing literature on youth in agriculture studies (see White, 2012; Sumberg et al., 2012; Anyidoho et al., 2012; Tadele and Ayalew, G., 2012), which indicates lack of interest in agriculture by the youth, it could also be that, the introduction of ICTs in agriculture make agriculture more attractive to young people within the study area. If this interpretation is right, ICTs in agriculture could be a tool to attract young people's interest and participation in agriculture. Alliance for a Green Revolution in Africa –AGRA, (2015), points out that there has been a gradual change in the agricultural landscape in Africa over the last decade through the use of ICTs. This according to the report, is attributable to the rising mobile phone and internet connectivity particularly in Sub-Saharan Africa (AGRA, 2015). The report makes the point that this development is "… not only helping to bring more youth back into agriculture, but also retaining young farmers already involved in the sector" (AGRA, 2015: 120). Whilst this buttresses the point about the potential role of ICT

in attracting young people to agriculture, it is difficult to draw conclusions as the scope of this research is too limited and there is no academic literature to support this claim.

Table 4.1. Age distribution of respondents

Age range	Frequency	Percent
20-29	90	64%
30-39	14	10%
40 and above	36	26%
Total	**140**	**100%**

Source: Author's own survey, 2018. **n = 140** (where 'n' represents number of respondents)

Table. 4.2. Age of respondents across Sex

Age Range		Sex of respondents		Total
		Male	Female	
Age of respondents	20-29	52 (58%)	38 (42%)	90
	30-39	7 (50%)	7 (50%)	14
	40 and above	3 (8%)	33 (92%)	36
Total		**62**	**78**	**140**

Source: Author's own survey, 2018 n=140

4.1.2. Gender/Sex distribution of sampled Farmers

The results presented in table 4.3 below show a high female participation in the project in the within the study districts, since they constitute the majority (56%) of the respondents in this study. Whilst it is encouraging to note that female are active participants in digital technologies for agriculture, it may only be a peculiar case for these districts selected. It came up through interviews that there is a gender officer for the project, which shows a certain level of commitment to dealing with gender issues in agriculture.

Table 4.3. Gender/Sex distribution of sampled farmers

Sex of respondent	Frequency	Percent
Male	62	44%
Female	78	56%
Total	**140**	**100**

Source: Author's own survey, 2018 n =140

Although the results from Table 4.3 shows a significant participation of women in the survey, this may not be a reflection of the wider female involvement in the overall project let alone female participation in ICTs beyond the project due to the fact that one of the communities surveyed had only women as beneficiaries of the project. This could probably have been done deliberately to ensure female participation in the project. In an interaction with field staff of ADVANCE II, it was revealed that there are about three of such homogeneous groups of female farmers numbering over two thousand (2500) members across the Northern region including Korkornasor women group in Cheriponi district and Kpanashi women group in Gushegu district both in the Northern region of Ghana, who are part of the project in an efforts to encourage women to take up farming as a business.

4.1.3. Number of Acres Cultivated by Smallholder Farmers

The study also did an assessment of the acreage cultivated by the smallholder farmers to establish the size of farms and the categories of farmers engaged in the project in terms of scale or capacity of production. According to the study, the average number of acres cultivated by a farmer was 2 acres, which confirms that they indeed can be characterized as smallholders. Smallholder farmers are described as small farms or household land which are smaller than 2 hectares (Nagayets 2005, FAO, G. R. 2015, Lowder et al., 2016) taking 1hectare to be equal to 2.471acares. As shown by results in table 4.4 the minimum number of acres cultivated is 1 acre and the maximum acreage cultivated is 8 acres. This shows that smallholder farmers with varied capacities participated in the project. It should be noted that out-grower business operators (OBs) were farmers or farm businesses who cultivated a minimum of 12 acres (4ha). This is so because OBs are expected to be medium to large scale farmers who have the capacity to support smallholders in terms of tractor services, shelling (removing of the husk of grains), combine harvesting, and other essential farm-related services.

Table 4.4. Farm size (number of acres cultivated) Note: 1 hectare=2.471 acres

Farm Size (No. of Acres Cultivated)	No. of farmers per farm size (Frequency)	Percent (%)
0-1.0	50	36%
1.01-2.0	34	24%
2.01-3.0	43	31%
3.01-4.0	10	7%
>4.01	3	2%
Total	**140**	**100%**

Source: Author's own survey, 2018 n = 140

Table 4.5. Farm size (Number of acres) by gender

No. of acres cultivated	Sex of respondents					
	Male		Female		Total	
	Frequency	Percentages (%)	Frequency	Percentages (%)	Frequency	Percentage (%)
0-1.00	50	100%	0	0%	50	(100%)
1.01-2.00	2	6%	32	94%	34	(100%)
2.01-3.00	2	5%	41	95%	43	(100%)
3.01-4.00	5	50%	5	50%	10	(100%)
4.01->	3	100%	0	0%	3	(100%)
Total	**62**	**44%**	**78**	**56%**	**140**	**(100%)**

Source: Author's own survey, 2018 n = 140

It is further observed that women constitute the majority (52%) within the first three cohorts. The majority of females in the survey cultivated between 1 and 3 acres of land. However, there was male domination within the farmers that cultivated more than 4 acres of land. No female cultivated more than 4 acres of land. This suggests that even among smallholder farmers, females tend to have less access to land compared with males. The major obstacles to women's participation in medium-sized agriculture could be attributed

to the lack of access to agricultural land and other related opportunities due to customary practices such as patriarchal power relations and as pointed out by (Stearns 2016, in Park and White, 2017). Women own only 1% of land in Africa and receive 7% of agricultural extension service according to Sanchez et al., (2005). In Ghana, women hold land in only about 10% of households as pointed out by Anaglo et al., (2014). Bina Agarwal (1994), notes that, women are not guaranteed control (the ability to decide on use and disposal) of land based on legal ownership. From interaction with some of the female farmers in the field, it appeared that most of them had no absolute ownership or control of the land they cultivated, rather it often belonged to their husbands or other male relatives of the family as indicated by Duncan, (2004). This corroborates the FAO, ECOWAS, (2018) report on the gender profile of agriculture and rural livelihoods that states that women's rights to land are directly linked to marriage.

4.1.4. Educational Status of Smallholder Farmers

The survey demonstrate that the majority of respondents (93%) do not have any formal education. With the exception of one person who indicated that she had had some secondary (High school) education, the rest of the 6% respondents who had formal education were elementary/primary school leavers. The low level of literacy among participants in the ADVANCE II project raises concerns about the effective use of the digital devices and possibly poor application of the information thereof, since level of education can be linked to one's ability to manipulate devices and apply instructions effectively. What this aspect of the study might also suggest is that literates (graduates) in Northern Ghana are not actively involved in smallholder agriculture. According to the Ghana Living Standards Survey (GLSS- 4 Report) cited in Afari (2001), a significant number of people in the agricultural sector (42.9%) in Ghana have never had any formal education (Afari, 2001:6). This according to Ewin Afari should be a major concern for agricultural policy in Ghana considering that extension education is very vital to farm productivity (Afari, 2001). Esoco (2017) also indicates in a baseline study carried out among smallholder farmers in the Northern, Brong Ahafo (Central Ghana) and Volta regions (Eastern part) of Ghana that, 52.9% of respondents in the study could not read, whiles 37.6% discarded messages due to illiteracy. Although the situation might have changed, this could still be a huge challenge. This therefore suggests a significantly high level of illiteracy among farmers in these regions, as this study the findings from this study seem to suggest.

Table 4.6. Educational Status of Respondents

Educational Status	Frequency	Percent
Formal Education	8	6%
Non-formal Education	2	1%
No Education	130	93%
Total	**140**	**100%**

Source: Author's own survey, 2018 n = 140

4.2. Types of Digital Technologies Available for Smallholder Farmers

Knowing the types of digital services available to and used by farmers is a good start to determining the role these ICTs play in smallholder agriculture in general. The research therefore sought to know the various services provided through digital technologies in the Northern Region of Ghana and the extent of use of these services.

Table 4.7. Digital/ICT services used by the farmers

What are the types of information/services that ADVANCE II provide for you?	Responses on use	
	Yes (%)	No (%)
Price Information	52%	48%
Market information	68%	32%
Weather information	59%	41%
Digital Financial Services (DFS)	5%	95%
Fall Army Worms Information	93%	7%

Source: Author's own survey, 2018 n = 140

The results presented in table 4.7 confirms information from website publications and project staff regarding the types of digital services provided under the project. Respondents confirmed having access to one or more of the following services: price information, market information, weather information, fall army worm information (call centre) among oth-

ers. However, about 95% of respondents indicated they did not have access to digital financial services (DFS). It was noted however, through interviews with the Business Service Officer (BSO) of ACDI/VOCA - the implementing organization of the ADVANCE II project - that as part of an objective to improve financial inclusion, beneficiaries were introduced to mobile money services to encourage digital financial transaction. This according to him was aimed at reducing the flow of physical cash which may reduce the risk of theft or robbery and could also serve as a means of accessing financial support from friends and family living in the cities or further away without necessarily passing it through banks. According to information on the website of ACDI/VOCA there was also the introduction of the Village Savings and Loans Association (VSLA) in some of the beneficiary communities, with the objective of saving among themselves as groups and borrowing from the funds at no interest. This is targeted creating an alternative to regular bank loans, which are often difficult to access by people from rural areas. From field interaction it was observed that the VLSA was mostly liked by women groups. However, among the sample no such respondent mentioned VSLA during the interactions. This was probably because there was no questions on VSLA and/or sources of funding for agriculture. On price information (access to prices of various produce from different market centres), 52% of respondents indicated that they access while 68% and 93% respectively responded in the affirmative to market information and Fall Army worm information respectively. It was discovered in the course of field interaction with farmers that they were also given inputs (fertilizer and improved seeds) on credit. Observations from field interactions with beneficiary farmers suggest that farmers paid a lot of attention to the input supplied to them on credit. This was probably because access to input is a big challenge for them. Although there were no direct questions on inputs, in farmers' response to the overall assessment of the project inputs kept coming up. In a question put via email to the Monitoring and Evaluation officer regarding whether the project collaborating with fertilizer and seed companies, this was the response:

> There are linkages [and] the project facilitates and act as a catalyst. The input dealers are also our actors because they fit into the value chain we are facilitating. So we initiate the relationship particularly with the input dealers and the lead actors, who in turn seals the deal with the input dealers and makes the SHFs [smallholder farmers] benefit. (M&E Officer, of the project – fieldwork).

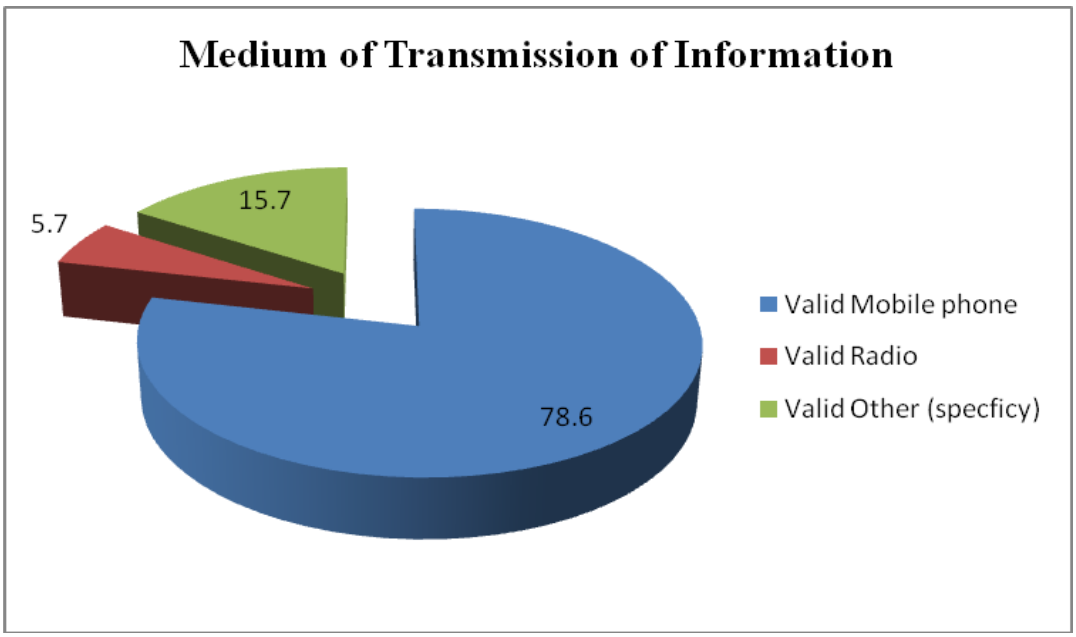
Actors in this sense refer to players in the agricultural value chain within the ADVANCE II project (including input dealers, tractor operators, produce buyers and farmers) for which ACDI/VOCA only facilitates linkages. This suggest that ACDI/VOCA initiates the relationship with the input dealer and then the lead actors, in this case the out grower businesses (OBs) takes over to do business (distribute inputs on credit basis) with farmers.

The input dealers together with the OBs decide on the modalities of repayment of the credit. While this may be helpful to farmers as they are able to get access to inputs on credit, it also raises concerns of a potential agricultural treadmills (Howard, 2009) or technological treadmill as Cochrane (1958) puts it. Howard Philip, describes technological treadmill as a situation famers are "locked" in the purchase of off-farm inputs instead of producing the inputs (seed, fertilizers and pesticides) on the farm themselves (2009: 1269). The situation where farmers in the project are made to take inputs on credit could lead to treadmills. In the case of seed, there is the tendency that farmers will stop seed saving particularly if they find improved breeds faster and more productive in terms of yield. Also farmers who finds chemical fertilizers more effective after using it may stop the preparation of compost and the use of animal droppings (manure) which has no financial cost and shift to the constant use of chemical fertilizer. Beyond the potential health and environmental concerns associated with these 'improved seeds' and fertilizers, it could create two potential problems. The first is the financial burden associated with constantly buying inputs with the scarce resources available to smallholders rather than saving seed from harvest or producing inorganic fertilizer or manure to fertilize crops. The second is the possible extinction and reduction or a possible narrowing of seed and crop variety and its impact on food (in)security. This situation is lead and promoted by big corporation in the chemicals seed industry (plant breeders) who has profit as their prime interest as suggested by Kloppenburg, (2004). Seed breeding by corporations is a means of capital accumulation according to Kloppenburg, (2004). Jack Kloppenburg notes that: "the agricultural plant sciences have over time become increasingly subordinated to capital and […] this ongoing process has shaped both the content of research and necessarily the character of its products" (2005: 8). In Kloppenburg's view corporate seed breeding leads to primitive accumulation and commodification (2004).

4.3. Medium of Transmission of Information

The study also identified the medium through which the ICT enabled services are delivered to the smallholder farmers. Mobile phones were identified as the main medium through which the digital services were channelled to the farmers. From field observation majority of phones sighted with farmers were simple phones with the exception of the female high school graduate (secretary of the women FBO in Gushie), and two other males (the OB for Gushie and my contact person for Labariga). It was revealed in an interview with the Business Service Officer that, owning or having access to mobile phone was a precondition for selection of farmers on the project since information would be channelled to farmers through that medium. He added that the project collaborated with one of the mobile telecommunication companies in Ghana (MTN Ghana) to run promotional sale of simple mobile phone at reduced prices to afford more farmers the opportunity to buy one. Every farmer that was selected according to him, had access to a mobile phone. Apart from mobile phones, radio was another source of information available for farmers on the project. The BSO pointed out that farmers were provided with solar-powered radio sets and made to form radio listenership groups in some selected districts. In collaboration with the ADVANCE II project and some radio stations within those districts, educative agricultural programmes on GAPs were designed in local languages for farmers to listen in groups to stimulate group discussions and sharing of ideas and experiences among themselves. What was unique about the radio listenership groups as stated by the BSO was the opportunity for farmers to phone-in to the live programme handled by agricultural experts to ask pertinent questions regarding their farming activities. Evidence from the field however indicated that this did not exist in the two districts under study. Some farmers mentioned though, that, they monitor agricultural programmes on radio usually during farming season albeit not as part of the ADVANCE II project

Fig. 4.1: Medium of Transmission of Information



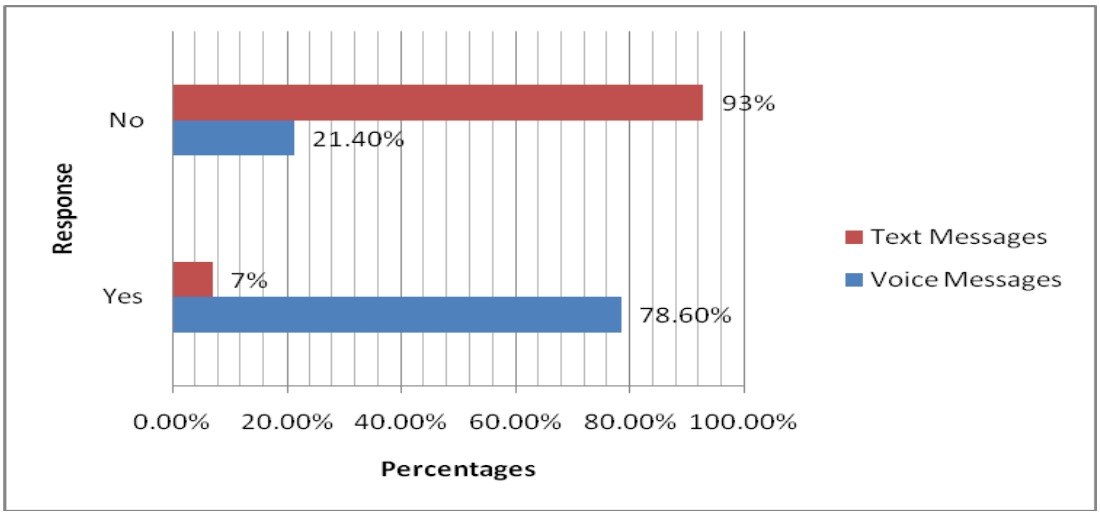
Source: Author's own survey, 2018 n = 140

4.4. Nature of the digital technologies

The study further gathered data to establish the nature of services that are provided via digital technologies for smallholder farmers. It revealed that the nature of the information given to farmers mainly took the form of Short Message Service (SMS) and voice (pre-recorded call) messages. The voice messages which are in the form of pre-recorded calls is the predominant one. The calls according to the study are designed in the local language of choice of the respective farmers. According to information from the website of Ignitia Ghana- one of the companies partnering with ACDI/VOCA in the ADVANCE project to deliver weather forecast information to farmers – they deliver forecast based on remote sensing data input. Forecast is then delivered to each subscriber base on their Geographic Positioning System (GPS) location usually near the fields or farm area of the subscriber. Voice and text messages are then generated and sent as SMS to their phones. Every farmer receives a unique daily forecast specifically regarding their location (Ignitia Ghana Website). This forecast is customized to suit the farmer in terms of their preferred language as explained by the M&E officer of ACDI/VOCA in an interview. The question this raises however is what happens when the farmer misses a call due to circumstances beyond their control? It presupposes that this valuable information will escape the farmer. Even more problematic is the fact that the system which is supposed to provide information and edu-

cation, is not interactive. Farmers can only listen and pick the information which comes as a call, but cannot interact with it. Such a system although seem to be quite supportive to the non-literate rural farmer, still needs to be improved upon in order to deliver a much comprehensive solution to smallholder farmers. In this regard, information could be delivered in the form of voice SMS which can be (re)read at every moment, rather than as a (one-time) call to avoid loss of vital information to the farmer.

Fig. 4.2: Nature of Information



Source: Author's own survey, 2018. n = 140

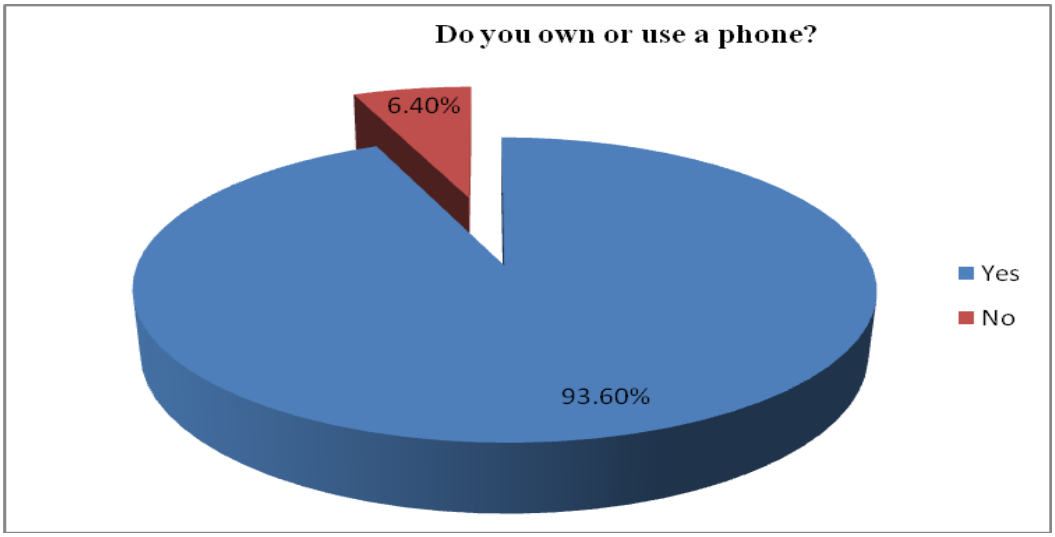
4.5. Accessibility of digital Technologies to Smallholder Farmers

This section of the study discusses survey results regarding the smallholders' access to the ICT enabled services. It was found out in the study that all one needed to do in order to be eligible for selection to access these services was to be part of a group of smallholder farmers identified under a nucleus farmer (NF) also known as an out-grower business (OB) operator. One also needed to have a mobile phone as a requirement to enable you access these services.

4.5.1. Number of Smallholder Farmers Own/Use Phone

This section intends to establish the number of smallholder farmers who own mobile phones and those who do not own but use mobile phones. Figure 4.3 shows the results of the assessment.

Fig. 4.3: Ownership/Use of Phone



Source: Author's own survey, 2018. n = 140

The study results showed that almost 94% of the smallholder farmers surveyed either own a phone or at least has regular access to a phone. This suggests that mobile phone ownership and access is quite high the ADVANCE II operational areas in northern Ghana. According to information on the website of GSMA, country overview report on Ghana puts unique mobile phone subscriber penetration rate at 67%. This is above the average in Sub-Saharan Africa of 44% according to the GSMA country overview report (2017). This signifies a relatively high mobile penetration rate in Ghana. Results from a baseline study conducted by Esoko on smallholder farmers in the Northern, Brong Ahafo and Volter regions of Ghana in 2017 shows that 89.5% owned phones of which 8% were smart phones (Esoko. 2018). The study revealed that about 6% of the respondents in the survey did not own a mobile phones. Since access to mobile phone was a pre-requisite for selection, it presupposes that these respondents did not own a mobile phone at the time of the research, but had access to it earlier on as a requirement for participation. The M&E Officer of ACDI/VOCA indicated that beneficiaries on the project who did not own mobile phones at the time of registration, used relatives whose phones they had regular access to, although he added that such cases were very few. This however, remains a serious challenge since such relatives could travel or move constantly out of reach of the beneficiary farmer making access to the information difficult. The findings however implies that the majority of the smallholder farmers owns or have access to phones that they use for various purposes.

4.5.2. Frequency of Receipt of ICT Enabled Information

On the question of how frequent digital information particularly the weather forecast is sent to farmers, about 36% of respondents and probably more were recorded as receiving information on daily bases, whiles 59% received it on weekly bases. It was also revealed in the Interview with Out-grower Business operators (OBs) that farmers might have interpreted 'every 7days' (weekly) to mean every day, which suggest that those who selected every 7days actually could be referring to daily. Also, information from the M&E Officer indicated that weather information was delivered to farmers daily, explaining that weather information is always given 48 hours ahead. Whilst this may be good and helpful, some farmers indicated that they wish there was weather advice on timing of farming activities for the season, with which they could take decisions on when to start ploughing and when to begin planting or sowing of some particular crops and other critical decisions. This suggest that to achieve the desired results for this project, farmers need more than just a 48 hours weather forecast. They also need specific information that will help them to plan well ahead of time to avoid wrong scheduling (timing) of farm activities which is often a challenge for farmers.

Beyond the provision of weather as well as price information, farmers also need to be encouraged to improve on the selection and saving of their own local varieties of seed rather than continuously buying seed from commercial seed companies. By training farmers on seed selection and saving, farmers will save huge sums of money which would have been used to buy 'improved' seed varieties. Also this will help protect local seed varieties from extinction and ultimately increase the nutrition and food security situation of rural household in particular. In an interview with a lead farmer, it was revealed that farmers are unable to save these commercial seeds for replanting. The middle-aged male farmer of 41 years noted as follows:

> To be honest, the yellow maize seed that is given to us on credit ADVANCE gives us very high yields, and I hear it is very expensive in the open market… But the problem with it is that, if you save it from your harvest for replanting it doesn't yield the same [as high] as the original seed… So we have to keep buying it to continue getting good yield even after the end of ADVANCE this year (Afa. A., Lead Farmer, LC).

This raises concern of a potential treadmill and narrowing of seed varieties due to low seed saving practice as pointed out earlier. Beyond the potential extinction or reduction in

the varieties of local breed of seeds and its financial and food security implications, it further throws some light on the idea of commodification of agriculture (Amanor 2010, Stone 2011). Price and market information is given twice a week according to the Business Service Officer in order to keep farmers updated and to give them the opportunity to sell whenever they deem appropriate. The project also linked farmers with produce buyers like Nestle Ghana and other private distributers and produce buying companies who serve as ready market to buy the farm produce of participants at prevailing prices at the farm gates.

4.5.3. Frequency of opening Messages or answering calls

The field survey showed that only 42% of farmers opened their messages (SMS, not pre-recorded calls) immediately. Others waited until their literate relatives are around. The Business Service Officer of ACDI/VOCA revealed that some farmers who are on SMS services particularly price and market information do not regularly open the messages. According to him, there are instances when lots of pending or unopened messages are seen on farmers' phones during field monitoring. The reason for these could probably be attributed to low level of literacy among the participating farmers within the northern region. It might also be the case that the farmers find the price information less relevant than they expected. These farmers perhaps are either not able to manipulate the phone or cannot read the messages that are delivered to them. Either ways, the low levels of education could be a factor contributing to this situation of unopened messages.

Table 4.8. Frequency of opening of messages or answering voice calls

Frequency of Accessing Messages or Answering calls	Frequency	Percent
Immediately	59	42%
Once in a day	40	29%
When my literate child is around	34	24%
Weekly	7	5%
Total	140	100%

Source: Author's own survey, 2018 n = 140

4.6. Extent of Application of Information in Farming

The study also sought to determine how effective smallholder farmers are able to apply the information in their farming. The results presented in table 4.10a revealed that the majority

of respondents do actually apply the information received particularly the weather forecast. Farmers indicated that it helped them in determining whether a particular day is appropriate for activities such as weeding, spraying weedicides, sowing of crops and applying fertilizer, in order to avoid rain washing them away. However, it also revealed that farmers used the information for other nonfarm purposes such as planning of trips based on the weather information received. It is also instructive to note that about 1.4% of the respondents indicated they could not use the information at all. This could be as a result of inadequate support on the part of field officers and agents. This suggest that a lot of effort is required to ensure that the rural farmer is given the requisite training and skill required to apply the information provided them to ensure effective utilization. From table 4.9d which shows access to ICTs across farm sizes, it can be seen that all farmers (100%) who had farm sizes of 1 acre or below as well as those who cultivated above 4 acres, always use the information received via ICTs in their farming. Overall, 48% of farmers in the survey use the innovations very often.

Table 4.9a. Extent of application of information across age and gender

Sex of respondents * How well are you able to apply the information in your farming? * Age of respondents Cross tabulation								
Age of respondents				How well are you able to apply the information in your farming?				**Total**
				Unable to use	Used sometimes	When information is relevant	Always use it	
20-29	Sex	Male	Count (%)			0(0%)	52(100%)	52(100%)
		Female	Count (%)			38(100%)	0(0%)	38(100%)
	Total		Count (%)			38(42%)	52(58%)	90(100%)
30-39	Sex	Male	Count (%)	0(0%)	1(14.3)	1(14.3%)	5(71%)	7(100%)
		Female	Count (%)	2(29%)	1(14%)	1(14%)	3(43%)	7(100%)
	Total		Count (%)	2(14.3%)	2(14.3%)	2(14.3%)	8(57.1%)	14(100%)
40 and above	Sex	Male	Count (%)	0(0%)	0(0%)	0(0%)	3(100%)	3(100%)
		Female	Count (%)	0(0%)	5(15%)	24(73%)	4(12%)	33(100%)
	Total		Count (%)	0(0%)	5(14%)	24(67%)	7(19%)	36(100%)
Total	Sex	Male	Count (%)	0(0%)	1(2%)	1(2%)	60(96%)	62(100%)
		Female	Count (%)	2(2%)	6(7%)	63(81%)	7(10%)	78(100%)
	Total		Count (%)	2(1%)	7(5%)	64(46%)	67(48%)	140(100%)

Source: Author's own survey, 2018 n =14

Table 4.9b. Extent of application of ICT by age

Age of respondents	Extent of application of ICT in farming (Frequency)				Total
	Unable to use	Used sometimes	When information is relevant	Always use it	
20-29	0(0%)	0 (0%)	38 (42%)	52 (58%)	90 (100%)
30-39	2(14.3%)	2 (14.3%)	2 (14.3%)	8 (57.1%)	14 (100%)
>40	0 (0%)	5 (14%)	24 (67%)	7 (19%)	36 (100%)
Total	**2 (1%)**	**7 (5%)**	**64 (46%)**	**67 (48%)**	**140 (100%)**

Source: Author's own survey, 2018 n =140

Table 4.9d: Effective application of ICTs by farm size

			How effective are you able to apply the information in your farming?				Total
			Unable to use	Used sometimes	When information is relevant	Always use it	
No. of acres cultivated	0-1 Acre	Count (%)	0(0%)	0(0%)	0(0%)	50(100%)	50(1005)
	1.01-2 Acres	Count (%)	2(6%)	4(12%)	23(67%)	5(15%)	34(100%)
	2.01-3 Acres	Count (%)	0(0%)	1(2%)	39(91%)	3(7%)	43(100%)
	3.01-4 Acres	Count (%)	0(0%)	2(20%)	2(20%)	6(60%)	10(100%)
	> 4 Acres	Count (%)	0(0%)	0(0%)	0(0%)	3(100%)	3(100%)
Total		Count (%)	2(1%)	7(5%)	64(46%)	67(48%)	140(100%)

Source: Author's own survey, 2018 n =140

Table 4.9c. Extent of application of ICT by Sex/Gender

Sex/gender	Extent of application of ICT for farming (Frequency)				Total
	Unable to use	Use sometimes	When information is relevant	Always use it	
Male	0 (0%)	1 (1.5%)	1 (1.5%)	60 (97%)	62 (100%)
Female	2 (2%)	6 (8%)	63(81%)	7 (9%)	78 (100%)
Total	**2 (1%)**	**7 (5%)**	**64 (46%)**	**67 (48%)**	**140 (100%)**

Source: Author's own survey, 2018 n =140

On whether these services they received and use are paid for by the smallholder farmers, the BSO indicated they were delivered to farmers at no cost to them adding that the project pays for it. This cost free ICT service situation however is likely to change after the end of the project. Farmers who wish to continue receiving this information will therefore begin to pay for it at probably at (near) market rates. This raises a potential treadmill situation since farmers would have gotten used to the service and hence may be 'compelled' to pay for it in order to keep up with or maintain the production.

Aside from the ICT enabled services provided to the smallholder farmers, I also found that farmers still have engagement with government agricultural extension officers who visits them for outreach activities. This finding indicates that next to the ICT services provided to smallholder farmers by private/donor actors, traditional (government led) agricultural extension service still goes on in the sampled districts.

4.7. Challenges Faced in the use/application of digital service

As part of its objectives, the study the study sought to identify the challenges facing smallholder farmers in the use or application of ICT enabled technological services. The relevance of the assessment was to establish the existing challenges as means of informing strategic interventions in enhancing digital technologies and smallholder farming. The results from the study reveal several challenges regarding the use/application of digital technologies. Prominent among these challenges are the following: difficulty in using the phone; inability to interact with the system or ask questions; low literacy level; inability to trace back a call when you miss it, leading to loss of information; weather forecast is for a shorter period (48 hours) than expected; late delivery of tractor services (sometimes tractors reach farmers very late in the season); and low supervision to guide farmers on how to use the phone. These challenges among others were identified by respondents during the interviews.

4.8. Effects of Digital Technologies on Smallholder Farming:

The survey also did an assessment of the effects of ICT services on the smallholder farming using indicators such as yield, post-harvest losses, access to price information and Financial services (mobile money savings, sending and receiving money from friends family and colleague farmers). The aim was to find out whether changes in these indicators were traceable to the introduction of ICTs.

4.8.1. Changes linked to ICT-enabled services in smallholder Farming

The study gathered information on how the ICT enabled technological services influenced the activities of smallholder farmers. Responding to the question "which aspect(s) of your farming process have changed?" Several issues emerged from the study. It was revealed that, ICT enabled services provide better advice on the timing of farm activities such as planting, sowing, application of fertilizer and other chemicals compared to their own prediction. In an informal interaction some the farmers indicated that the weather forecast helps them to avoid chemicals being washed away by rain. They further indicated that the field training workshops on GAPs which was done using videos and pictures via tablets by the field officers with support from The Grameen Foundation, contributed to increasing productivity. As part of Grameen Foundation's bid to support smallholder agriculture, they developed a project called Smartex where trained extension agents assist farmers with agricultural tips and good agronomical practices such as land selection and preparation, planting in rows, appropriate fertilizer application pests and weed control as well as proper drying and storage. According to the BSO, this was done in the field with the help of mini projectors to demonstrate for farmers through videos and pictures. Further assessment was done to establish the aspects of the farming activities of the smallholders that has changed attributable to the ICT enabled technological services. The results of such assessment are presented in table 4.10 below.

Table 4.10. Changes linked to ICT-enabled services in smallholder Farming

Type of change	**Responses**	
	Yes (%)	**No (%)**
Increased crop yield	81%	19%
Decreased post-harvest losses	94%	6%
Access to information on prices	47%	53%
Financial management	62%	38%

Source: Author's own survey, 2018 n =140

Majority of respondents confirmed that digital technologies had a positive effect in the form of improved yield (good harvest) and decreased post-harvest losses due to improved methods of drying and storage according to the study. However nearly half (47%) agreed

that these services improved their access to prices information. Access to price information in this study implies farmers get to know prices of various produce in different markets on a weekly basis, to help them to decide when to sell and at which market centre. In response to a question posed to a respondent regarding the his view on the price information and his view about it, this is what the 38 year old maize and soy farmer had to say:

> Assuming I am in Tamale, and the prices of produce in Yendi market are good, it will not make economic sense to fare my few bags of [example., maize] to that market since the transportation cost alone will make me run into losses, as the price differences are usually very marginal. Only large scale farmers stand to benefit from such marginal difference in prices (Farmer – field interview, Labariga community).

The distance from Labariga community to the market centre in Yendi Municipality is about 57km and the estimated cost per 100kg bag of maize at the time of the survey was about Gh12.00 Ghana cedis (an equivellence of United States dollars $2.50). In the farmer's estimation a small scale farmer may incur losses if she/he tries to transport their few bags of harvest to sell at that market centre. This is very instructive as it indicate that rather than naïve, smallholder farmers are very calculative.

4.8.2. Impact of ICTs on production/farming process

The survey also sought to assess the impact of the ICT services on farmers' productivity. This was through the open question "how has your production process changed"? One important thing to note is that, for the two communities which were surveyed, the ADVANCE II project was in their third year of operation including the current farming year (2018 farm season). Table 4.11 shows the results of responses of 115 farmers to the question. These responses are categorized into three main types (increased productivity, improved agricultural practices; and no impact yet). From this it can be seen that all young the young people (20-29) who answered this question indicated that productivity increased and/or improved farming practices. Surprisingly all young females in this age category saw an improvement in their farming practices whereas their male counterparts indicated an increase in productivity. Although these are two related indicators (one been the result of the other), respondents seemed to have differences in how they pursue them. The signals this sends out is that, whiles young females on the project are concerned about processes (farming practices), young males are interested in outcomes (yield). Overall, 3% of re-

spondents to this question, indicated they had not felt any impact, pointing out that they had just started as participants in the project.

Table 4.11. Impact on production process across age and gender

Sex of respondents * How has the information impacted on your production processes? * Age of respondents Cross tabulation							
Age of respondents				How has the information impacted on your production processes?			Total
				Productivity has increased	Improved farming practices (GAPs)	No real impact yet, just started	
20-29	Sex	Male	Count (%)	51(100%)	0(0%)		51(100%)
		Female	Count (%)	0(0%)	38(100%)		38(100%)
	Total		Count (%)	51(57%)	38(43%)		89(100%)
30-39	Sex	Male	Count (%)	3(50%)	3(50%)	0(0%)	6(100%)
		Female	Count (%)	2(29%)	3(43%)	2(28%)	7(100%)
	Total		Count (%)	5(39%)	6(46%)	2(15%)	13(100%)
40 and above	Sex	Male	Count (%)	2(100%)	0(0%)	0(0%)	2(100%)
		Female	Count (%)	(46%)5	4(36%)	2(18%)	11(100%)
	Total		Count (%)	7(54%)	4(31%)	2(15%)	13(100%)
Total	Sex	Male	Count (%)	56(95%)	3(5%)	0(0%)	59(100%)
		Female	Count (%)	7(13%)	45(80%)	4(7%)	56(100%)
	Total		Count (%)	63(55%)	48(42%)	4(3%)	115(100%)

Source: Author's own survey, 2018 n =115

4.9. Effects on Indigenous Agricultural Knowledge

As part of assessing the effects of digital technologies on activities of smallholder farmers, the study investigated the perceived effects of ICT-enabled technologies on the indigenous knowledge of smallholder farmers. Respondents were asked whether based on the effects of the innovations, to what extent do they agree that "beneficiary farmers are no longer able to operate without the digital technological services" Although three years might not be long enough to cause significant impact on loss of knowledge, the study revealed that about 43% of the smallholder farmers acknowledged that the digital technologies in agriculture have the potential to cause some loss of indigenous knowledge particularly the ability to predict the weather, while the remaining 57% responded to the contrary. They latter added that these services rather complement indigenous knowledge. Some of these respondents argued that they were doing quite well in farming before they got introduced to these digital services hence it cannot take away what they already know.

4.10. Usefulness of ICT services to smallholder farmers

The study further sought to establish how useful the ICTs have been to the smallholder farmers (Table 4.12). On that score about 93% (sum of useful and very useful) of respondents found it 'useful', with the majority of respondents rating it 'very useful'. This high ratings could is however be attributed to the fact that farmers not only use the information for agricultural activities alone, but also for non-agricultural activities.

Table 4.12: Usefulness of innovations across age and sex/gender

Sex of respondents * How useful are the innovations? * Age of respondents Cross tabulation								
Age of respondents				How useful are the innovations?				**Total**
				Insignificant	Fairly useful	Useful and reliable	Very useful and reliable	
20-29	Sex	Male	Count (%)			2(4%)	50(96%)	52(100%)
		Female	Count (%)			0(0%)	38 (100%)	38(100%)
	Total		Count (%)			2(2%)	88(98%)	90(100%)
30-39	Sex	Male	Count (%)	0(0%)	1(14%)	3(43%)	3(43%)	7(100%)
		Female	Count (%)	1(14.3%)	0(0%)	5(71%)	1(14.2%)	7(100%)
	Total		Count (%)	1(7%)	1(7%)	8(57%)	4(29%)	14(100%)
40 and above	Sex	Male	Count (%)	0(0%)	1(33%)	2(67%)	0(%)	3(100%)
		Female	Count (%)	1(3%)	6(18%)	24(73%)	2(6%)	33(100%)
	Total		Count (%)	1(3%)	7(19%)	26(72%)	2(6%)	36(100%)
Total	Sex	Male	Count (%)	0(0%)	2(3%)	7(11%)	53(86%)	62(100%)
		Female	Count (%)	2(3%)	6(8%)	29(37%)	41(52%)	78(100%)
	Total		Count (%)	2(1%)	8(6%)	36(26%)	94(67%)	140(100%)

Source: Author's own survey, 2018 n =140

4.11. Smallholder Perceptions of Effects of Digital Technologies on Productivity

The results as presented in table 4.13, shows that, out of four indicators, namely: perceived improvement in productivity (yield); perceived decreased post-harvest losses; perceptions about access to price information and perceived increased income, that were listed to seek farmers' opinion, the majority of respondents had a positive perception regarding them. Each indicator recorded over 90% of responses to the affirmative except "access to price information" which recorded only 47% affirmative, with slight majority of 53% giving a

negative response. This suggest that the product designed to ensure farmers' access to good market prices did not yield the desired impact per this study.

Table 4.13. Perceptions of Smallholder Farmers on ICT technologies

Has there been improvement in productivity since you started using these digital information?	**Responses**	
	Yes (%)	**No (%)**
Increased yield	99%	1%
Decreased post-harvest losses	94%	6%
Access to price information	47%	53%
Increased income	99%	1%

Source: Author's own survey, 2018 n =140

The results suggest that smallholder farmers who participated in the study largely hold the view that ICTs or digital technologies have a positive influence on smallholder farming activities in the study area. However, whiles this may be true, would the responses be same if beneficiaries were required to pay for these services? This is to say that perception studies may vary sharply depending on the object being studied, and the conditions under which the study is done. There is often a high tendency for people, particularly rural farmers to speak good about projects which are implemented without direct cost to them. This might have accounted for the high score in perception as shown in 4.13 above.

Asked whether they would be willing to pay for the weather information services after the project ends or when the need arises, the results of the study showed that 97% of the smallholder farmers indicated that they are willing to pay for the services. However, the rest of the 3% who indicated they were not willing to pay cited lack of financial resources as their reasons. Also on the question of how much they were willing to pay, the majority of the respondents mentioned amounts between 2 Ghana Cedi or bellow per month (less than 0.5 US dollars) which in a way confirms findings by Palloni et al., (2017) on willingness to pay (WTP) for "digital nutrition sensitive agricultural information services" in Ghana, that at lower prices farmers' willingness to pay for digital services is high but decreases rapidly as price rises (Palloni et al., 2018: 4). They noted that:

> …at the monthly market price of 0.5 Ghanaian cedis (GHC), 95% of users would be willing to participate in the program even without any price subsidy. The share of farmers willing-to-pay for VFC service is at low prices and then decreases rapidly as the price increases; at 1.0 GHC, 85% would register for the service; at 2.0 GHC 50% would register; and at 3.0 GHC, just 19% would still be willing to participate (Pollani et al., 2018: 3).

They also found that women's WTP was significantly lower than that of men in an assessment of WTP by gender within households with an adult female and male (Palloni et al., 2018). In terms of the smallholders general assessment of the ICT enabled technological services to farming, the study revealed that digital services have helped in improving farming practices like land selection, appropriate fertilizer application and planting in rows.

4.11.1. Smallholder Perceptions about the Importance of ICTs in Agriculture

On the extent to which they agree or disagree with the statement that, "farmers are no longer able to operate effectively without digital technological services" majority of respondents agreed, with about 67% strongly agreeing to the statement offering reasons including: increase in production; weather information being accurate and timely compared with their own guess work about weather previously; improved farming practices; among other reasons.

Table 4.14. Ratings of Smallholder farmers Perceptions

Beneficiary farmers are no longer able to operate without digital technological services	Frequency	Percent (%)
Strongly agree	94	67%
Agree	13	9%
Disagree	29	21%
Strongly disagree	2	1%
Indifferent	2	1%
Total	**140**	**100%**

Source: Author's own survey, 2018 n = 140

This shows that despite the varied ratings, largely the finding is that significant numbers of smallholder farmers have the feeling that they are influenced by the ICTs and could rarely operate without relying on them. However, the smallholder farmers further revealed that even though they rely on the ICT enabled technologies, they still use their indigenous agricultural knowledge and practices. The 22% of farmers who disagreed with the statement indicated reasons including the fact that farmers already had deep knowledge of farming regarding when to plough, sow, as well as when and where to sell. They also added that technology cannot take away what they already knew, rather it can only add to their knowledge. These reasons confirms Halbrendt et al., (2014) idea about "locally situated knowledge" and "mental models" (2014, page 50).

Chapter 5: Conclusion

It is important to point out first of all that, though the study is based on survey questionnaire and semi structured interviews of smallholder farmers, out-grower Business operators and project staff as well as information on secondary sources of data, the sample used in is not large enough to make a generalisation on the Districts under study or Northern region at Large.

Information communication technology (ICT), according to Heeks (2009), is anticipated to play a major role in the future of both rich and the poor across both global south and north, as social, and economic issues (including agriculture) in the 21st century are expected to be digital in nature. The International Telecommunication Union (ITU) points out that even poor countries are investing in the expansion of telecommunication in ways that will provide livelihood support through agricultural extension, information and marketing (Duncombe 2014). The rapid increase in coverage and adoption of ICTs, particularly, mobile phones in the past two decades (Aker et al., 2016; Duncombe 2014), is therefore not surprising giving the challenges smallholders face. These challenges which include low access to physical infrastructure and financial services and information asymmetries, limits farmers ability to take decisions regarding production harvest and marketing of produce (Aker et al., 2016). The ICT4D framework is therefore developed as a model that can improve the poverty situation particularly in development countries. The ADNAVCE II project in Northern region of Ghana implemented by ACDI/VOCA is based on this model.

This study sues the ADVANCE II project as a lens to view the role of ICTs in smallholder agriculture in northern Ghana. The study sought to assess the accessibility, extent of use/application challenges and the potential effects of ICTs smallholder farming and how these affect performance and independence of smallholders.

The various ICT-enabled agricultural services available to smallholder farmers in the ADVANCE II project as identified in the study include: price information, market information, weather forecast, digital financial services fall army worm information as well as information on good agricultural practices (such as land selection and preparation; planting in rows and spacing; appropriate fertilizer application an d pest and weeds control. However, low usage of the price and market information which appeared to be of less priority in terms of smallholder farmers' needs. As it turned out in the study, the price difference in various market centres is not worth the efforts of transporting the produce to these places

to sell, since cost of transportation might add up leading to losses. Large scale farmers therefore stands to gain more from the marginal differences in price (due to economies of scale) than smallholders.

On accessibility of the ICTs by farmers, the study revealed that owning or having access to phones is a prerequisite to having access to digital services in agriculture since it the major medium through which the information is sent through to the targeted farmers. Mobile phone ownership among participants in the study is very high. The GSMA (2017) indicates a mobile penetration rate of 67% in Ghana which confirm the high phone ownwership recorded in the survey. Esoko Ghana in a baseline study of smallholder farmers in the Northern, Brong Ahafo and Volta regions of Ghana also puts mobile phone ownership among smallholder farmers at 89%, similar to the 94% from this survey. Since access to and participation in ICTs in agriculture is tied to ownership or access to phones, it makes the 6% of farmers without phones as recorded in this study a major concern. As indicated by Heeks, (2009) there is a possibility of digital exclusion as economic social and political life in the 21st century will increasingly get digital putting those without it at a disadvantaged position (2009: 2). There is the need for policy makers therefore to work towards making mobile phones more affordable and accessible to everyone.

On the extent of use of ICTs in agriculture in the study area, the results seem to be quite high. Majority of farmers according to the survey do apply the information particularly the weather information they receive in their farming activities. According to the study weather forecast helps farmers to plan on the appropriate day and time to undertake farm activities such as sowing of seeds, fertilizer application, and weedicides as well as pesticides spraying. It also came out from the survey that, the forecast is used for planning other non-farm activities such as daily trips and others. Judging from the high illiteracy level (93%) among participants in the study area and considering that literacy level has an impact on ability to use or apply digital information, it is surprising that 48% indicated that they always use the information. What is worthy of noting is whether the information were appropriately applied.

Also according to the study, young people dominate in the use of the ICTs. All respondents (100%) within the age 20-29 years indicated using the services although some use it only when they find it relevant to them. Men according to the survey use the service more, compared with females. Overall 48% of farmers apply the information regularly. It is also observed that farmers with farm size 4 acres or above which is made up of only men according to the study, always use the information received from system.

Digital information is delivered to participating farmers at no cost as that burden is born by ACDI/VOCA wihinthe project lifespan. The main challenge anticipated however is whether farmers will be able to afford to pay for the cost of these services at (near) market prices after the project has exited. Also the cost of commodified inputs (which poor farmers has no control of) may become unbearable due the profit-cantered nature of these corporate bodies who manufacture or serves as vendors of these inputs. The likelihood is that farmers may be forced to abandon these products and services as suggested by Stone, (2011) probably due to the cost. However if farmers continue use them because they have become accustomed to them in their farming, then they run the risk of been locked-up in a treadmill situation where they are almost compelled to cope with rising cost of ICT services and inputs or be thrown out of farming because they are unable to cope with the situation due to losses or even possible debts resulting from high prices. It also raises concerns about commodification of agricultural information (Stone, 2011), in the form of extension services which could be provided by government at no or less cost.

Although majority of farmers strongly agrees that ICT-enabled agricultural services can have an effect in terms of (loss) of indigenous knowledge, others (20%) disagrees, indicating that technology can only add to but not take away from their knowledge. It is important to acknowledge however that, three years of implementation of an agricultural innovation such as this, is not enough to make an assessment of a potential loss of knowledge or traditional practice. It would require a longer period to cause such a change in practices or habits that has been cultivated over a long period. However, this result sends a signal that the potential of its occurrence exist. The idea of different form of knowing is also expressed in farmers' response of rejection on the price and market information options. As well as the statement to the effect that digital technologies only add to their knowledge but not take reduce it.

There appear to be a gap between the frame (theory) of the innovation and the implementation (practice) particularly in e-agriculture as suggested by Stone (2011) in the e-Sangu project in India. The commodification of agricultural information (Stone, 2011) and There's a likelihood of the project becoming 'agents of commodification' partnering with corporate manufactures or vendors of commodified inputs as witnessed in the case of e-Sangu in India. There are often actors with "vested interests" in e-agriculture who play a role in hyping its relevance beyond reality as pointed out by Stone, (2011). The creation of linkages between farmers OBs and input manufacturers or their distributors in the

ADVANCE II project, and the heightened interest of farmers in these commodified inputs as the survey indicates, reflects a potential for commodification as well as dependency which raises concerns about the independence of these farmers (in terms of agency) to take decisions and make choices.

Many challenges confronts smallholder farmers in the application of ICTs in agriculture. Prominent among these challenges are: difficulty in operating or using phones, inability to interact with the system for feedback, low literacy levels of farmers, loss of infomation as a result of inability to answer calls, shorter forecast period (48 hours), and late delivery of tractors services. Varied as these challenges are they point to two major problems, namely: low capacity or skills of farmers and also weaknesses in the system/innovation. The capacity of smallholder farmers therefore need to be improved through education and training in order to overcome these challenges. There is also the need for an improvement in the nature of the system to ensure that it delivers the intended services efficiently and ultimately lead to achievement of the desired goals set for the project.

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Appendices:

APPENDIX 1: QUESTIONNAIRE

The questions contained in this instrument are aimed at gathering data to support analysis of academic research. The study is part of a partial fulfilment as a requirement for the award of a master's degree in development studies. I wish to assure you that any information generated in respect of this questionnaire shall be used solely for academic purposes. I also wish to indicate that your identity shall be anonymous. Analysis shall be cantered on issues relevant to the topic "digital technology and smallholder agriculture in Northern Region of Ghana. I count on your cooperation in this regard.

SECTION A: TYPE OF ICTS

1. Are you a beneficiary of the ADVANCE II project?
   a) Yes b) No

2. What are the types of information/services that ADVANCE II provide for you? (multiple selection allowed)
   a) Price information
   b) Market information
   c) Weather information
   d) Digital Financial Service (DFS)
   e) Radio programs
   f) Fall Army worm call center
   g) Other (specify) ……..

3. By what medium do you receive the information?
   a) Mobile phone
   b) Radio
   c) Other (specify) ……

4. In what form does the information reach you?
   a) Text message
   b) Voice message
   c) Video message
   d) Other (specify) …….

5. In what language does the information come?
   ……

SECTION B: ACCESSIBILITY OF ICTS

6. Do you own/use a phone?
   a) Yes b) No

7. If Q6 is yes, do you receive weather information and other agricultural tips via your mobile phone?
   a) Yes b) No

8. If Q7 is yes, how often do you receive this information?
   a) Every day
   b) Every two days
   c) Weekly
   d) Monthly
   e) Other (specify) ……..

9. How often do you open the message when it is delivered to you?
   a) As soon as it comes
   b) Once a day
   c) Any time my literate son/daughter is around
   d) Weekly
   e) Other, specify

10. How effectively are you able to utilize/apply this information in your farm? Choose from a scale of 1 to 5, where 1 is the least and 5, the highest ability.
    a. 1-Not able to use
    b. 2-Use sometimes
    c. 3-when information is relevant
    d. 4-Always use it
11. Do you pay for this service?
    a. Yes
    b. No
12. If Q11 is yes, how much do you pay for the service?
    .....

13. Aside the digital technological services, do you have outreach engagements with agriculture experts?

    a. Yes

    b. No

14. If yes to Q13, how often do you engage with these experts?

    a. Once per season

    b. Twice per season

    c. Thrice per season

    d. Four and above per season

15. If your answer to Q13 is no, why?

SECTION C: EFFECTS OF DIGITAL TECHNOLOGIES ON FARMERS

16. How long have you been receiving this information from ADVANCE II?
17. How has this information impacted on your production process?

---

18. Which aspects of your farming process have changed? (you can tic more than one answer).
    a) Yield
    b) Post-harvest losses (due to market availability)
    c) Good/better prices
    d) Financial management
    e) Other, specify ……..

19. How has your farming process changed?

Based on the effects of the innovations, to what extent do you agree that "beneficiary farmers are no longer able to operate without the digital technological services".

a. Strongly agree
b. Agree
c. Strongly disagree
d. Disagree
e. Indifferent

20. What are your reasons for your answer in Q17 above?

Q22. Do you notice any effect of digital technologies on indigenous agricultural knowledge?

a. Yes

b. No

21. If yes to Q22, what indigenous agriculture knowledge do you think is affected (loss) by the introduction of the digital technologies?

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22. If no to Q22, do you still rely on indigenous agricultural knowledge (e.g. weather forecasting)?

    A. Yes

    B. No

SECTION D: PERCEPTIONS OF SMALLHOLDER FARMERS ABOUT DIGITAL TECHNOLOGIES

23. Are these innovations or information helpful to you?
    a. Yes
    b. No
24. On a scale of 1 to 5, how will you rank these innovations?
    a. 1 not impactful
    b. 2. Insignificant impact
    c. 3. Fairly good to agricultural knowledge
    d. 4. useful and reliable
    e. 5. Very useful and reliable

25. Has this innovations led to a change in your agricultural practices?
    a. Yes
    b. No
26. Has there been an improvement in productivity since you started using these digital information?
    a. Yes
    b. No
27. Has there been an improvement in your household food security situation since you started using these digital information?
    a. Yes
    b. No
28. Has there been an improvement in the income level of your household since you started using these digital information?
    a. Yes
    b. No
29. Are you prepared to pay for the service to continue after ADVANCE II project ends? And how much are you willing to pay?
30. How much (GhC) are you will to pay per week for the information
31. What is your general assessment of the digital technologies?

SECTION E: CHALLENGES OF FARMERS IN THE USE OF DIGITAL TECHNOLOGIES

32. What are some of the challenges you face in the use and adoption of these innovative digital services?

……
……
……
……
……

SECTION F: SOCIO-DEMOGRAPHIC CHARACTERISTICS

33. Age of respondent
    a) 15 to 19
    b) 20 to 29
    c) 30 to 39
    d) 40 or above
34. Sex of respondent
    a) Male b) Female
35. Educational status
    a. Formal education
    b. Non-formal education
    c. No formal education
36. Level of formal education
    a) Primary
    b) JHS/SHS/O'level/Certificate
    c) Diploma
    d) Bachelors' degree or above
37. Respondent's annual income (GhC)
    a) 0 to 500
    b) 501 to 1000
    c) 1001 to 5000
    d) > 5000
38. Number of acres of land respondent cultivates----------

THANK YOU.

INSTITUTIONAL INTERVIEW GUIDE:

This document contains a set of broader questions that are aimed at eliciting information on an academic study of the role of ICT in smallholder agriculture in Ghana. I intend to ask questions about the application of digital technologies in rural agriculture, targeted at

improving productivity of the smallholder farmer. The import is to gather implementing organization's perspective of the role of digital technologies in smallholder farming. However, other agents and partners who may have been involved in the implementation of the ADVANCE II project relevant to digital technologies shall be interviewed as well. The information when gathered shall be used solely for academic purposes and nothing else. I therefore seek your assistance and audience in this regard.

TOPIC:

DIGITAL TOOLS AND SMALLHOLDER AGRICULTURE: THE ROLE OF MOBILE PHONE-ENABLED WEATHER FORECASTING IN IMPROVING SMALLHOLDER FARMING PRACTICES IN NORTHERN GHANA.

1. Types of ICT and digital technologies provided for smallholder farmers (probe: **nature, categories, mode of transmission** [mobile phone, radio, TV], **forms** [*text messages, audio, video*], **package** [content of the *text*, *audio* or *video* Msg.] etc.).

2. Accessibility of the technologies to smallholder farmers (probe: **frequency** [*daily, weekly* etc.], **adequacy, affordability,** [free or paid for], **usability** [are farmers able to apply the information effectively on their own], etc.).

3. Effects of ICT technologies on smallholder farmers (probe: **types** [positive or negative], **nature** [both positive and negative effects], **extent** [eg increased productivity/yield and livelihoods] etc).

4. Smallholder farmers' perceptions about the ICT technologies (**types** [positive/negative], **nature** and **level of reliance** etc.).

5. Challenges facing smallholder farmers in the use of the technologies (**types** [eg illiteracy, poverty, no electricity etc.] **nature**, and **extent,** etc).

6. Implementing partners (who, what, how).

7. What is the geographical coverage of the ADVANCE II project in Ghana (which regions)? How many Districts in Northern Region are covered? What is the estimated number of beneficiaries on the project in Northern Region?

8. Did you establish any form of linkage between the implementation of the technologies and changes in livelihoods of beneficiary households?

9. What happens to these digital innovations (service) after the project ends.

10. Has there been in your opinion any form of knowledge transfer in terms of agricultural practices?

Thank you.