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ELECTRONIC AGRICULTURE EXTENSION AND THE RURAL FARMER: THE NEXUS OF TECHNOLOGY AND LITERACY

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BY

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AUGUST, 2022

DECLARATION

Student

I hereby declare that this dissertation/thesis is the result of my original work, and no part of it has been presented for another degree at this University or elsewhere:

Candidate:

Signature: Date: 22nd August, 2022

Name: Abubakari Sadik Tamimu

Supervisor

I hereby declare that the preparation and presentation of the dissertation/thesis were supervised following the guidelines on supervision of dissertation/thesis laid down by the University for Development Studies.

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ABSTRACT

The global system for agricultural extension is seen as a key strategy for addressing the farming needs of small-holder farmers. Ghana places much emphasis on extension officers and their systems but pays less attention to the needs of farmers and their views on using computerized agricultural extension services. This study assessed adoption of electronic agriculture extension services vis a vis technology literacy of farmers This research was carried out in the Yendi municipality of northern region, Ghana. The main aim of this study was identifying the link between literacy and technology adoption amongst rural farmers. The study location was purposely sampled because of high level of farming activities and prevalence of agriculture led NGOs in the area. Farmers who had access to the training and visits by some NGOs were targeted in the four extension zones in Yendi. Through (Simple random) sampling technique, 195 farmers from the four (4) extension zones in Yendi were surveyed. The study adopted the mixed model design of gathering the data. Descriptive, linear regression and content analysis were employed in analyzing the study's data. The descriptive analysis of the study revealed that, majority of the farmers receive agriculture-related information through multiple sources such as radio sets (14.29 %), television (3.97 %), NGOs (4.76 %), and mobile phones (3.17 %)The regression result shows that, Age, remittance, membership of MoFA groups, NGO groups, and access to credit and education were the significant factors influencing farmers' access to electronic extension services.at 5% level of significance. The study recommends that to further root the acceptance level of electronic extension services for mass implementation, systematic institutional changes are required to reshape the extension delivery system and services to meet smallholder farmers' needs, including making them user-friendly.

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DEDICATION

I dedicate this piece of work to the entire humanity from which I rise and fall.

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ABBREVIATIONS

GSGDA	Ghana Shared Growth and Development Agenda
GSMC	Global System of Mobile communication
GSM	Global system for mobile communication
ICT	Information and Communication Technology
ITDG	Intermediate Technology Development Group
ITU	International Telecommunication Union
AEAs	Agricultural Extension Agents
FAO	Food and Agricultural Organization
IMF	International Monetary Fund
SAPs	Structural Adjustment Programs
GDP	Gross Domestic Product
NGOs	Non-Governmental Organizations
LDCs	Low Developing Countries
MDGs	Millennium Development Goals
MOFA	Ministry of Food and Agriculture
T&V	Training and Visit
UNESCO	United Nations Educational Scientific and Cultural Organization
PFAG	Peasant Farmers Association of Ghana
ACDEP	Association of Church-based Development Projects
PFJs	Planting for Food and Jobs
VoIP	Voice over Internet Protocol
HCI	Human-computer interaction
OLS	Ordinary Least Squares

CHAPTER ONE

INTRODUCTION

1.0 Background of the Study

Undoubtedly, the world's main source of both revenue and food comes from agriculture. In the developing world, it is estimated to provide employment and income for almost 2.5 billion people (2008). It continues to be the foundation of many African economies, accounting for 57% of all employment, 17% of GDP, and 11% of export revenue on the continent (World Bank, 2008). Particularly in Ghana, the sector generated US$2,197 million in foreign exchange revenues in 2009, primarily from selling non-traditional agricultural products like cocoa, lumber, and rubber (ISSER, 2010). The Oxford Business Group reports that the agricultural sector has significantly contributed to the nominal GDP amounting to 15.3 percent in the second quarter of 2019, down from 31.8 percent in 2009. Farmers, loggers, fishermen, and hunters make up 50.6% of all labourers in the country, according to the MoFA (2010), with women making up 51.8% of this workforce in 2009 and, more recently, in 2019. Despite the sector's ups and downs, it plays a key role as a significant employer, employing 44.7% of the workforce. According to various calculations, between 44.1 percent and 51.5 percent of households, or 7.3 million people, own or operate a farm.

Essegbey (2020) reports that the government has been making considerable modernization efforts since 2017 due to the importance of agriculture in providing jobs for Ghana's expanding population. Even though Ghana's economy depends heavily on agriculture for growth, the industry lately saw declines in GDP, employment, tax revenue, and foreign exchange earnings. In 2010, the services sector

outpaced the agriculture sector as the largest contributor to GDP, growing by 6.1 percent and making up 32.8 percent of GDP, according to MoFEP (2010). Agriculture increased by 4.8 percent in 2010 and made up 32.4% of the GDP.

Many researchers have claimed that the inadequate post-harvest infrastructure (storage, processing, transport), low levels of technology, particularly mechanization, limited infrastructure, low uptake of research findings by stakeholders, and a lack of improved technological packages, particularly planting materials and certified seeds, are all contributing factors to the slowing growth of agriculture over the past few years (MoFA, 2007). Agricultural growth is necessary, though, for agriculture to assume its leadership position as the largest source of employment and the elimination of poverty for the majority of rural people. Agricultural extension services are intended to close this gap, but they are now a key activity and component of initiatives and programs designed to advance agriculture and enhance the standard of living for rural poor farmers (MoFA 2007, World Bank, 2008, NDPC, 2011, Danso-Abbeam et al. 2018).

In light of these challenges, one promising trend over the past two decades has been the substantial growth in the coverage and adoption of information and communication technologies (ICTs) and their impact, especially in remote rural areas (Aker, 2011; Aker and Blumenstock, 2015; Aker and Mbiti, 2010; Nakasone et al., 2014, Shaibu et al. 2018).

Particularly, the proliferation of mobile phones presents new chances for rural households to achieve several more general development goals. ICTs offer the ability

to improve farmers' access to financial services, connect buyers and sellers, boost farmers' access to public and private information, and facilitate the collecting of agricultural data. According to reports, Ghana's ICT infrastructure is advanced compared to other low-income nations worldwide, and the world bank claims that this development is even above average for sub-Saharan Africa (World Bank 2016). ICT for agricultural efforts have been developed and spread by both public and private sector actors during the previous decade, with more than 140 deployments globally in 2015. Most of these projects have given farmers, and traders access to pricing, weather, pest, and technical information (Aker, 2011; Nakasone et al., 2014), while a lesser portion has connected buyers and sellers or made financial services more accessible. These programs appear to have a mixed effect on agricultural outcomes, such as information availability, technology adoption, marketing, yields, or profits, according to an increasing number of economic analyses of them. However, despite the efforts made to close the gap, there is still a very significant digital divide in Ghana between urban and rural areas. By creating community information centres in each constituency in 2009, the ministry of communication pursued a program to address the information needs of rural residents to close this gap (Shaibu et al. 2018). This paradigm was crucial because small-scale farmers, who make up most of the population in these rural areas, are the sector's key players. These small-scale farmers greatly increase agricultural productivity; thus, they require pertinent information promptly to be productive.

1.1 Agriculture in Ghana

Between 2014 and 2018, the Ghanaian agricultural sector grew steadily. The third quarter of 2018 saw agriculture rise by 5.5 percent year over year, outperforming the growth of the overall non-oil GDP. This is according to the Ghana Statistical Service (GSS). According to budget data, the agricultural industry increased by 6.1 percent in 2017, more than double the 2.9 percent growth in 2016, and is projected to grow by 7.1 percent annually through 2022. According to the GSS, agriculture improved by more than 1% quarter-over-quarter in each of the first three quarters of 2018. The sector contributed value was GHS7.4 billion ($1.6 billion) in the third quarter of 2018 and GHS21.9 billion ($4.7 billion) in the first nine months of the year.

This implies that agriculture has not been able to lift many people out of poverty, especially rural people who significantly contribute to Ghana's agricultural productivity. Smallholder farmers, who make up the majority of the labour in Ghana's agricultural industry and who often farm on smaller plots of land (less than 2 hectares in size), use traditional farming practices and agricultural inputs. According to Asfaw et al. (2012), improving agricultural productivity growth can only be accomplished by creating and making available to smallholder farmers in rural areas superior agricultural technologies. Small-scale rural farmers are to blame for some problems, including insufficient credit, limited market access, and a lack of extension contacts, among others. One of the main barriers to the growth of the agricultural industry and rural community development, in general, has been identified as inadequate extension services. Due to the recent threats brought by climate change and the rapid advancement of technology, more farmers require capital investments in agriculture

and human capacity development to at least continue to make a living from farming. The strengthening of farmers' administrative and technical abilities through training, facilitation, and coaching, among other methods, is part of agricultural extension's responsibility today, which goes beyond the transmission of technology and an increase in output (Danso-Abbeam et al., 2018).

1.2 Agriculture Extension

One of the main avenues for addressing rural poverty and food insecurity has been agricultural extension programs. This is because it may facilitate technology transfer, enhance adult learning in rural areas, help farmers solve problems, and engage them actively in the agricultural knowledge and information system. According to the FAO, extension refers to "systems that should facilitate the access of farmers, their organizations, and other market actors to knowledge, information, and technologies; facilitate their interaction with partners in research, education, agribusiness, and other relevant institutions; and assist them in developing their own technical, organizational, and management skills and practices." Additionally, Davis (2008) defines extension and advisory services as the full group of institutions that help agricultural producers find solutions and acquire knowledge, skills, and technology to enhance their livelihoods and well-being.

In many developing nations, especially in the 20th century, achieving national food security was a top priority. This is known as extension service. To increase the yields of food crops, technology transfer was the main extension strategy adopted (Swanson

& Rajalahti, 2010). Agriculture extension has undergone a significant transformation, and new trends are still impacting its development and reform.

According to Davis (2008), extension in Africa was first designed as a service to convey knowledge based on research to the rural sector to enhance the lives of farmers, with the major focus being on increased yields through farmer training. However, this has altered today and is anticipated to go beyond fundamental farmer education regarding farm output. With a wide range of goals, including connecting farmers to domestic and international markets, promoting crop diversification, poverty alleviation, and environmental conservation, and viewing agriculture as part of a larger rural development process that includes enterprise development and nonfarm employment, it is necessary for EAS to play a bigger role in addressing the new challenges that face agriculture today. The extension now involves employing farmer group ways to connect them to output and input markets as well as a wide variety of concerns like financial services, typically through various types of partnerships. The use of standardized models has historically been a part of agricultural extension. However, decentralization, outsourcing, and privatization are the current tendencies in agricultural extension. Additionally, the private sector is taking on a bigger and bigger role in agricultural consultancy services, particularly regarding value chain development. Several actors have become involved in EAS because of this.

Most businesses are generated in the agricultural sector in many African nations, and this is what propels rural economic development (Heemskerk, Nederlof & Wennink, 2008). To help the millions of subsistence farmers, many of whom live in distant

places, more effectively, rapid productivity increases in smallholder farming is also necessary. Farmers also require an increase in financial assistance, access to fresh information, talent, and markets, as well as better physical infrastructure and communication systems. In recent years, many nations have realized the need to resurrect agricultural extension services to support pro-poor growth, reach out to poor, marginalized smallholder farmers, and address new challenges relating to sustainability, environmental degradation, and climate change, according to Zhou (2008). To help smallholders become more productive, make more money, enhance their quality of life, and help ensure food security, a variety of policies should be implemented, including the new paradigm of extension services (Swanson, 2008).

Among other things, the effectiveness and calibre of extension and advisory services (EAS) determine the long-term viability and productivity of the global agricultural sector. Farm yields are frequently low not because better methods do not exist but rather because farmers are either completely or practically ignorant of them. Governments, aid agencies, civil society organizations, and the commercial sector can all take steps to boost farmers' access to information. The equation includes an extension. The dissemination of agricultural research information to farmers was the definition of agricultural extension (Davis, 2008). The extension is currently expected to address several concerns facing agriculture, including but not limited to food security, environmental preservation, and building human and social capital (Davis, 2008).

The focus of agricultural development goals has shifted from technology transfer to prioritizing farm revenue growth and enhancing rural lifestyles. Organizing farmers into producer and other farmer groups is a crucial step in this process. Another crucial issue is educating farmers on managing natural resources and agriculture sustainably (Swanson & Rajalahti, 2010). Adopting integrated pest management techniques is part of training in sustainable agriculture methods (IPM). In SSA, most of the rural population occasionally has no access to any formal or informal banking services. To support the small farmer this has called for creative funding methods. Input-output interlocked credit arrangements are typically used by agro-processing enterprises to grant credit.

The best extension model for meeting the varied agricultural goals of different countries is currently the subject of a heated discussion, claim Swanson & Rajalahti (2010). There have been advanced creative models that aim for balance. Some of these supports a multispectral approach to extension development, highlighting the importance of the public sector while also recognizing the substantial role those private enterprises have played in technology transfer and extension, as well as the importance of non-profit groups in bridging the gap between the two.

According to Swanson & Rajalahti (2010), most extension models or paradigms are crucial for achieving various agricultural development goals. However, it will be necessary for most public extension organizations to move toward higher use of facilitatory and non-formal education extension methods to both enhance farm income and improve rural livelihoods for the rural poor. Small-scale male and female farmers,

including landless farmers, can start forming community or farmer groups. They can then learn the technical, management, and marketing skills they'll need to gradually diversify into higher-value crops, livestock, or other businesses that will boost their farm's household income.

Additionally, the agricultural sector has become more liberalized in terms of markets, inputs, and other services, and the role of NGOs and farmers' organizations (FOs) has advanced. This has increased the diversity of service providers at the local and national levels. Several nations are committing themselves more and more to participative and pluralistic extension systems. Extension workers today need diverse abilities as they need to become "facilitators" and "brokers" of knowledge rather than merely functioning as teachers due to the need from farmers for advisory services that go beyond teaching them how to use a particular technology. According to Swanson & Rajalahti (2010), technology transfer and advisory services tend to be increasingly privatized, and the agriculture industry in most nations is becoming more commercialized. To further expand agricultural productivity growth, as well as to raise the incomes and improve the quality of life for small-scale and landless farm households, it is crucial to forge strong public-private partnerships during this process.

The participatory approach is another method for providing extension services because it is thought that participation unites all parties in democratic or development discourse. An important benefit of involvement is accountability, according to the Axis's examination of participatory initiatives (as cited in Feder et al., 1999). Through farmer-led experimentation, analysis, and feedback, also has a good impact on

determining cause and effect. Participation also creates leaders, especially women, with relevant local backgrounds. It has also been noted that addressing gender issues in agriculture is a barrier to raising productivity. FAO (2011) points out that not all attempts at participation, though, result in totally pleasant experiences. Howell says (as referenced by Feder et al., 1999),

> *"Decentralization is frequently practically necessary for efficient local participation. Contrarily, there is a chance that the elite will reap the rewards of conventional agriculture with more passive forms of engagement."*

In the SSA and Ghana specifically, agricultural extension has not produced significantly more fruitful outcomes over time. The Peasant Farmers Association of Ghana, SEND-Ghana, and the Ministry of Food and Agriculture have engaged in a statistical discussion regarding the human resource strength of the delivery of agricultural extension services in Ghana. According to data from the Ministry of Food and Agriculture, there is one Agricultural Extension Agent (AEA) for every 1,500 farmers nationwide (1:1500). There is 1 AEA for every 3000 farmers, according to data done by the Peasant Farmers Association of Ghana and the SEND-Ghana organization (1:3000)- (PFAG, SEND GHANA, 2016) As a researcher, I find the situation in Ghana concerning when I compare the numbers to the FAO standard of extension officer-farmer ratio, which is 1:400.

If attention is not paid to the Agricultural Extension Services, which are the forces behind this transition, the goal of agriculture extension will continue to be a mirage (Matemilola 2017). According to Grasman et al. (2016), the issue is made worse by a shortage of the necessary equipment for the few AEAs to carry out their tasks, such as motorcycles, computers, and information. Additionally, Ghana's extension service agents are underpaid, especially those operating in remote and severely underserved communities, which leads to their being unmotivated, scarce, and unproductive.

The report asserts once more that the effects of subpar extension services delivery to smallholder farmers included poor agronomic practices, difficulties with post-harvest management, inefficient input use, pesticide abuse, low adaptive capacity for research and technology uptake, and insufficient access to supplementary information that could aid in increasing agricultural productivity in Ghana.

1.3 Electronic Agriculture Extension

Agriculture is growing more and more dependent on the use of information and communication technology (ICT). A recent field called "e-agriculture" aims to advance rural and agricultural development by enhancing information and communication infrastructure. The idea, design, development, testing, and implementation of novel information and communication technology (IT) used in the rural domain, with a heavy emphasis on agriculture, is what is specifically referred to as "e-Agriculture." We completely anticipate that as our knowledge of the topic advances, the scope of e-agriculture will change and broaden.

In the statement and action plan of the World Summit on the Information Society (WSIS), e-agriculture is one of the action lines that is highlighted in the "Tunis Agenda for the Information Society," published on November 18, 2005, highlights the leading and assisting responsibilities that UN agencies must play in carrying out the Geneva Plan of Action. The Food and Agriculture Organization (FAO) of the United Nations oversees planning actions associated with action line C.7 ICT Applications on E-Agriculture.

According to reports, mobile phone penetration in Ghana is so great that practically everyone has access to or owns one. Ghana alone has a penetration rate of over 24 percent and over 7 million smartphone users out of a population of 30 million, according to Newzoo's Global Mobile Market Report (2018). Considering this, it is important to investigate issues about digital technologies and platforms, especially in rural areas where ICT infrastructure is lacking, as more Ghanaians acquire or have access to cell phones.

It was found that the response in terms of satisfaction with the service and its utility was not particularly encouraging in research to evaluate the value of mobile-based agro-advisory services in a disadvantaged area, such as the state of Meghalaya in North-East India. Contrarily, farmers were quite enthusiastic about using cell phones in farming. This is encouraging because all the respondents had mobile phones, even though 50% of them had a TV and 65% had a radio in their homes. Surprisingly, 17.5 percent of those polled were functionally illiterate but still used family members to

help them decipher their texts. The study did, however, also show that most participants were not aware of the online channels that were accessible to them.

According to Hanumankar (2011)'s evaluation study, there is significant interest and acceptance among farmers for ICT-based agricultural extension services. According to the report, farmers aged 29 to 48 years are the most frequent users of a digital platform. Regarding academic background, farmers with over five years of formal schooling (86 percent) and farmers with fewer than ten years of experience are more inclined (47.5%) to make phone calls than to seek out digital platform support.

According to a study conducted by Suchiradipta (2012), many farmers had no idea the source of the information they received, and those who wished to receive such information had no idea whom to contact. According to a study conducted by Shaibu et al. (2018) on the effects of digital technology in rural parts of Ghana's Pru district, the most prominent benefits of utilizing digital technology were social networking and relationship development. According to the report, most respondents said that digital technology had either improved or substantially enhanced their ties and contacts with friends and relatives. The findings also demonstrated that the social benefits of digital technology were associated with fewer physician visits and lower travel costs. These findings show that, in addition to saving time and money on travel, digital technology assisted rural people in overcoming vulnerabilities connected to social isolation.

The link between digital technology usage and daily activity efficiency also produced a highly positive reaction, with respondents admitting that digital technology has led

them to accomplish more livelihood activities efficiently, which is a big contribution to human capital. The adoption of digital technologies allows rural residents to participate in a variety of activities, which can lead to increased revenue and cost savings (Shaibu et al., 2018). One of the findings of Shaibu et al. (2018) demonstrated a negative impact of digital technologies among rural people, indicating that the availability of digital technology devices had a negative impact on people's adoption behaviour.

In emerging countries, there is an increase in new apps that use data analytics to provide data on weather and growth conditions, commodity prices, ideal harvest windows, and extreme weather monitoring. Agricultural extension through digital advisory services, drip irrigation with soluble fertilizers, solar-powered pumps that deliver clean water to drip irrigation systems, human or drone soil and crop monitoring, and farm machinery guidance using positioning and mapping technology to determine the best routes are just a few examples of precision farming applications.

In agriculture, risk and uncertainty are omnipresent and diverse. They are caused by the unpredictability of the weather, pests and illnesses, volatile market conditions, and commodity prices. Agriculture risk management is especially critical for smallholders since they lack the resources to mitigate, transmit, and cope with risk. External parties are also discouraged from investing in agriculture due to risk. Timely information is critical for risk management. Information and communication technologies (ICT) are highly cost-effective tools for gathering, storing, analysing, and communicating risk information.

ICTs have lowered the costs of acquiring, processing, and disseminating risk-mitigation information for farmers. Farmers can receive early warnings of bad weather, market movements, and pest and disease outbreaks via information systems delivered via mobile phones and radios. Steps can be made to mitigate potential losses with early notice. Farmers can use remote advisory services to help them make risk-mitigation decisions or pick the best course of action in response to an early warning. These decision support systems are crucial for converting knowledge into risk-reduction actions.

Although there haven't been many ICT applications for managing agricultural shocks, those that have been created are essential and possibly game changing. It is simpler for ground personnel or impacted persons to contact whoever oversees the shock response with access to a mobile phone. This communication leads to more targeted humanitarian efforts. In the event of a shock, ICTs facilitate transfers and remittances to farmers from state and humanitarian organizations, as well as from farmers extended social networks. ICT is used to facilitate producer organization meetings and to enable agricultural Innovation Systems for Smallholders, making agricultural marketing stronger ICT and agriculture work together to promote "green growth" ICT facilitates and makes data gathering, monitoring, and assessment easier. These fantastic performances' efforts enable all these things to happen: Create exact copies of the text, drawings, photographs, audio, video, process descriptions, and other types of information at a significantly lower cost, send knowledge quickly over long distances using communications networks, develop standardized algorithms to large

amounts of information relatively quickly, and increase interactivity in communicating, evaluating, producing, and sharing useful information

1.4 Role of Information in Agriculture

At each stage of the process, farmers need information, including weather predictions, pest attacks, inputs, growth techniques, pest and disease management, and prices, in addition to having access to markets and other financial services. Farmers and traders are examples of agricultural market agents who historically obtain knowledge from various sources, including trial-and-error, neighbourhood social networks, agricultural extension services, and broadcast media, such as radio.

While traditional economic theory presumes that market participants have access to sufficient information to make the best decisions, farmers and business owners incur significant costs due to the difficulty in gathering this information in environments with numerous markets and inadequate infrastructure (Dorosh et al., 2010; Svensson and Yanagizawa, 2009). Due to the uncertainty of information regarding input pricing, output prices, weather patterns, possible buyers and sellers, natural disasters, and new technologies, farmers' and traders' decision-making is affected, which leads to inefficient markets (Aker,2010).

1.5 Literacy

There is no universal definition or criterion for literacy. The still-in-use definition of functional literacy was adopted by UNESCO's General Conference in 1978: "A person is functionally literate who can engage in all those activities in which literacy is

required for the effective functioning of his (or her) group and community and for enabling him (or her) to continue to use reading, writing, and calculation for his (or her) own and the community's development." Decision-making, results in inefficient marketplaces (Aker, 2010)

To address the difficulties of globalization, including the impact of new technology and information media and the emergence of the knowledge economy, literacy definitions were extended in the 1980s and 1990s. The literacy issue was characterized as "filling the basic learning needs of every child, teenager, and adult" in the World Declaration on Education for All (Jomtien, 1990). Nowadays, literacy is seen not just as a personal trait but also as a contextual and social phenomenon. The term "computer literacy," which is frequently used synonymously with "technology literacy," refers to someone's understanding of and aptitude for using computers (McMillan, 1996; National Research Council Committee, 1999) or to the level of comfort someone has with using computer programs and other applications associated with computers. Similarly, information and communication technology literacy are defined as the capacity to use technology to obtain, organize, analyse, and report information (Leu & Kinzer, 2000). The definition employed in this article, however, focuses on a broader vision of educational technology literacy. These notions have an educational context and focus on characteristics of technology literacy. According to Hansen (2003), technology literacy is "the capacity of an individual to embrace, adapt, develop, and evaluate technology to positively affect his or her life, community, and environment". A person who is digitally literate may, in the words of Eisenberg and Johnson (2002), "use technology as a tool for organization, communication, research,

and problem-solving." A complex combination of epistemological and pedagogical views, intrapersonal elements, social factors, and environmental affordances must undoubtedly take place to build technology literacy and effectively implement it in a scenario (Ertmer, 2005; Leu, 2006; Richardson, 1996).

This study will rely on this definition: technological literacy is the capacity to use technology (i.e., any tool, piece of equipment, or gadget, electronic or mechanical) effectively to complete essential learning tasks. People who are technologically literate understand what technology is capable of, how to utilize it proficiently, and make informed judgments about which technology to use and when to use it. Measuring the amount to which technology is adopted and used efficiently, on the other hand, can be difficult. While various attempts have been made to define technology integration and assess technology literacy (International Society for Technology in Education, 2007, 2008; Technology in Schools Task Force, 2002) these assessment strategies rely on technology adoption as a key indicator when evaluating technology literacy. A good frame for establishing technology literacy is simple to execute, but it is perfect for measuring technology literacy at its greatest degree. As a result, as shown in the table above, this study will apply a scheme to assess the literacy kinds and degrees of farmers.

1.6 Problem Statement

Delivering and funding agricultural EAS, such as marketing, input supply, and financing to smallholder farmers, is one of Africa's major development concerns (Coulter et al., 1999). Coulter et al. (1999), note that rural extension and advisory

services are crucial for maximizing the potential of rural people, empowering them to improve their quality of life, and fostering sustainable rural development. State-run, state-funded agricultural extension and advising services were instrumental in boosting agricultural output during the 1960s and 1970s. Public extension services were curtailed or even eliminated during the 1980s and 1990s due to economic liberalization and institutional reforms. The private sector must now supply extension and advisory marketing services in a creative, effective, and economical manner if agricultural output is to be increased.

The World Bank and other financial donors promoted several useful experimental models to provide a small-scale farmer extension following the failure of the public extension systems. Decentralization of extension services to the district level, privatization (transferring ownership and control to the private sector), cost recovery, cost-sharing, outsourcing, and demand-driven and participatory extension—group approaches, farmer-field schools, and farmer consultations in design and implementation—were some of these. Each of these four extension paradigms or models is crucial to achieving various agricultural development goals (Swanson & Rajalahti, 2010). There has been a lot of controversy surrounding the planning, carrying out, and funding of agricultural extension projects in developing nations (Swanson & Rajalahti, 2010). Public, private non-profit, and private for-profit sectors are the three main entities that could potentially offer EAS. How to best deliver and subsidize extension and consulting services is the problem.

What should be the roles of the public sector, private sector, and civil society; how can we make agricultural advisory services efficient and financially sustainable; how can we ensure that female farmer, the poor, and other marginalized groups have access to agricultural advisory services; how can we ensure that agricultural advisory services are demand-driven and meet the diverse information needs of farmers.

The necessity for a pluralistic extension system, which might include the delivery of extension services from the public sector, the private non-profit sector, and the private for-profit sector, has been suggested in a significant amount of the material we've evaluated. Finding an acceptable "mix" of public and private funding and delivery systems for the extension that will achieve various agricultural goals and serve a variety of target communities is the main challenge in developing a pluralistic service. Decentralization, contracting, cost-recovery, privatization, and the involvement of NGOs and farmer-based groups are major reform tendencies globally.

Since the late 1980s and early 1990s, governments of most developing countries in Africa have been implementing structural adjustment reform policies. These regulations, which were primarily issued by the World Bank and the International Monetary Fund (IMF), favoured structural adjustment programs (SAPs) and stabilization measures while pushing for drastic changes in the agricultural sector. These were centred on the privatization and liberalization of agricultural production, marketing, the provision of extension services, limiting the role of governments in policymaking, and the provision of essential public-sector goods and services (Ha-Joon, 2009).

The degree of impact of these reforms has varied across countries and sectors. One area that has been negatively affected by these reforms has been agricultural extension through the scaling down and/or disbandment of public extension services. The share of agriculture in overall bilateral and multilateral aid decreased from a peak of 22.5% in 1979–1981 to a low of 5.4% in 2003–2005 before rising to 6%, according to 2009 data from the Development Assistance Committee of the Organization for Economic Co-operation.

Many of the world's poor make their living in the agricultural sector, where the failure of the reform initiatives has been particularly severe. Strengthening rural productive sectors is necessary for food security, the elimination of poverty, and economic progress. However, investment in public goods (such as agricultural research, education, extension, and infrastructure) has been badly impacted by the state's departure from a developmental role, which has decreased agricultural productivity. In addition, market-oriented financial institution reforms have reduced access to finance for farmers even further than before. The increasing competition from imports brought on by trade liberalization has put many farmers' livelihoods in danger. The simultaneous promotion of agricultural exports in numerous nations that frequently specialize in the same goods has led to declining prices and export revenues.

It is the failure of these reforms and, in part, the loss of stature of EAS resulting from the promotion of a "one-size-fits-all" model— the Training and Visit (T&V) system, as well as the decline in investment in agriculture, both by developing country governments and aid donors that have led several developing countries, donors and

other stakeholders to revisit the method of delivery, financing and role of agricultural EAS.

Farmers throughout the nation urgently require the direction and assistance of extension officers, according to the Peasant Farmers Association of Ghana and SEND-Ghana, to embrace contemporary agricultural practices. They also urge the government to spend more on agricultural extension services by buying more motorcycles, providing extension employees with the tools they need to do their jobs, and ensuring that extensive research is properly linked. They urged the government to provide CSIR with adequate funding so that they could convey research findings to farmers and conduct more studies to identify even more crucial items that cater to farmers' requirements.

In particular, the research seeks to investigate how, despite the numerous interventions and initiatives by government and non-governmental organizations in the country, the role and relationship of literacy in the adoption of electronic agriculture platforms and programs as such initiatives are primarily successful when the target audience can effectively understand, associate, and use appropriately, the information and knowledge being disseminated.

ICT for agricultural projects have, according to research, enhanced farmers' knowledge, but this hasn't always resulted in higher yields, output prices, or profits. Basic issues of technology accessibility and usability—or the significance of separating the information effect from the technology effect—are less frequently

considered in economic studies on the topic. This is crucial because, even within the same nation, farmers' search strategies might differ significantly by crop, technology, and sociodemographic traits. The importance of the information source and trust, which are essential to comprehend how users interpret and use information, are emphasized in pertinent literature influenced by sociological and information systems techniques.

This study focused specifically on how one's ability to read, create, understand, identify, and manipulate a piece of information or technology despite gender, level of education, ethnicity, farmer group membership, location, and many others. To achieve this, the following research questions and objectives were used as a guide.

1.7 Research Questions

i. What is the literacy level of farmers?
ii. Which types of technologies are mostly used by farmers?
iii. How are farmers and extension officers able to use the technology and innovation available to them?
iv. How accessible are agricultural innovations and technology to farmers?

1.8 Research Objectives

i. To measure the literacy levels of farmers
ii. To identify the type of technologies that are mostly used by farmers
iii. To understand how farmers and extension officers can use the technology and innovations available to them

iv. To understand how accessible agricultural innovation and technology are to farmers

1.9 Justification

Most people in Ghana live in rural areas where agriculture is the main source of income. Most of the food produced in the country is produced in the rural sector. Thus, it is important to raise the living level of those who live there. An agricultural transformation strategy that is implemented in a methodical manner and speeds up for higher production and income is one way to do this. One of the objectives of offering extension services is to help farmers acquire improved agricultural technology, microloans, and marketing opportunities so they may boost farm output and generate wealth for better living conditions.

To do this, the government of Ghana has prioritized offering extension services more recently, but little progress has been made. This has been ascribed to a number of issues, including inadequate extension logistics, low funding for extended services programs, and undermotivated extension field employees. The success of this study's conduct and accurate documentation of its results in a written report will not only add to the body of literature as a database but will also serve as a model for future research into other facets of the social, cultural, and economic lives of those living in the study area. The research's conclusions will also be used by the government and organizations spearheading the campaign for rural development through digitization as input and lessons learned.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter will highlight, in an intellectual context, the literature on electronic agriculture extension and literacy of the farmers in sub-Saharan Africa and Ghana precisely. The review will begin by discussing the nature of agriculture extension in Sub-Saharan Africa and Ghana precisely, it will, on a second level, examine the state of electronic agriculture extension in the SSA and Ghana specifically before narrowing it down to the study area. This will then be followed by the discussion on the trend of accessibility of electronic agriculture extension and the skills and factors that enable accessibility. Another part of the review will look at the availability of electronic agriculture extension platforms that are available for both farmers and extension officers in Ghana and the study area precisely. The review will also examine the tents of digital platform usability by farmers, taking into consideration issues surrounding the literacy of the target of the digital platforms.

2.1 Policies and Programs that Support Electronic Extension and Advisory Services

In many countries, government policies and frameworks are one of the driving forces behind digitalization. These initiatives aim to create a competitive environment for digital marketplaces and electronic services. Governments are increasingly deploying their own electronic services, or "e-government," particularly in the fields of agriculture, health, and education, among other crucial areas of governance. Although

many developing nations have made little headway, designing, and implementing a digital government strategy demands a high level of administrative expertise (Affisco & Soliman, 2006).

Low-income developing nations typically have the most difficulty putting the process into action. Progress in these endeavours also depends on the industry, and in many nations, the agricultural industry, which is significant employment in rural areas, lags. Government digitalization strategies have not been the subject of published study; however, information can be gleaned from proxies such as the level of e-services provided by governments and their data and connectivity policies.

Juxtaposing the situation in the last decade, Governments have significantly improved digital networks and ICT access. Fixed and mobile connections are helping some affluent countries achieve nearly universal access, while the expansion of mobile services is helping poorer countries make progress. Several governments have started utilizing digital platforms in industries including education, agriculture, and health. However, due to low incomes, constrained user capacities, and a lack of infrastructure, many people in LDCs and developing nations cannot use digital platforms (ITU, 2021). As a result, they lack access to ICT. Because of this, further development of digital governance in these nations may be constrained as the pace of technical innovation accelerates.

Few countries offer e-Agriculture services, and government e-service development is frequently particularly delayed in this industry. The business climate and regulatory

framework for agribusiness are often better in countries that do make a big deal out of using ICT in agriculture. Because this does not appear to be correlated with GDP contributions from agriculture, levels of education, or literacy in such a country, it may be tied to the usage of ICT.

Studies have shown that the private or non-governmental sector has ripped off more positive feedback on implementing electronic services in rural areas than the efforts made by the government. Farmers in rural areas are more eager and active in participating in private or NGO-led extension services than government-led ones. For example, Danso-Abbeam et al. (2018), in their study on ACDEP, a non-governmental organisation's extension service delivery, discovered that involvement in the ACDEP agricultural extension program enhances welfare by raising farmers' income. Nevertheless, the effect levels varied depending on the method of empirical assessment used. The non-governmental organization Cowtribe, which focuses on animal health, has also been employing electronic means to extend farm services and has had better outcomes than the government's approach, according to Mumuni (2019).

To understand why this phenomenon prevails, Trendov et al. (2019) report that industrialized nations are setting the bar for national-level digital agricultural strategy implementation. In some instances, it is accomplished by making the agri-food industry the main focus of the already established national digital initiatives that seek to benefit a wider sector of business and society. The majority of electronic agriculture services, however, are integrated into e-government or ICT plans in developing

nations, where the primary goal is to offer fundamental electronic agriculture services like early alarm notifications and general information.

In Ghana, for example, the governments have, over the years, implemented agricultural sector policies and programs that require using electronic or digital platforms. The latest one is the famous Planting for Food and Jobs (PFJs), established in 2017 by the government. This policy was implemented to make it easier to access the input and output markets, thereby generating jobs along the agricultural value chain. The PFJ was established to provide the required energy for a medium- to the long-term transformation of the agriculture sector and the economy. To facilitate and coordinate relationships between farmers and pertinent agribusiness firms, all parties involved in the PFJ program would be connected to an integrated electronic platform.

In the first year, many stakeholders had issues with the implementation, therefore, (Mabe et al., 2018) assessed the implementation of the pillars and found out that farmers were not much aware of the packages of electronic agriculture, agricultural extension services and market linkages as compared to fertilizer and seed components of PFJ.

2.2 The Concept of Literacy

There is minimal consensus over what concepts like digital literacy and literacy might signify. While reading print texts is the standard definition of literacy, it symbolizes much more than that. The concept and phrase are a blank canvas on which the fears and aspirations of the public imagination and morality are painted (Bulfin et al., 2015).

According to Somi and de Jager (2005), there are two types of information literacy: understanding information contents and proficiency in utilizing ICT. These two types of information literacy are the foundation of lifelong learning in the information age.

> *Literacy* is *the ability, confidence, and willingness to engage with language to acquire, construct and communicate meaning in all aspects of daily living.* (Nichol et al., 2021; Somi & de Jager, 2005).

To help people realize their goals, expand their knowledge and potential, and actively engage in their community and the larger society, literacy involves a continuum of learning (Montoya, 2018).

The above definitions spell out the fact that the issue of literacy is slippery and unstable, but some key issues cut across all the definitions above, which the research will highlight below.

- ✓ It is about how individuals use it to express themselves through several media.
- ✓ Literacy is multiphase; the context varies depending on the purpose.
- ✓ Literacy involves continuous and proactive learning and is measured at different proficient levels.

Digital literacy has definitional issues and serves as another "empty canvas" for various interpretations. For instance, governments worldwide have championed the necessity of digital literacy in education policy and beyond since the 1990s, but this has been done in ways that are at odds with one another. On the one hand, if future

prosperity is to be ensured by a workforce capable of succeeding in the economies of the future, improving digital literacy is an economic need. According to Bulfin et al. (2015), there will be definite haves and have-nots in these new economies based on levels of digital literacy.

Education professionals, researchers, politicians, the media, and others will continue to show a significant interest in literacy and technology because of how deeply they relate to our pasts and our personal school experiences. Young people's and farmers' educational and social futures appear to be greatly impacted by the complexity of literacy and new technology. Users must use their comprehension of information structure or content to convey context during communication; the process of information transfer is influenced by individual or group capabilities, which include personal factors (such as information and information literacy core competencies), social pressure, shared beliefs, and motivational incentives, social network structure, physical proximity, recipient availability, and media characteristics (Gerpott et al., 2014; Tondeur et al., 2017; Wang et al., 2017.)

According to Milenkova et al. (2020), as society becomes more digital, there will be a greater need for people with digital abilities, including those who can use technology effectively, comprehend outputs, and design programs and apps. In addition to fundamental literacy and numeracy abilities, this calls for data management and communication abilities. ICT is developing at an exceedingly rapid pace and learning rates must keep up. Therefore, education must advance quickly in populations where such abilities are missing.

According to Hicks (2019), the discussions surrounding information literacy, digital literacy, and literacy skills have pushed educational definitions to the background because these topics are now more contextual and utilitarian in nature. According to Soyoof et al. (2021), new literacies studies draw from various interdisciplinary fields of study and tend to approach literacy and new technologies with two basic tenets: first, the definition of literacy has altered in tandem with other more significant social and economic changes. The second assumption holds that bettering literacy instruction in formal educational settings can benefit from an understanding of how individuals utilize literacy and new technologies outside of the classroom. From these views, the new literacies studies largely pursued two areas of inquiry: one examining a skills-based view of digital literacy, and the other examining young people's engagement in popular digital cultures.

For instance, in studying the old concerns and new opportunities of digital theories, according to Bulfin & McGraw (2015), digital literacy encompasses much more than simply knowing how to utilize a certain technology for its intended purpose. At its core, it also entails participation in meaningful, context-specific practices that draw on a variety of input. Each of these components is important in any assignment using new technologies, including digital tools, the texts they display, create, support, and share, as well as the social and cultural practices that develop around the use of certain technologies and texts.

Besides, Yu et al. (2017) argued that the debate on the digital divide and literacy no longer hangs on the access to digital infrastructure but on the ability of rural people to

utilize digital resources available to them appropriately, however, Trendov et al. (2019) report on digital technologies for rural people believes that access to digital infrastructure and institutions of learning remains important in winning the war of digital divide.

According to Bulfin & McGraw (2015), if digital literacy is something that certain people and groups can own, learn, or use, it must also be something that other people and groups cannot. Therefore, efforts to promote digital literacy must acknowledge that the ideal depends on its opponent, digital illiteracy. We must acknowledge that others face exclusion if digital literacy allows some groups to experience inclusion.

Digital literacy encompasses much more than merely being able to utilize the many digital gadgets that are accessible at any given time, as evidenced by the complex social, economic, and political environment in which these discussions and debates take place. The focus of this study will be on how farmers and people living in rural areas can use or not use the digital tools that are available to them.

Access to forms of rich engagement in settings that allow smallholder farmers to learn and practice critical digital literacy presents a problem in this case, in addition to access to technologies. Given the frequent claims made by governments that digital literacy promotes significant individual and societal advancement, as well as economic growth and affluence, a fuller understanding of digital literacy, must consider the significant economic forces influencing its promotion in policy and practice.

2.2.1 Digital Technologies and Literacy in Rural Areas

Basic literacy and numeracy skills, as well as specialized technical knowledge and abilities, are necessary for using digital technology. Yu et al. (2017); UNESCO (2017). Therefore, in increasingly digitally driven cultures, especially in rural regions, persons without such abilities may find themselves at a disadvantage. Youth and women are disproportionately affected by the high unemployment rate in rural areas. In rural areas, the agriculture sector remains a significant source of employment. The sector's transition to digitalization will have a big impact on how work is done and how much demand there is for labour and skills. In agri-food jobs, digital literacy will be more and more of a prerequisite, and appropriate education and training will be needed.

2.2.2 Types of Technologies and Platforms Used by Farmers

Nearly 80% of mobile phone owners in the sub-Saharan region send text messages primarily using their smartphones. In Tanzania, 92% of mobile phone owners use their devices to send texts, compared to at least 50% of mobile phone owners in other African nations. In South Africa, 95% of mobile phone owners use their devices for this purpose (Silver & Johnson, 2018) 49.7% of users had access to mobile internet in 2017, and most of these users were in Asia and Africa. Kenya recorded the highest volume of mobile Internet traffic, followed by Ghana, Indonesia, Nigeria, India, Singapore, and Nigeria.

Furthermore, 3 hours and 14 minutes a day are spent globally using mobile phones to access the internet, and diverse activities are performed on them depending on the user's age, gender, and personal preferences. Calls, text messaging, emails, creating

films, and social networking are the most frequent activities. In Uganda, 56% of adults have used mobile money services to withdraw cash, followed by 54% who have received or sent money (46 per cent). In Malawi, 42% of the adult population uses mobile to buy airtime, while 30% use mobile for cash withdrawals, followed by 23% for receiving money, 18% for sending money, and 12% for cash deposits (17 percent).

There is a dearth of research on the use of mobile internet and social media in rural areas in sub-Saharan Africa, despite the tremendous rise in these technologies' usage worldwide. Central and Southeast Asia have had the fastest increases in social media penetration, with rates of over 90% and 33%, respectively, according to Hafiz Yusoff et al. (2019). Social media use has surpassed 100% in Taiwan, Malaysia, and the Philippines. Saudi Arabia, with an 87 percent penetration rate, had the fastest individual country growth rate at 32 percent. India is next, where social media users have increased by 31 percent annually. Only 19% of the population in Nigeria, however, actively uses social media, thus, usage there is still low. The country with the highest penetration of active users is Ghana, with 29% of the population.

2.2.3 Mobile Apps, social media, and Networks Among Agriculture Stakeholders

Tourism, entertainment, health, shopping, education, and farming have all seen significant increases in the use of mobile apps to assist their businesses. In both rich and developing countries, mobile agriculture apps show a lot of promise for modernizing the agricultural sector. Mobile apps, for instance, can help small-scale producers raise their income, lower supply and distribution transaction costs, improve

consumer traceability and quality standards, and offer opportunities for financial institutions Costopoulou et al. (2016). Customers and farmers find it difficult to select from the expanding possibilities in mobile app stores because of the abundance of food and agriculture apps available.

There is also a wide range of agricultural apps available in developing nations, provided by either public organizations or local businesses sponsored by NGOs. Agricultural, horticulture, animal husbandry, and other agricultural disciplines have mobile apps available through this popular government platform. In India, Information about agricultural extension and increasing its effectiveness and cost-efficiency can be found at Digital Green. A well-known SMS and voice mobile app in Kenya are called iCow, which offers information as part of a subscription service. The objective is to increase farm productivity by giving farmers access to experience, knowledge, and information. Ethiopia and Tanzania both have access to this application. Small-scale farmers in Kenya, Uganda, Tanzania, and the Ivory Coast can use WeFarm, a similar SMS service software, to text questions and receive answers from other registered users. Esoko and M-Pesa, both owned by the Vodafone Group, are active in Ghana and other nations, offering voice and SMS information to farmers on various aspects of the agricultural value chain.

The Ministry of Agriculture and the Nigerian Central Bank introduced Smart Money in 2012, a mobile wallet initiative that distributes subsidized fertilizer through a digital voucher distribution system. It's a savings-and-payment system that's now available in Uganda and Tanzania as well. In the entire value chain, this approach replaces cash

payments. Large agribusinesses utilize Smart Money to send electronic crop payments to intermediate buyers' e-wallets, who then pay small farmers using the same method. This market is dominated by large worldwide corporations. They've been concentrating on building and launching apps in recent years. Monsanto, for example, has a digital agricultural platform called "Climate Field View. It provides information at the field level about the weather, soil, and crops to help with production decisions. To help farmers determine the number of goods and water needed per tank or region, DuPont Crop Protection has developed a new "Tank Mix App." Additionally, the German company Bayer Crop Science provides apps that let users confirm the existence of 232 pests and 218 diseases in different crops and provide suggestions for efficient treatment methods. Using a "Weed ID App," BASF hopes to identify 140 different weed species in the United Kingdom. Additionally, BASF provides a "Cereal Disease ID App," which gives mobile users immediate access to details on 36 cereal disorders. (Details on the host, life cycle, symptoms, significance, and available controls).

On the Android operating system, there were 561 agri-food-related apps available in 2016. For the iOS operating system, 589 apps were available. Some of the app categories include business and financial data, animal production, crop management, pests and diseases, agricultural machinery, spraying-related tasks, weather forecasting, training, agricultural news, and others (relevant to the agri-food sector). In 2016, there were just 42 mobile applications for the agricultural industry on the Windows Phone, which is still a relatively young device. Many of these are available on multiple app

stores. The most downloaded app has over 100,000 and focuses on farm machinery (Costopoulou et al. 2016).

2.2.4 Social media and Agriculture

Mass influence is the main reason agricultural producers use social media, which is an engagement medium (Varner, 2012). It gives farmers a voice and the capacity to interact directly with consumers, which can support both widespread interpersonal contact and direct marketing targeted at boosting sales (Carr & Hayes, 2015).

Peer-to-peer networking, connections between farmers and the processing industry, and consumer engagement are all significant benefits of social media communication in agriculture (Stanley, 2013). According to Sokoya et al. (2012), social media is being used more and more by agricultural researchers, professionals, and other industry stakeholders. When using social media platforms like Facebook, YouTube, blogs, wikis, and podcasts, extensionists must choose their content and outreach based on their target audience (Gharis et al., 2014). Saravanan & Bhattacharjee (2016), According to the study, there were almost 300,000 hits for the term "farming" on YouTube, 889,000 results for "agriculture," and 10,400 results for "agricultural extension." In recent years, farmers have started using social media more often. There are a ton of "farm selfies" on Facebook. In a study by Bhattacharjee & Saravanan (2016) that included 62 nations, it was discovered that Facebook was the social network that agriculture stakeholders used the most. With 336 000 members, "Digital Farmers Kenya" is one of the largest agriculture groups on Facebook and shares successful and innovative agricultural and food practices. Another is the "Africa

Farmers Club", which has 127 000 members and was established by a group of young, enthused farmers to foster a sense of community among African farmers by sharing knowledge, expertise, success stories, and encouragement. Southeast Europe has comparable platforms that are equally effective, particularly in the former Yugoslavian nations. 124 000 people from the area are members of the Facebook group "Dobra zemlja," who are worried about issues like those covered on the previous platforms.

In addition to social media, digital tools (VoIP) like WhatsApp are used to connect with the various parties involved in the agricultural value chain. To convey information, messages, and circulars via WhatsApp, the Department of Agriculture in the Indian state of Karnataka has mandated that all agricultural development employees possess smartphones. Similar to Facebook, the WhatsApp group "Baliraja" enables farmers from remote locations to ask and exchange agricultural advice, connect with experts in other fields, and pick up new concepts.

In addition to social media, digital tools (VoIP) like WhatsApp were used in 2017 to connect with those involved in the agricultural value chain. In order to convey information, messages, and circulars via WhatsApp, the Department of Agriculture in the Indian state of Karnataka has mandated that all agricultural development employees possess smartphones. Similar to Facebook, the WhatsApp group "Baliraja" enables farmers from remote locations to ask and exchange agricultural advice, connect with experts in other fields, and pick up new concepts. Agriculture, forestry, and fisheries had the lowest percentage of firms with a website (12%, compared to 50% of all businesses) and the lowest percentage of businesses with a social media

presence (11%, compared to 38% of all businesses) across all economic sectors in 2015-2016 (Dufty & Jackson, 2018).

Rural Africa has experienced a very high rate of ICT adoption during the past 34 years, which is changing the way farmers communicate, access, and distribute information, especially among younger generations (Jere & Erastus, 2015). Odiaka (2015), African farmers now have new opportunities to develop their knowledge and livelihoods due to the quick adoption of ICT (Aker & Mbiti 2010; Asongu 2015).

According to Andres & Woodard (2013), high internet costs and low smartphone ownership limit farmers' access to information and limit the agricultural support that may be provided through social media sites like Facebook. These restrictions mostly affect farmers in Africa, Asia, and other developing countries. Furthermore, due to a lack of understanding, At the professional or organizational level, farmers and agricultural extensionists are still lagging in using social media for information dissemination (Rhoades & Aue, 2010).

2.2.5 The Use of ICT in Agriculture Extension

According to the World Bank (2017), increasing investment in agricultural research, a keen interest in digital technology development on the part of the corporate sector, and the emergence of organizations dedicated to the agricultural development agenda have all increased ICT's ability to support agricultural sector development. ICTs, when implemented correctly, can create economic opportunities and social and political inclusion, resulting in shared wealth. The expansion of ICTs in developing countries

enables users to communicate and receive critical information, particularly for individuals and communities that are in remote areas (Aker, 2011).

Farmers and communities in remote locations confront challenges due to a lack of financial resources and personnel. According to Bell (2015), strong public extension agencies can only contact 10% of the farmer population directly. This figure is significantly lower in the case of restricted operational capital. Using digital tools such as social networks and VoIP to provide digital advisory services will broaden the range of farmers served. Sulaiman et al. (2012) investigated how ICT was being used in South Asia to promote innovation and found that its communicative potential had not yet been completely utilized. They contend that networks must be enabled so that communities can take advantage of the information generated and that ICTs can better realize their potential if intermediaries' obligations and innovative capacities are acknowledged and incorporated.

Zossou et al. (2010) reported that open-air video displays promoted unsupervised learning, emancipated local creativity and experimentation, and increased confidence, trust, and social cohesiveness among rural residents, especially the underprivileged, young people, and women. In Uganda, the goal of the Grameen Foundation Community Knowledge Worker is to increase farmers' access to trustworthy information by setting up a network of peer advisors who utilize smartphones and social media to connect with farmers in far-off areas. Delivering precise, accurate information that is pertinent to farmers' requirements is necessary just to contact them. Extensionists and extension organizations can stereotype farmers even though many

farmers use social media to engage with peers and experts and get information and knowledge: Farmers are reluctant to employ digital tools because they lack technological know-how and reliable information (Diem et al., 2011).

Inappropriate posts, privacy worries, competing opinions of stakeholders, and a lack of social media proficiency, despite the positive attributes of ICTs in delivering agricultural extension services, act as obstacles to the use of social media for the implementation of extension service programs, according to the report (Fuess, 2011; Newbury et al. 2014; and Lucas 2011). According to the FAO (2015), over 300,000 farmers in over 3900 communities in India, Ethiopia, and Ghana have been reached by the nearly 3000 videos that Digital Green has produced in over 20 languages. More than 370 000 adoptions have resulted from the videos, which have been seen over 200 000 times. The key obstacles to limited usage of social media in agriculture, according to Bhattacharjee & Saravanan (2016), concerns concerning information use include time management and personal privacy.

Furthermore, field-level extensionists' poor use of social media is attributed to a lack of awareness and social media abilities. Agriculture extension systems in developing nations do not use even basic use of ICT in the teaching and learning process. Due to a lack of ICT expertise among teaching staff, a lack of funds to purchase ICT, erratic access to power, and a lack of supervisory pressure to adopt and use ICT, this is the case (World Bank, 2011). Agricultural extension service stakeholders are frequently undereducated, and using social media necessitates both educational and technical knowledge. Extension workers, according to Thomas & Laseinde (2015), need basic

social media training. Among agricultural extension and research professionals in India, Facebook is the most popular social network. In Mali and Burkina Faso, Traditional approaches to using ICT for an agricultural extension have been top-down on radio and television programs created by organized extension agencies (Bentley et al., 2014). Farmers and local extension workers in Mali and Burkina Faso, according to Bentley et al. (2014), have remarked that further potential and current technologies, such as video on a cell phone and Bluetooth, in agricultural extension are largely untapped.

2.2.7 Usability of Agriculture Innovations and Technologies Available to Farmers and Extension Officers

The ISO 9241-11 Usability is defined as

> *"The extent to which a product may be utilized by specified users in a stated context of usage to achieve specified goals with effectiveness, efficiency, and satisfaction."*

Effectiveness explains how users might achieve goals methodically and accurately. Efficiency indicates the pace at which users attain accuracy and completeness goals. Satisfaction: This metric indicates how well people accept the system and how comfortable they are with it. According to Patil et al. (2016), The happiest users are those who find a website to be beneficial, informative, and simple to use; this is referred to as an "engaging user experience." In agriculture, usability is critical in engaging more farmers with modern digital data and technologies. "User acceptance"

is a limiting factor in utilising many agricultural applications regarding new technology. When it comes to technology, farmers are notoriously conservative.

Human-computer interaction (HCI) is a topic of study concerned with the design, implementation, and assessment of interactive systems while considering the context of use and the task that the user must complete. Usability is one of the focus areas of HCI. Later in the development life cycle, usability cannot be retrofitted into a design. The process of defining requirements should include usability specifications (Dix et al., 2004).

Using usability concepts is one approach to bringing usability into the design process. These guidelines can help designers make judgments that don't compromise the app's usability. Because there are fewer limits on how the principles should be implemented, Numerous circumstances can benefit from the application of usability design concepts (Dix et al., 2004; Kotze & Johnson, 2004). The principle of feedback, for example, stipulates that sufficient feedback should be supplied to users for them to determine what they need to do next to finish the work at hand. However, the approach is adaptable regarding how the feedback is given (Kotze & Johnson, 2004; Preece et al., 2007). For example, depending on the needs of specific user groups, feedback could be supplied by text, images, audio output, or a combination of these.

According to some researchers (Friemel, 2016; Ghobadi & Ghobadi, 2015; Van Deursen & van Dijk, 2015; Venkatesh & Sykes, 2013), due to a lack of knowledge of the many ICT decision behaviours, efforts to reduce the digital gap frequently fail.

Acceptance and adoption of the ICT method have been acknowledged as crucial challenges in closing the digital gap and ensuring its successful implementation. Along with technology, goods or services, social contact, and human factors, people's predisposition to use ICT must be considered (Goldhammer, Naumann, & Kebel, 2013;).

The main reason for this is that urban areas have more completed Internet infrastructure than rural locations. As a result, ICT use in rural areas has progressively received attention in recent years because these technologies drive rural and regional economies and enhance life quality from both an economic and social standpoint. Therefore, closing the digital divide between urban and rural areas has become a top goal in many countries. (Bruno, et al, 2010; Gerpott & Ahmadi, 2015b; Ghobadi & Ghobadi, 2015).

As a result, few policies have benefited from the intrinsic attributes of information literacy and interactive and online technology, even though ICT encourages some people to use new information technologies. Acquiring the necessary knowledge and abilities to use ICT successfully and efficiently has been the focus of discussion regarding the digital divide. These changes raise concerns about the rural population's access to information, the digital divide, and information literacy.

Knowledge and information have emerged as significant wealth-determining factors in today's knowledge-based economy and Internet era, replacing personal money as the primary driver of social standing (Ayanso, et al., 2014; Van Deursen & Van Dijk,

2011). Based on the assumption that accumulated information is disseminated globally via Internet-based media. ICTs offer the ability to provide timely, valuable, and accessible content to many farmers. However, the information given is only important and relevant if it is content-specific and localized. In rural areas, where agriculture is the primary source of income, most people in India live. Despite the government's significant efforts, farmers are unaware of the wealth of agricultural data that is available to them because of digital illiteracy (Raikar & Gawade, 2017).

Computers and mobile-enabled information services, as well as the rapid rise of mobile phones, have improved information distribution in the knowledge-intensive agriculture sector. In agriculture, mobile apps and websites may be the best alternative for increasing a country's net agriculture productivity. Farmers nowadays receive a variety of information on farming, such as seeds of many kinds, crop diseases, crop selection, agricultural weather, fertilizer, insecticides, and so forth. Various resources are dispersed throughout several distinct regions based on their origin, manufacturers, or suppliers. The data may have a variety of formats and contents, indicating that its structure and format are heterogeneous. As a result, a system that provides farmers with the necessary information immediately and in a localized manner must be created.

Researchers have proposed and tested ways to improve the usability of agriculture information and knowledge, as well as the importance of audience usability of various forms of digital technologies. For example, Khokhar et al. (2014) addressed the different ICT options that may be used to strengthen or improve the use of technology in Pakistan's rural agriculture industry. It was suggested that the latest agricultural

news and information be made available via e-boards and mobile devices. The idea was to automatically send users' phones local language text messages and photographs from e-boards to provide updates. In this way, farmers receive up-to-date information. The goal of the study was to make information more accessible and understandable. Farmers will benefit from increased usability and efficacy, which will help them boost agricultural yield. This aids in bringing a rural community up to international (standards).

Agriculture, according to Tamoutsidou (2013), is important for developing nations. It must adapt to meet the demands of the present. Since the beginning of time, humans have engaged in agriculture as a way of life. It should be remembered, though, that the need for agricultural knowledge predates the history of agriculture by almost as much. According to the study's findings, agricultural e-learning is a technology that improves farmers' education by expanding access to it. Finally, it was found that e-learning offered opportunities and benefits for the agricultural sector. Therefore, farmers will gain from appropriate E-learning instruction.

For farmers, Soumalya et al (2014) proposed an iconic interface. It has a feature called speech-based interaction in Indian languages. Farmers must take important agricultural knowledge with them. With numerous multiple modes of engagement strategies, the proposed interface bridges the language gap for Indian farmers. It also bridges the digital divide between farmers and non-farmers. Liu (2008), made the case that by using a variety of evaluation techniques, web designers can better understand their target audience, better understand their needs, and better tailor their work to meet

those needs. This argument was made about the topic of usability testing and the need for it. The essay describes how to assess a website. Examples of evaluation approaches include focus groups, cognitive walkthroughs, heuristic assessments, thinking aloud, questionnaires, and usability testing. The report recommends that designers be aware of the techniques and use them while skilfully analysing websites.

Grewal (2015), conveyed to farmers the significance of getting the right information they need for successful farming. Numerous web portals and agricultural websites are accessible for farmers, but few are aware of them. The paper discussed the necessity of effective communication between portals and farmers. Farmers should occasionally access practical and helpful information on the weather, crop pests, irrigation schedule, etc.

Panda (2013) examined how the digital divide affects the Indian situation and the rest of the world. The function of the rural library in bridging the digital gap is critical. It will also assist in the liberation of society and development of a well-informed society. The digital gap in India is highlighted by Bist (2007). The article goes on to detail the government's many ICT projects. In the context of India, the major obstacles and significant solutions for bridging the digital gap are discussed.

According to Liu & Meng (2007), socioeconomic issues are the primary causes of the digital divide. This is because most consumers struggle to comprehend digital items and their usage. The development of digital product usability aids in the fight to close the digital divide. If the design is user-centred, it is a solid strategy to eliminate the

digital divide's usability factors. In a nutshell, it will aid in the bridging of the digital divide. The authors discovered, for example, that while study participants were eager to embrace new technologies to improve their circumstances, designers' failure to consider the special usability requirements of low-literacy users prevented them from taking advantage of the opportunities presented by new technologies. Even though over 90% of off-farm workers had cell phones, most survey participants only used them to make and receive phone calls. The phonebook functionality, for example, was never used. Instead of using this function to save information about potential employers, for example, they jotted it down on scraps of paper, risking misplacing it.

Patil et al. (2016) explored how ICTs can assist farmers in attaining higher crop rates and yields by providing precision agriculture information. The information was distributed to the farmers via SMS. Using a database, a software system was developed to provide exact crop information. Automatic information distribution was made available in the local language via the website, app, and SMS.

2.3 Accessibility; Concept and Issue in Agriculture Extension

Access refers to receiving information on agricultural production activities from various sources and extension methods, such as the media, extension services, on-farm research, and so forth, as well as their frequency. Providing farmers with better technologies is essential for expanding agriculture (Pipy, 2006). Farmers who have access to various information sources can learn about new technology and encourage the adoption of innovations. Planning various extension events assists in disseminating various agricultural information, which then improves the utilization of that

information. These events include public engagement, instruction, exhibits, field days, and visits.

Numerous studies demonstrate that participating in various extension events positively affects adopting different agricultural technologies. Tesfaye et al. (2001) discovered that participation in on-farm demonstrations and training had a favourable impact on farmers' adoption decisions. Yishak (2005) In a related investigation into the factors that influence the adoption of enhanced maize technology, it was found that farmers' participation in the demonstration had a favourable and substantial association with adoption in Damote Gale Wereda. Several authors have also regularly noted the beneficial and significant connection between farmers' access to and usage of extension services. For example, Nkonya et al. (1997) discovered that extension officers visiting Northern Tanzania had a beneficial impact on corn and fertilizer quality. Many additional authors, notably Kansana et al. (1996), discovered a connection between taking part in training, having access to communication channels, having access to a variety of information sources, having a high level of understanding, and using enhanced wheat types. Because of this, it is essential to advise farmers that training, participation in demonstrations, and field days top priorities to disseminate pertinent agricultural knowledge and promote the use of cutting-edge agricultural technologies.

The dissemination of agricultural innovations also depends on other information sources like the media and local farmers. Interpersonal networks of communication between farmers, in particular, are important and have been shown in numerous

research to have a significant impact on farmers' adoption decisions. To provide information about a large region in the shortest amount of time, the mass media frequently play a significant role. According to Yahaya (2002), the current state of Nigeria's agricultural development demonstrates that the mass media has enormous potential for disseminating agricultural information. Numerous studies have demonstrated that the media significantly and favourably affects the uptake of agricultural technologies. In line with this, Yishak (2005) found that radio ownership and demonstration participation had a favourable impact in his investigation of the factors that influence the adoption of superior maize technologies in Damote Galewereda's Wolaita, Ethiopia.

2.3.1 Access and Use of Internet and Digital Technologies in Rural Areas

The use of social media, mobile devices, and the internet by farmers and agricultural extension agents, as well as rural residents' digital skills and a culture that encourages digital agripreneurs and innovation, are three key enablers. Given the prevalence of fast internet, web-enabled cell phones, mobile apps, and social media, VoIP3 and digital interaction platforms provide a huge chance to improve access to information and services for rural populations. Many small-scale farmers in developing nations are, however, still cut off from digital technology and are unable to use them. A climate that fosters innovation among farmers and agripreneurs is necessary to establish a "digital agriculture ecosystem.". Digital agriculture projects are already receiving more funding and collaboration, and start-ups are drawing interest from foreign investors and the media. In this process, youth always have a special role to play. They frequently have the upper hand in being digitally literate and capable of coming up

with novel ideas. When digital issues are included in learning programs, students will also learn how to use digital tools and develop their creative talents (Trendov et al., 2019).

Trendov et al. (2019) discussion of the prerequisites for access to digital technologies in rural areas refers to some fundamental prerequisites for using digital technology, which will afterwards lead to the farm and food sector's digital transformation. These include accessibility, affordability, educational achievement (literacy, ICT education), and institutional intervention. Subscriptions to mobile networks, network access, internet access, and electrical power are all examples of infrastructure and connection. By enabling users to tap into the talent of their workforce, form strategic alliances, access support services like training, finance, and legal services, and—most importantly—reach markets and customers, access to digital technology can offer smallholder farmers and other rural businesses with significant benefits. Users can connect with suppliers and information. However, bringing digital technologies to rural areas might be difficult. The number of people living in rural areas is decreasing globally, and there are few options for employment and education. Infrastructure, including basic IT infrastructure, is sometimes lacking, especially in extremely remote rural settlements and those with sizable indigenous populations. Particularly in emerging and least-developed countries, the expenses of rural locations with high poverty rates, and IT infrastructure is a substantial challenge.

Cellular subscriptions for mobile devices have increased recently over the globe. 67 percent of the world's population currently has a mobile service subscription after 1

billion additional mobile users were added between 2013 and 2018. (GSMA, 2018c; 2019a). Countries in Africa, Asia, and the Pacific have been largely responsible for this recent increase. In LDCs and developing economies, access to computers and the internet has also grown. However, 3.8 billion people are still unconnected, and a disproportionate number of them live in rural and isolated locations (GSMA, 2018c). Network connectivity in rural areas continues to be a problem. Only around a third of rural residents in LDCs have access to 3G networks, even though 4G is now the most widely used mobile connection worldwide and 90% of people can access the internet using 3G or better networks (GSMA, 2019a). Consumers now access the internet in large part because of smartphones. Mobile devices are becoming more accessible and inexpensive, even for rural populations, thanks to declining handset pricing and innovations like pay-as-you-go programs (Hahn & Kibora, 2008).

Seven out of ten of the world's poorest families have a cell phone, and more households in LDCs have one (ITU, 2018) However, these gadgets are typically not web-enabled (ITU, 2018). In the age of digitalization, information, and communication technologies (ICTs), such as computers and mobile phones, have fundamentally altered how people access knowledge and information, conduct business, and use services. However, there are still wide digital gaps both within and between nations (European Parliament, 2015b). Even though smartphone ownership and mobile broadband usage have increased more rapidly in developing countries than in developed countries in recent years, there are still twice as many mobile broadband subscriptions per 100 inhabitants in developed countries as there are in developing countries. Affordability is the main

barrier to smartphone ownership in LDCs, where a basic mobile broadband package still costs, on average, more than 60% of gross national income per capita (ITU, 2017).

Digital agricultural and food systems require a strong digital infrastructure, especially in rural areas. Although technological advancements and legislative reform have increased access to ICT for people worldwide, there is still a digital divide (Trendov et al. 2019). In addition, just as one technology, like dial-up Internet, becomes accessible to people of all income levels, another, like broadband, emerges, leaving users in developing nations "playing catch-up." Even though over the past five years, nations in Africa, Asia, and the Pacific have led the way in mobile cellar subscriptions, a large portion of people still do not own or use a mobile phone, and ownership is unevenly distributed.

Additionally, there is still very little availability of web-enabled cell phones and quick 3G or 4G internet connections in rural areas. To reduce this inequality and encourage smartphone purchase and use in places where it is currently unavailable, work will need to be done. Rural people in developing nations and LDCs have notably poor literacy and educational levels, which makes it difficult for them to adopt digital technologies.

According to Trendov et al. (2019), young people usually experience higher rates of unemployment than the national average, and this is especially true in rural areas. Employers are increasingly seeking candidates with technological expertise. Rural populations would lag in the new labour market due to a lack of e-literacy and technical

capabilities. It is necessary for school curricula to include digital subjects, for instructors to get better knowledge and abilities, and for classrooms to have more access to digital devices.

According to Trendov et al. (2019), governments must establish an enabling regulatory environment to realize the potential of the digital agriculture transition fully. Some countries, especially LDCs and emerging nations, lack the administrative expertise necessary to implement digital government programs. In addition to making reducing the digital divide a top priority, governments should explain to farmers, potential investors in the private sector, and start-up companies the socioeconomic justification for the digitalization of smallholder farming. Governments in developing countries and LDCs will need to make a significant effort to enhance their capacity in order to support this shift in policy and regulation.

Due to the growing need for data-enabled farming and related services, the market has seen a large influx of start-ups and new companies from the technology industry. Massive data collection will encourage the usage of machine learning and AI, and new models will be needed to make the data useful. The information gathered so far is typically insufficient to enable the comprehensive solutions and partnerships needed to transform smallholder farms into prosperous, long-lasting digital businesses. A decision must be made regarding data ownership and use; whereas manufacturers can use the data they collect from their goods; farmers are typically reticent to provide their data without obtaining anything in return. IT infrastructure and social,

organizational, and policy reforms must be incorporated into digital agricultural transformation programs in underdeveloped nations.

2.3.2 Empirical Studies: Factors Affecting the Use and Access of Agricultural Information

Different people and organizations have carried out several empirical investigations on the adoption of various agricultural technology both inside and outside of Ethiopia. However, there are few empirical research on the variables affecting how people acquire and use agricultural information. Since agricultural knowledge and information may be accessed, shared, and used in a material embodied form, the partial usage of varied agricultural information is expressed interns of the use of technology in this study. The primary focus of the literature study is on the various applications of agricultural technologies, including cereals and horticulture crops. For ease of presentation, the variables are divided into four groups: institutional factors, socioeconomic factors, psychological factors, and household personal and demographic variables.

2.3.3 Personal and demographic characteristics of households

Personal and demographic features of households are some of the most prevalent household traits most closely related to the access and utilization patterns of farmers. Age, sex, and education were examined from this group of variables in this study, but other variables were not examined due to the limitations of an empirical investigation.

The demographic features of homes should also be described in terms of age, which might provide a hint about the age distribution of the sample and the general population. Compared to older farmers, younger farmers are eager to learn new things. Older farmers may also be less inclined to employ knowledge and new technologies since they are more likely to be at risk and less adaptable than younger farmers. Various research presents a range of age-related findings. For example, Haba (2004) examined consumers' willingness to pay for new agricultural information distribution methods such as publication, radio, farmer-to-farmer visits, expert visits, and television. He also stated that older farmers were less inclined to pay for these agricultural information delivery systems than younger farmers, indicating that as age increased, older farmers were less willing to pay for information. Katungi (2006), found that older males in rural Uganda were less likely to engage in simultaneous information-sharing and -receiving, possibly because of the diminished capacity for effective communication that comes with ageing.

According to a study by Teklewold et al. (2006) on the use of agricultural information in Debre Zeit, Ethiopia, farmers' decisions on the level of adoption of exotic poultry breeds were negatively impacted by the age of the household head.

Another aspect that restricts access to and use of agricultural information is gender. Due to the prevailing sociocultural attitudes and conventions, men may be considered to have greater freedom of movement, which allows them to attend more meetings and training sessions and, as a result, have better access to knowledge. According to a

study by Katungi (2006), households headed by men typically develop and maintain a wider network of ties with family and friends.

Due to the detrimental effects of cultural norms and customs, male-headed families potentially have better access to agricultural information than female-headed households (Habtemariam, 2004). According to a study by Pipy (2006), there is a considerable difference in how men and women obtain knowledge about chicken production and how they use that information. Similar findings from earlier studies were reported by Yahaya (2001), who found that gender differences exist in the sourcing and application of agricultural knowledge. According to some authors, women are less likely to participate since they have a heavy workload at home and less free time to acquire or utilise the information that is provided. The assumption that married women will learn the information from their husbands prevents them from participating in the transfer of improved agricultural methods (EARO, 2000). In a study on the effects of Planting for Food and Jobs in Ghana published in 2018, Mabe et al. (2018) found that women were underrepresented in the activities of agricultural information distribution.

Women-headed families have fewer access to new technology, land, extension services and credit, (Mabe et al. 2018; Danso-Abbeam et al 2018). This demonstrates that the phenomenon of gender imbalance in agriculture has not been rectified through time to assure almost equal access and involvement. Extension programs and technical materials are primarily targeted toward male farmers, according to Dagnachew (2002). Male farmers are visited by extension agents more frequently than female farmers.

Women struggle to access extension channels on their own because of their low levels of education and cultural restrictions. Furthermore, the male-dominated extension system often forbids interaction and work with women because to the strong taboos and value systems in rural areas.

Women will always play an important part in agriculture, and this is acknowledged globally. Policymakers and administrators, according to Habtemariam (1996), still think that men are the ones who do the farming and that wives of farmers just have a "supporting function." This mentality among both planners and implementers has a serious detrimental effect on women's access to agricultural extension services.

According to Habtemariam (1996), extension workers have a bias against women. Because they don't consider the unique needs of women farmers, extension agencies frequently don't provide adequate information to them. They are frequently less educated than men, have fewer access to resources like money, and are frequently overwhelmed with family responsibilities that they cannot outsource in addition to productive activity. Women have not benefited as much as men from publicly funded extension services, but if an extension program successfully overcomes these barriers, it will be simpler for women farmers to join in activities (FAO, 1996; World Bank, 1995).

Compared to men, rural women and girls often have less access to education and modern technology. Due to their unequal access to knowledge, individuals are at a disadvantage when trying to decide what to produce and when to sell their products

(FAO 2002). It is generally accepted that obtaining, assimilation, utilization, and education are all related to agricultural knowledge. A farmer's ability to access, interpret, and evaluate information from a variety of sources is regarded to be improved by education, and it is also believed to help farmers make appropriate judgments to utilize agricultural information by reading better and analyzing (Shaibu et al 2018; Danso-Abbeam 2018; and Trendov et al. 2019).

A study by Shaibu et al. (2018) emphasized the role of social capital and networking in the present agriculture value chain. The study examined the effects of digital technologies on rural livelihoods and found that these tools have significantly increased social and economic interactions among rural residents.

2.3.4 Farming Experience

Another significant household-related factor that affects the manufacturing process is farming expertise. The utilization of agricultural technologies is aided by accumulated farming knowledge and expertise, which comes with more extensive farming experience. For instance, Danso-Abbeam et al. (2018) discovered that farmers with greater experience in the agricultural industry are more inclined to participate in ACDEP programs to boost farm output and profitability.

2.3.5 Household's socio-economic variables

Knowledge systems are dynamic as a result of people acquiring and assimilating ideas from many sources as well as adapting to changes in their environment. But access to and distribution of knowledge are not equal within or between communities. People

may have varying amounts of access to knowledge and resources, as well as varying levels of goals, interests, perceptions, and beliefs. Different social and agro ecological contexts interact with one another to create and transmit knowledge. It has to do with access and authority. Social status disparities can affect opinions, access to information, and, most crucially, the worth and authority of one's expertise. The knowledge of rural poor people, especially women, is usually overlooked and undervalued (FAO, 2004). As a result, a person's social and economic situation has a big impact on their ability to obtain knowledge.

Knowledge is created and transferred through interactions among various social and agro ecological contexts. It has to do with both access and control. The worth and authority of someone's knowledge can be impacted by differences in social position, which can also affect opinions and access to knowledge. Rural poor people's knowledge, especially that of women, is usually overlooked and undervalued (FAO, 2004). As a result, people's ability to obtain knowledge is strongly influenced by their social and economic circumstances (Katungi, 2006). Furthermore, farmers that live near a market will have the opportunity to learn from other farmers and input suppliers. The likelihood that a farmer will get important information increases with distance from a market. (Abadi, 1999; Roy, 1999). As a result, market frequency and distance from dwelling are crucial factors in agricultural information access and consumption.

2.3.6 Psychological Factors

The utilization of technologies and the availability of agricultural information are both impacted by psychological difficulties. In this study, attitude toward enhanced

farming, openness to innovation, drive for production, and information-seeking behaviour were identified as major variables impacting agricultural information availability and usage.

Typically, attitudes are described as a tendency to react favourably or unfavourably to a certain thing (idea, object, person, and situation). They are based on our experiences and involve or are closely related to our thoughts and beliefs. Because attitudes typically have some connection to interpersonal interactions, they serve as a crucial bridge between cognitive and social psychology (Kearsley, 2008). The degree to which respondents' farmers have a positive or negative opinion of improved farming is the definition of attitude toward improved farming in this study. A favourable attitude toward improved farming is one of the factors that can hasten the agricultural transformation process. Additionally, necessary for behavioural change is attitude modification. In a study conducted in the Adami Tulu District, (2006) discovered a statistically significant correlation between willingness to change and the uptake of dairy products.

The individual's receptivity to novel concepts related to diverse agricultural facts served as the operational definition of innovation proneness in this study. In a study conducted in the Dire Dawa administrative council in eastern Ethiopia, Asres (2005) discovered a statistically significant link between women's propensity for creativity, access to information about productive roles, and the use of readily available development information.

Information-seeking behaviour has been one of the theorized traits determining access to and use of agricultural information. This variable represents the respondents' eagerness to learn about various agricultural operations from various sources. According to Soylu et al. (2016), information-seeking behaviour has a favourable link with access, awareness of, and utilization of agricultural activities. Also, Soylu et al. (2016) conducted a comparative study between developed and developing country farmers in Sweden and Turkey, reporting that urban farmers have more alternative sources than rural farmers, and they concluded that access to various sources of information correlates with farmers' information-seeking behaviour.

The option of "asking other people" was highly popular with farmers in both Sweden and Turkey, according to the data included in their study that was gathered from those two nations. Vendors (Sweden) have low rates in both countries when requesting information from farming organisations in Turkey and the appropriate authorities.

2.4 Effect of Technology Adoption on Productivity

The innovation aims to boost production and efficiency to increase agricultural productivity, farmer welfare, and rural development in general, agricultural research and development initiatives seek to invent new technologies. A lot has been written about how agricultural technology affects food output, farmer satisfaction, and economic development Besley & Case (1993), Doss & Morris (2001), Mendola (2007), and Becerril & Abdulai (2007) have all written extensively on the importance of agricultural technology adoption in enhancing farmers' well-being, alleviating poverty, and reducing food insecurity (2009).

However, there are conflicting reports from emerging countries, according to Gemeda et al. (2001) and Morris et al. (1999), If agricultural technology adoption rates were low, raising rural farm households' living standards through increased output would be an unattainable goal in developing countries. As a result, established agricultural technology must be adopted to increase production and productivity, and thus the living conditions of the rural poor. Furthermore, agricultural technology dissemination and adoption is the best approach for developing countries to catch up with rich countries (Foster & Rosenzweig, 2010).

Most impact studies on agricultural technology adoption, whether reviews, whether global or national and empirical, have been conducted. A variety of approaches, including standard econometric modelling and qualitative narratives, have been used to investigate the impact of agricultural technology on productivity, farmer welfare, and other important social and development variables (Hailu et al, 2014). In researching agricultural technology adoption and the influence on farm income, Hailu, et al (2014) utilized regression models with econometric analysis, such as the Probit and Ordinary Least Squares (OLS) models. The outcomes of the regression analysis also showed that adopters outperformed non-adopters in terms of how adopting agricultural technology affected farm revenue.

2.5 Limitations to Smallholders' Adoption of Technology

Despite various initiatives, technology adoption among smallholder farmers has been demonstrated to be quite low, which limits their access to improved agricultural knowledge and technologies (Ajayi et al., 2003; MOFA, 2010). Adoption of

technology is a decision-making process that is limited for many reasons. These limits are typically imposed by external forces, as documented in TAM2 and TAM3.

A key factor in long-term adoption is farmers' ability to meet the resource demands of technology and technical requirements. Farmers must acquire the requisite abilities and knowledge because new technology has a price. Most smallholder farmers in Ghana lack resources and are ignorant (MOFA 2010). Agriculture technology adoption has been proven to be significantly influenced by changes in agricultural commodity pricing (Kijima et al. 2011). If the predicted benefits from adopting a technology outweigh the existing expenses, farmers may stop using it. Farmers may give up on the technology if the anticipated gains from adoption are less than the existing costs while being initially persuaded by higher commodity prices.

Peer effects or learning from other farmers is another factor mentioned in the literature that promotes the adoption of agricultural technology. Peer effects, according to (Kasirye, 2013), work in three different ways during the adoption of any technology: (1) people gain from acting in a way that their friends or neighbors would; (2) Friends can inform people on the benefits of the technology, and (3) peers can teach people how to apply a new tactic. Access to agricultural information and extension services is restricted for smallholder farmers. They frequently lack the resources to get information because of their resource limitations. Farmers' expectations that adopting new technologies will be profitable, as well as the accessibility and affordability of those technologies, are cited as two key factors that influence how risk-averse farmers are and are therefore important for successful agricultural technology adoption in

developing nations, according to (Kasirye, 2013). The aforementioned expectations are influenced by a variety of variables, including land size and availability, family labour, agricultural enterprise prices and profitability, and peer impacts.

The availability of cultivable land is one of the most prominent barriers to the implementation of agricultural technologies (Janvry et al., 2011) and (Carletto et al., 2007)). It is suggested that having access to land helps households with their cash flow problems and lowers their risk aversion. A large landowner's ability to experiment with new agricultural technologies can, however, influence the rate of adoption because they are more likely to be the early adopters.

2.6 Theoretical Framework

This section's goal is to showcase the research from the standpoint of diverse theoretical foundations for technology adoption and literacy. This study lends itself to several theories, but just a handful will be discussed in this part.

2.6.1 Theory of Technology Adoption

Since innovation adoption has been studied for so long, a variety of hypotheses and models have been created to explain it. Among the theories and models, the Theory of Planned Behaviour, the Roger Innovation Diffusion Theory, the Theory of Reasoned Action, and the Technology Acceptance Model stand out. According to Lai (2017), there are various theories and models of technology adoption. These include the Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1975), the Theory of Planned Behavior (TPB), and others (Taylor & Todd, 1995). The Technology Acceptance

Model (TAM) (Davis, Bogozzin, & Warshaw, 1989), the Technology Acceptance Model 2 (TAM2) (Venkatesh & Davis), and the Technology Acceptance Model 3 (TAM3) (Venkatesh & Bala 2008) are three examples of technology acceptance models. Roger's Theory of Innovation Diffusion (Roger, 2003). Roger's innovation diffusion hypothesis is extensively cited and used to model technology adoption.

2.6.2 Innovation Diffusion Theory

According to Rogers (1995), the "diffusion of innovation" hypothesis should serve as the foundation for the study on the acceptance and implementation of technologies. After reviewing more than 508 studies on diffusion, Roger created the "diffusion of innovation" theory to explain how inventions spread through individuals and organizations. The idea outlines how an innovation spreads over time through certain channels among the members of a social organization.

The process through which an invention progressively spreads among people in a social system is known as diffusion. The steps of comprehension, persuasion, choice, implementation, and confirmation helped shape Rogers before invention and acceptance, according to Rogers' (1995) diffusion of innovation theory. An S-shaped adoption curve comprises the early adopters, the early majority, the late majority, and the laggards (Lai, 2017). The Rodgers adoption theory, which is described below, outlines five innovation-decision stages of adoption. This work focuses on three of those stages.

The Decision Stage

During the choice phase of the innovation-decision process, the person decides whether to accept or reject the invention. While adoption refers to the "full use of an innovation as the best course of action available," rejection means "not to adopt an invention" (Rogers 2003). Innovations with a partial trial basis are often adopted more quickly because most people want to experience the innovation in their situation before choosing to embrace it. The vicarious trial can hasten the innovation-decision process. Rejection is possible at any stage of the innovation-decision process, though. Rogers distinguished between two types of rejection: active rejection and passive rejection. When innovation is actively rejected, the person contemplates adopting it after trying it out but eventually chooses against it. A discontinuation option, which entails rejecting an innovation after originally adopting it, is a type of active rejection. When someone adopts a passive rejection (or non-adoption) position, they do not even consider accepting the innovation. Rogers contends that these two types of rejection have not been effectively differentiated and studied in earlier diffusion studies. Rarely the processes of information, persuasion, and decision-making may be completed in the opposite sequence. Especially in collectivistic cultures like those in Eastern nations, group impact on adopting an innovation can transform an individual decision to accept an innovation into a collective innovation decision (Rogers, 2003). However, the decision stage is always followed by the execution stage.

The Implementation Stage

During the implementation phase, innovation is used. Though innovation is responsible for the novelty that "some degree of uncertainty is involved in

dissemination". Uncertainty over the outcome of the innovation can still be a problem at this time. The implementer could need technical assistance from change agents and other people to reduce the amount of ambiguity surrounding the results. Additionally, because "the invention loses its distinctive nature as the individual identity of the new notion fades," the decision-making process for innovations will come to an end (Rogers 2003). Reinvention is a crucial component of this stage because it typically occurs during the implementation phase. "The extent to which a user adapts or modifies an innovation during the adoption and implementation phase" is referred to as "reinvention" (Rogers 2003). A distinction between innovation and invention was also made by Rogers (2003). A new idea is used through the innovation adoption process, as opposed to how "a new notion is discovered or developed via the process of invention" (Rogers, 2003). Rogers continued by saying that the more times innovation is reinvented, the quicker it is adopted and institutionalized. Since computer technologies are innovations that comprise a wide range of potential applications, they are more open to reinvention.

The Confirmation Stage

The choice to innovate has already been made, but during the confirmation stage, the decision-maker looks for proof to back it up. According to Rogers (2003), a person may decide to modify their mind if they are "exposed to conflicting messages surrounding the invention." The person would rather avoid unfavourable comments and search for messages that support their decision. As a result, attitudes become significantly more important throughout the confirmation period. Depending on the degree of support for the acceptance of the invention and the individual's mentality,

later adoption or discontinuance occurs during this stage. Discontinuance during this stage can take place in one of two ways. The person starts by rejecting the innovation and substituting a better one. This type of choice to discontinue is known as replacement discontinuance. The reverse of the discontinuance decision is disenchantment discontinuance. In the second scenario, the individual rejects the innovation because they are unhappy with how well it functions. This kind of discontinuance decision may also consider the invention's failure to satisfy the individual's needs. Because of this, it lacks the primary innovation characteristic that affects the adoption rate: a perceived comparative advantage.

2.6.3 Theory of Reasoned Action

The Theory of Reasoned Action (TRA), which Fishbein & Ajzen created in 1975, is one of the most well-known and frequently used technologies adoption theories. It makes assumptions about how people would act when utilizing new technologies. The TRA model can be used to comprehend and identify a person's attitude toward a behaviour's aim. This idea holds that a person's intention influences their perception of and attitude toward their behaviour, which in turn influences their perception of and intention for their action. Additionally, "subjective norms," acknowledged societal norms, control how someone presents their goal. In their 1975 definitions, Fishbein & Ajzen defined "attitude" as a person's evaluation of an object, "belief" as a relationship between an object and some attribute, and "action" as the result of an intention. Attitudes, which are based on a set of ideas about the behaviour in question, are emotional in nature (Lai, 2017). The individual's subjective norms regarding how members of their immediate group feel about specific behaviours are a second

element. The theory of reasoned action states that a person's behaviour in a particular circumstance is determined by their attitude toward exhibiting the desired behaviour following the subjective norm, which describes how they react to pressure and influence from others they are related to and who are believed to be significant concerning the performance or non-performance of a behaviour.

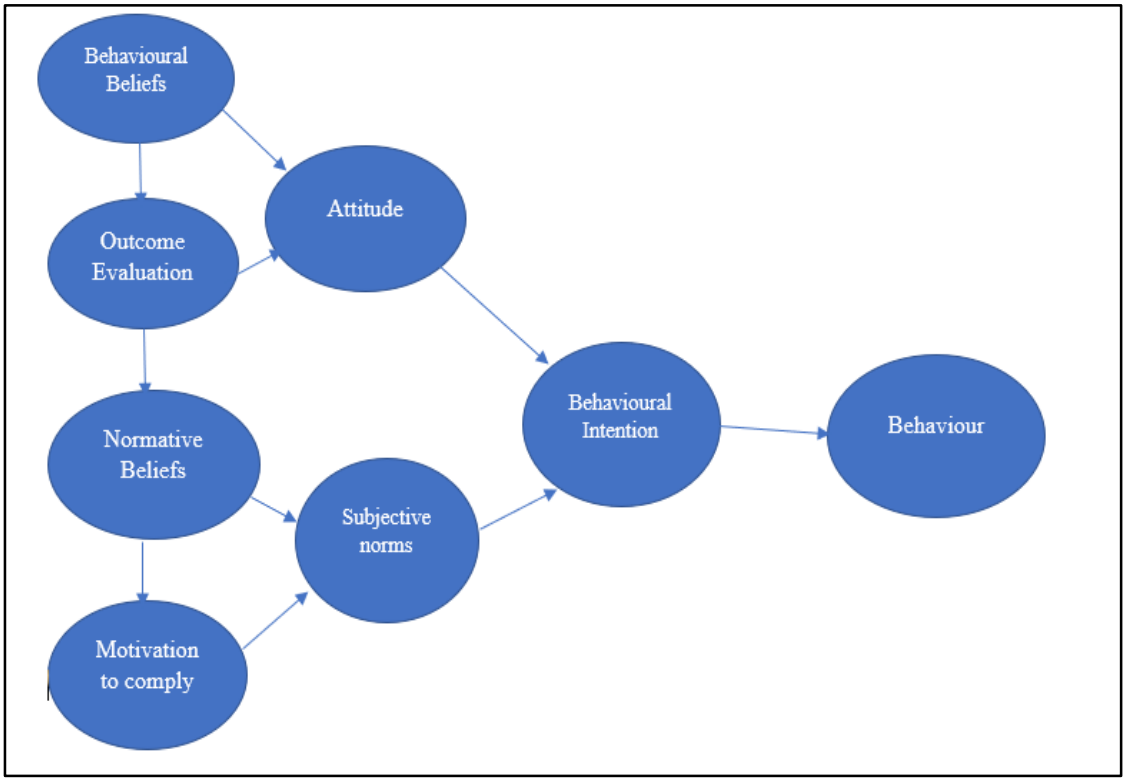

Figure 2.1: The Theory of Reasoned Action Source: Fishbein and Ajzen, 1975

2.6.4 Theory of Planned Behaviour

Ajzen's (1991) and later (2006) produced the Theory of Planned Conduct (TPB), which improved Fishbien & Ajzen's (1975) TRA by identifying the behavioural goal of the subject's attitude toward the behaviour revealed. Similar to the Theory of Reasonable Action, the first two TPB elements are: (Fishbien and Ajzen, 1975). The third factor, referred to as perceived control of conduct, refers to the power that people believe they have over their behaviour. The main objective of TPB is to anticipate intentional and prepared conduct. To explain the increasingly common circumstance in which people do not have full voluntary control over their behaviour, such as when they lack the means or capacities to perform a given activity, the theory incorporates the idea of perceived behavioural condition as an addition to the TRA (Ajzen 1991 and Ajzen 1985). The TPB essentially contends that three types of beliefs affect how people behave.:

- Individual judgments regarding the likely consequence of behaviour are reflected or represented by behavioural beliefs (Attitude toward a behaviour).
- Individual conceptions of the social norms in his or her immediate social surroundings, including family, friends, co-workers, and society at large; and
- Control perceptions (Perceived Behavioural Control) are beliefs or perceptions regarding the presence or absence of elements that might help or hinder the performance of an activity (Ajzen 1991).

Ajzen (2005) defined behavioural beliefs as associations between interest conduct and anticipated outcomes. A behaviour belief is a personal likelihood that a particular

action will lead to a particular result. Even though a person may have many behavioural beliefs regarding any conduct, only a limited number are always available. It is believed that these obtainable beliefs, along with the subjective values of the anticipated results, define the general attitude toward the conduct. The degree to which one values a behaviour's performance favourably or unfavourably depends on one's attitude toward that action (Ajzen, 1991; Ajzen 2005). Ajzen (2005) asserts that the entire collection of readily available behavioural beliefs linking activity to various outcomes and other characteristics determines one's attitude toward that conduct.

The subjective norm is the perceived social pressure to partake in or refrain from the conduct. Using an analogy to the expectancy-value model attitude, Ajzen (2005) emphasized that the totality of available normative views regarding the expectancies of pertinent referents determines the subjective norm.

2.6.5 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) is an information systems theory that explains how technology users come to accept and use it (Davis 1986). Perceived utility and perceived ease of use, which are crucial components of TAM, are the two elements that determine an individual's adoption of technology (Davis 1986, Lai 2017; Surendran, 2012).

Perceived usefulness, according to Davis (1986), is the prospective user's subjective likelihood that using a particular application system will enhance their ability to accomplish their work. Perceived ease of use refers to how much a prospective user

thinks the system requires little effort. Surendram (2012) found that these two factors are influenced by outside factors.

The social, cultural, and political forces are the external factors that manifest most frequently. Social elements include things like skills, language, and enabling circumstances. The use of technology in politics and political crises are examples of political aspects.

The Theory of Reasoned Action (Ajzen & Fishbien, 1980; Sheppard, Hartwick, and Warshaw, 1998), Theory of Planned Behavior (Ajzen, 1991), and Decomposed Theory of Planned Behavior (Taylor and Todd, 1995) have all been extensively studied, but Lai (2017) claims that most of it has been applied to already-available products and has taken societal perspectives into account (Subjective norm). On the other hand, the Technology Adoption Model (TAM), created by Fred Davis in 1986, is specifically made for modelling user acceptance of technologies or information systems.

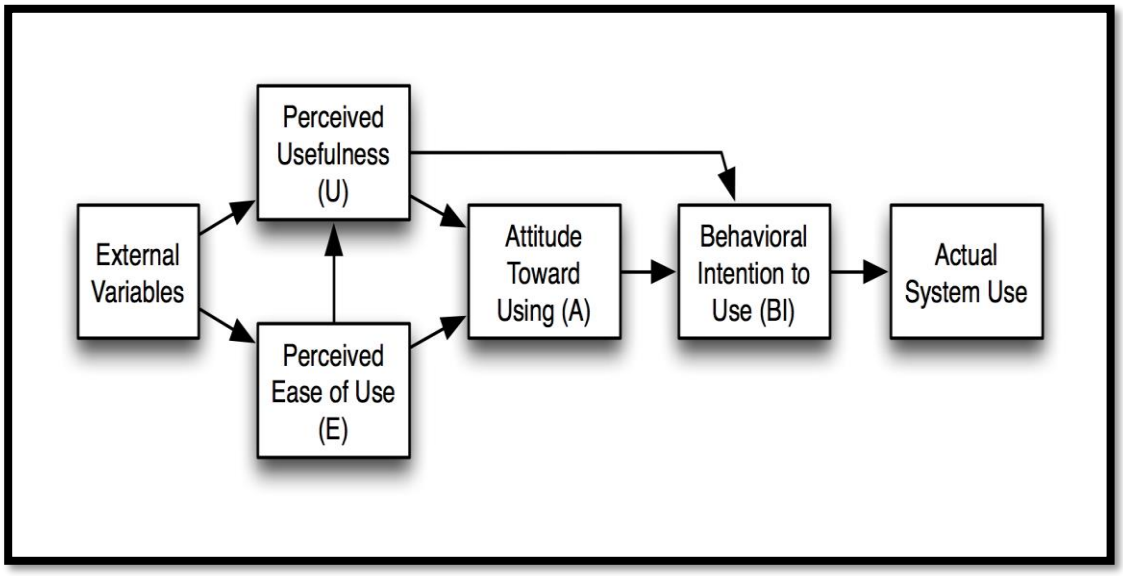

Figure 2.2: shows a diagram that represents TAM

One of the ideas that is used the most frequently to explain how information systems are used is the technology acceptance model. Numerous studies have been conducted, leading to changes to the concept that was initially given (Surendran, 2012).

The TAM 2 was introduced by Venkatesh and Davis in 2000, and it included more thorough justifications for why users thought a particular system was advantageous before installation, one month after implementation, and three months after implementation. According to TAM 2, a user's impressions of the system's usefulness are based on their mental evaluation of how significant work goals and the results of completing tasks utilizing the system line up (Venkatesh & Davis, 2000 as cited in Lai, 2017). TAM 3, an integrated model of technological acceptability, was created by Venkatesh & Bala (2008) by combining TAM 2 of Venkatesh & Davis (2000) and the

model of elements of perceived ease of use (Venkatesh 2000). In their technology acceptance model, Venkatesh & Bala (2008) considered four key factors: individual differences, system characteristics, societal influences, and enabling circumstances.

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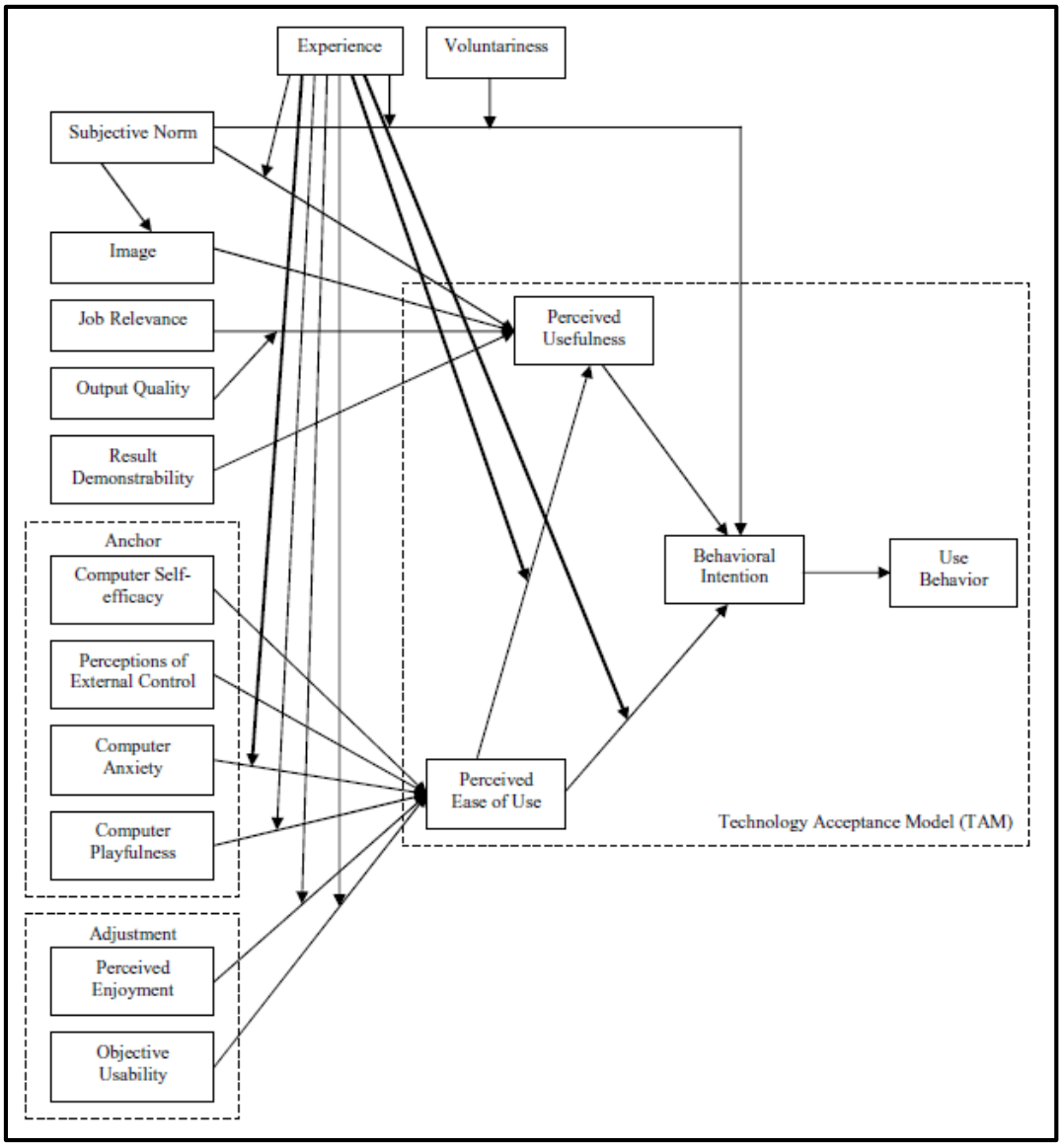

Figure 2. 3: presents a diagram of TAM 3

University students' behavioural intentions to use e-learning were assessed by Park (2009) using TAM 3, which measures users' behavioural intentions. The basic structural model was created based on the technology acceptance model and included e-learning, self-efficacy, subjective norm, system accessibility, perceived usefulness, perceived ease of use, attitude, and behavioural intention to utilize e-learning. The

TAM was discovered to be an excellent theoretical instrument for analysing consumer adoption of e-learning. Similarly, Chen et al. (2005) used TAM in conjunction with motivational theory to examine students' use of internet-based learning media.

According to Lai (2017), the UTAUT model's performance expectancy comprises five related dimensions: perceived usefulness, extrinsic motivation, job fit, relative advantage, and result expectations. In contrast, the effort expectancy includes the concepts of perceived ease of use and complexity. According to validation studies conducted by Venkatesh et al. (2003), social influence was minimal in situations involving voluntary activity. Because TAM has gained such widespread recognition, it has been cited in most studies on users' adoption of technology (Lee et al, 2013). TAM attempts to assist academics and practitioners in determining why a specific technology or system may be acceptable or improper and in taking the required safeguards by offering an explanation in addition to prediction (Lai, 2017).

Comparing the models

Various academics have utilized the TAM, TRA, TPB, TAM2, TAM3, and DOI over the years to explain technology adoption behaviour in individuals, groups, enterprises, and organizations. As new variables are emphasized and added by the various models, they have varying strengths and limitations. Davis, et al (1989) study compared the Technology Acceptance Model (TAM) with the Theory of Reasoned Action (TRA), leading to the convergence of TAM and TRA. Thus, a model based on three theoretical factors—perceived utility, perceived usability, and action intention—was produced (Lai,2017). According to Davis et al. (1989), cited in Lai (2017), social norms (SN)

are a weak predictor of behaviour intention (BI), and TAM does not take into account social norms (SN), which is a significant predictor, as posited by Theory of Reasoned Action TRA and Theory of Planned Behaviour (TPB).

Mathieson (1991) and Yi et. al (2006) claimed that human and social factors might play a role in the adoption of technology using the TPB model, arguing for the use of a combination of TRA, TBP, TAM, and DOI to overcome their limitations and maximize their collective strengths. As a result, the TAM might be supplemented with elements from the DOI theory to account for the social aspects that influence technological adoption. Some researchers have used many adoption theories to explain adoption behaviour.

Instead, Shih & Fang (2004), as cited in Lai (2017), investigated the adoption of internet banking using both the TPB and the Decomposed TPB and found that their findings were consistent with those of Venkatesh and Davis (2000). They found that in a mandatory environment, the subjective norm was likely to have a significant influence on behavioural intention to use, whereas, in a voluntary environment, the effect was likely to be insignificant.

According to Davis et al. (1989), cited in Lai (2007), social norms scales have very weak psychometric properties and may have little impact on people's behaviour intentions, particularly when the innovation being spread is quite private and individual usage is by choice. Additionally, TAM was created expressly to address the issues influencing consumers' system technology acceptance (Chau & Hu 2002 as

cited in Lai, 2017). The study's comparisons thus supported the finding that the Technology Acceptance Model was simple to implement in a variety of research contexts. Han (2003), Lai and Zainal (2014, 2015), and others pointed out the benefits of utilizing TAM capabilities.

2.6.6 Perceptions, attitude, and the adoption of technology

the process by which people convert sensory information into a coherent, thorough comprehension of their surroundings, which then affects how they behave. Although it depends on information, perception is generally equated with reality and governs human behaviour. The recognition and interpretation of sensory facts by us is the definition of perception. Information is perceived differently depending on how we understand it. It is possible to think of perception as the method by which we take in sensory information from our environment and use it to communicate with it.

Fishbien & Ajzen (1975) defined "attitude" as a person's evaluation of something, "belief" as a link between something and quality, and "behaviour" as the result of an action's intention. Attitudes are based on a set of emotionally charged beliefs about the topic of conduct (Lai, 2017). The tendency of a person to react favourably or adversely to a specific idea, object, person, or circumstance is known as their attitude. Using your understanding of the environment to take an interest in it.

The Theory of Reasoned Action (TRA), Roger Theory of Innovation Diffusion, Theory of Planned Behaviour (TPB), and Technology Acceptance Model all highlighted the influence of individual perception on technology adoption (TAM).

TRA disagreed, arguing that a person's attitude toward a technology influences their intention and degree of adoption. TRA further asserts that recognized social standards, also referred to as "subjective norms," are what control intention.

Even though perception, attitudes, and ideas concerning technology adoption are inextricably linked, previous studies on the subject seem to concentrate a lot of emphasis on socioeconomic and farmer traits. The review study by Seline et al. (2015) reached the following conclusion: We do not claim that traditionally studied variables, such as farmer characteristics and economic variables, are not important in the decision-making process or those existing models focusing on extrinsic factors have flowed, even though we suggest that knowledge, attitudes, and perceptions about the benefits and challenges of the technology play an important role in the decision to adopt.

Farmers' opinions on the production guidance offered to them vary. And these impressions have an impact on how they adopt such technologies. Farmers in Ghana believed that improved crop varieties of oil palm (Elaeis guineensis), cassava, and maize (Zea maize) lacked some desirable traits of the landraces and were expensive to adopt, according to a study by Asiedu-Darko (2014) that looked at farmers' perceptions of agricultural technologies in the context of some improved crop varieties.

2.6.7 Bill Green's '3D' or three-dimensional model of digital literacy

The concept has been applied in various contexts, including theatre, ESL, math and numeracy, ICT, English, media studies, and geography. It was initially developed to

assist students in thinking about writing across all subject areas in the classroom. However, it will be employed in this study to look at digital literacy with agricultural extension (Green 1988; Green and Beavis 2012).

The paradigm asserts that literacy [or digital literacy] encompasses three interconnected dimensions or components in a holistic, integrated picture (Green 2012). The operational, cultural, and critical are those. Together, these three aspects bring together, in that order, power (the critical), meaning (the cultural), and communication (the operational). One important distinction is that none of the dimensions must take precedence over the others; all the dimensions must be considered in any comprehensive strategy for promoting digital literacy.

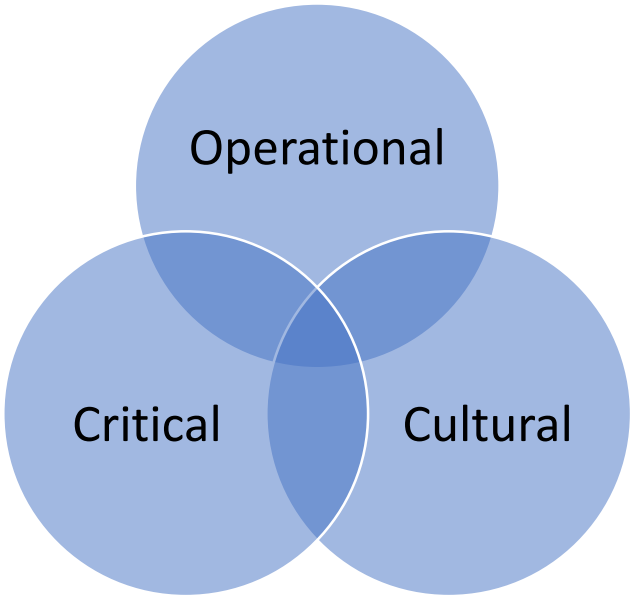

Figure 2.4: shows the three dimensions of the 3D model: operational, cultural, and critical

The operational component involves, but goes beyond, proficiency with 'tools'—for example, the steps and methods needed to manage a written and spoken language system effectively. People must be able to read and write efficiently and properly in a range of situations, including online contexts, in order to function within the operational dimension. Decoding letters on a paper or screen and writing in a variety of conventional genres, whether offline or online, are two examples. This dimension could encompass "functional" skills like "using" a computer, "sending" an email, or "uploading" a video to YouTube, but it's not just limited to those.

The cultural component acknowledges that being literate involves more than just being able to "operate" technological and linguistic systems; it also involves having contextual understanding. It might also be said that we never read anything objectively; rather, we always read something in the framework of a particular discourse or way of seeing the world. These affect the way we read and comprehend. The cultural factor forces educators to create genuine chances that connect to targets' everyday lives, experiences, and knowledge rather than decontextualized skill and drill exercises or useless lists of school-type digital literacy skills. The cultural aspect serves as a reminder of how elusive aspects like meaning, values, intentions, passions, beliefs, and ideology interact with behaviors, situations, and relationships to produce, in the context of this section, digitally literate identities.

Recognizing that all literacy is socially built or produced, or created or enacted via social acts, is the final crucial element. They contain certain knowledge, ways of thinking, and representations while omitting others, making them selective or

incomplete. The critical component focuses on power issues and how some forms of literacy are more common or powerful socially in particular contexts than others. To ensure that all people and groups may participate and make meaning and to transform and rebuild social practices, educators and students can analyze the implications of adopting dominant and marginal digital literacies by focusing on the critical dimension.

2.7 Conceptual Framework

The study focused on the types of digital technologies or some of the ICT equipment utilized by smallholder farmers in the study area after examining pertinent literature. The goal is to identify the various forms of digital technology before assessing how smallholder farmers are utilizing and implementing them. According to studies by the World Bank Group, digital technology can assist small-scale farmers in overcoming informational obstacles to market access, enhancing their expertise, and discovering novel approaches to enhance agricultural supply chain management (Deichmann et al. 2016). In addition, they noted that digital technologies are rapidly being used as fresh approaches to raise agricultural output worldwide, notably in the developing nations of Africa. Based on this, the study looked at farmer literacy of technology. The theories employed up until this point has helped the researcher develop the conceptual framework.

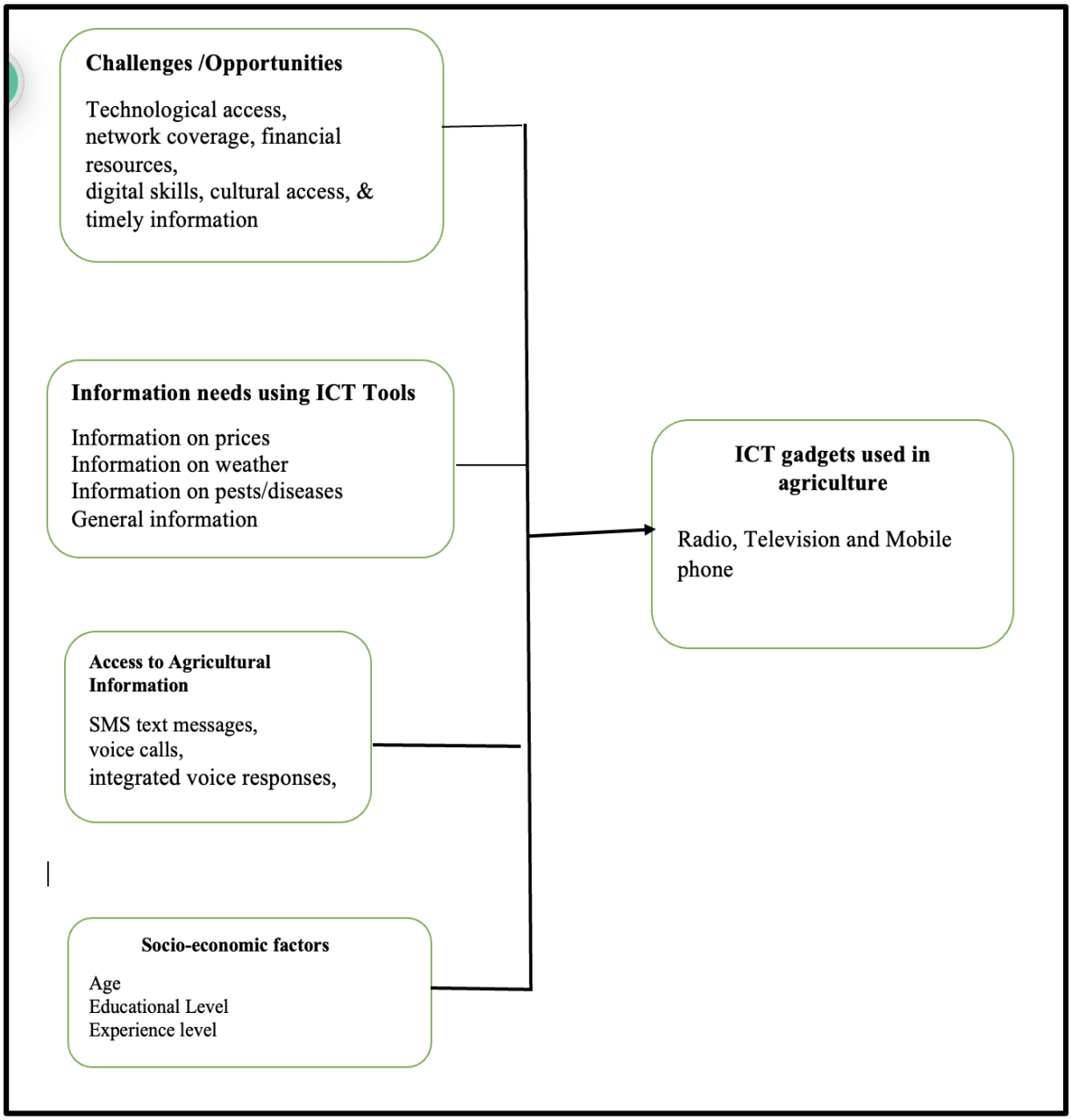

Figure 2.5: Conceptual Framework

The conceptual framework mentioned above provides descriptions of several elements relating to the usage of ICT by farmers in the study area. Regarding the use and application of technology in farming activities, the study looks at electronic agriculture extension and the rural farmer.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The Yendi Municipal is in Ghana's northern, eastern corridor. Most residents in the Municipality work in subsistence agriculture. Only 15% of the 535,000 hectares of total land are cultivated, with 481,000 hectares of the amount being arable land (Municipality MTDP, 2010-2013). Weaving, agro processing (extracting shea butter), meat processing, fish mongering, wholesale and retail of general products, transportation, and other economic activities are only a few examples. These are medium- and small-scale activities. Agriculture in the Municipality has a lot of promise. The land is good for growing vegetables, tubers, and raising livestock. Cattle, sheep, goats, pigs, and poultry fowl are among the animals raised for both home and commercial reasons (GSS, 2020).

3.2 Research Design

A descriptive correlation survey was the study's method of design. This design is appropriate because it examines the current situation and potential relationships between variables (dependent and independents) without attempting to change those variables. (Vanderstoep & Johnston, 2009). According to Best & Kahn (1998), researchers who use survey designs evaluate a wide range of variables, infer timeliness about past behavior, have experience, and test numerous hypotheses. According to Neuman (2003), survey researchers methodically ask several people the same questions about the status of a program.) In survey research, a sample of the population is typically examined to provide a quantitative description of trends, attitudes, and

opinions. According to Babbie (1990), questionnaires or structured interviews are the methods used for data collection and involve extrapolating from a population.

Additionally, this approach offers generalizable estimates for the entire population in each situation (Kraemer 1993; Glasow 2005; Creswell 2014). Both qualitative and quantitative methodologies were used in this investigation. This is due to the inclusion of both quantitative and qualitative research methodologies in numerous studies published in the field of social science (Creswell 2009; Creswell 2014). For a better comprehension of the data that was gathered, it is imperative that both methodologies be used in this study.

In this study, quantitative and qualitative methods were used to collect data on the literacy levels of farmers, the types of technology they use, and the accessibility of the innovations and technologies that are available to them. The researchers hope that this information will help them better understand how farmers and agricultural extension officers can use the technology and innovation that is available to them.

3.3 Data Sources

For this investigation, both primary and secondary data were gathered. Farmers, extension agents, and other study area stakeholders provided primary data. The Ghana Statistical Service (GSS), the Ministry of Food and Agriculture, and the municipal assembly provided secondary sources.

3.4 Sample Frame

The population from which the sample for this study was taken was the total number of farmers in the four agricultural zones of the Yendi municipality. Institutions in the frame included the Ministry of Food and Agriculture and the city parliament.

3.5 Sample Size

According to Best & Kahn (1998) there is no fixed percentage or number of subjects determines the size of a satisfactory sample. They argued further that a sample size may perhaps depend on either the nature of the population, the type of data to be collected, the analysis to be done or funds that will be available for the study. They also argued that when the communities are homogeneous or have the same characteristics there no need to select a large sample. In addition, Fraenkel & Wallen (2000) argued that for a descriptive research, the sample should contain a minimum of 100 elements for a correlational study and minimum of 30 elements for causal comparative study. They further stated that a minimum of 50 elements would be required to determine the existence of relationships.

Lists of all registered farmers from an Agriculture Technology Transfer group numbering 1,393 working with the four zonal AEAs in the yendi Municipality were compiled into a sampling frame for selecting farmers. A simple random sampling technique was used to select 195 farmers from the 1,393 farmers based on using Krejcie and Morgan (1970) table for determining sample size from a given population, a sample size of 195 farmers was chosen. The population was stratified into the zones. Proportionate random sampling technique was used to separately select sample

farmers from each of the selected community based on their populations. Best & Kahn (1998) explained the unbiased nature of simple random sample when they wrote that it guarantees that every sample of a given size as well as every individual in the target population has equal chance of being selected.

3.6 Sampling Procedure/Techniques

The study employed a multistage sampling technique in selecting the respondents for the study. Yendi municipal was purposively selected for its continuous and high level of production of agricultural goods in the northern region. It is also one of the municipalities that have received both government and non-governmental assistance in the agriculture sector aimed at ending poverty and ensuring food security (GSS 2020).

The Gnani, Malzeri, Adibo, and Yendi zones, the four agriculture extension zones in the municipality, were utilized in the second round of data collecting. Eight towns total—two from each agriculture extension zone—were chosen randomly to participate in the study. A random selection of farmers from each of the eight communities was made in the third stage of the sampling process, resulting in a total of 195 farmers, with 25 smallholder farmers from each community.

To ensure that the researcher had enough detailed information on the study, purposeful sampling was used to target the extension officers in each of the four extension zones. To gather further information to support or refute the concerns raised by the farmers and extension agents, the MoFA director of the municipality was also questioned.

3.7 Method of Data Analysis

This research was broken down into two sections for analysis. The qualitative phase used topic and content analysis to examine respondent opinions, whereas the quantitative phase used statistical tools (SPSS and Excel) for data analysis.

Objective 1: Descriptive statistics such as frequency, percentages, means were used. Frequency and percentages were used to analyze the following variables such as, sex, education, marital status. Emphasis were laid on farmers' ability to identify numerals, identify alphabets and their ability to place phone calls. The researched served respondents with samples of numerals and alphabets and asked the respondents to identify them. On the ability to place calls, when a respondent claimed they could place phone calls, researcher asked them to demonstrate. Also qualitative data was obtained from the extension agents on why one metric of the literacy measure was more predominant than the other.

Objective 2: Percentages and frequency was used to analyze farmers access to ICT tools, the type of information and the number of hours spent on such devices they have access to. Devices such as mobile phones, televisions and radio sets were used as the benchmarks. Percentages, frequency were used to analysis types of agricultural information, types agricultural information received.

Objective 3, looked at the technologies used by farmers, it also looked at education in forms of training on those technologies, the source of training and the duration of such

trainings. This is to ascertain how rural farmers have access to and use of farming technologies. Cross tabulation was used to present the findings

For objective 4, the Pearson, & Spearman correlation was first used to determine whether relationships existed between socio- economic and back ground characteristics of farmers and their ability to adopt electronic extension services. The point biserial was used to measure categories variables such as sex, age, farmers' groups and ability to identify numerals and alphabets. Also the Pearson was used to measure continuous or interval or ratio variables. For example, age and Spearmen was used to measured ordinal variable such as education. Thereafter, linear regression was used to determine the best predictors of frequency use of mobile phone and where tested at 0.05 alpha level. The Socio-economic and background characteristics variables influencing adoption of electronic extension services were computed below:

Y= access to electronic extension (dependent variable) Independents variables

Sex (1=Male, 0=Female)

Age (Years)

Household Size (Number of Person under the Care of a Farmer's & AEA's Heard)

Household Size (Number of Person under the Care of a Farmer's)

Farm Size (Acres)

Remittance (do you make income from your farming

Livestock (do you rear livestock)

Membership of MoFA group (Does the farmer belong to a MoFA group)

Membership of NGO group (Does the farmer belong to a NGO group)

Access to credit (whether farmers have access to credit)

No education (whether the farmer has been through school)

ICT tools to support farming (availability of ICT tools to support faming activities)

Able to read alphabets and numerals (farmers ability to identify numeral and alphabets)

3.7.3 Probit Regression Model

Since the probit model is effective at estimating dichotomous variables, it was used to evaluate the factors that influence farmers' decisions to adopt e-extension or not. Nagler (2002) asserts that the probit model restricts the estimated probabilities to 0 and 1 and does away with the need that the effect of the independent variables is constant across the predicted values of the dependent variable. The model assumes that the dependent variable (Y) has values of 1 and 0. The value of Y is, however, determined by an invisible or latent continuous variable (Y*) (Kuwornu et al. 2012). The Y binary variable found in this experiment is E-extension access (i.e., access and non-access).

The model's advantages are due to its efficient use of maximum likelihood estimation to estimate coefficients with asymptotic error distributions (Nagler, 1994). To put it another way, the probabilities are realistic, and the error term distribution is believable. The probability that the event—accession e-extension or otherwise—will occur is estimated using the cumulative density function of the error term, which has a normally distributed distribution. As a result, identifying the elements influencing farmers' decision to access e-extension services. Let the state of access to e-extension service be represented by AC, where AC= 0 for no adoption and AC= 1 for adoption.

The study assumes that Y can be expressed in the following way:

AC(Y)=f(X)

AC(Y)=($\sum_{i=1}^{n} \beta iXi$)

AC(Y) = $\beta_0 + \sum_{i=1}^{14} \beta$iXi + εi

AC(Y)=$\beta_0 + \beta_1 X_1 + \beta_2 X_2 + .. + \beta_n X_n + \varepsilon_i$

where AC(Y) is a dichotomous dependent variable which is refers to 1 access and 0 to non-access. That is

Y = 1 if Y > 0 (e-extension access)

Y = 0 if Y ≤ 0 (non-e-extension access)

β= represents unknown parameters to be estimated

X= Socioeconomic control variables and reasons for access

ε_i = Error term respectively.

3.8 Framework for Concepts

3.9 Ethical Consideration

The researcher made sure to treat all respondents and farmers respectfully while conducting the fieldwork. During the individual interviews and group discussions, the researcher provided farmers and interviewers with information sheets and explained the purpose of the study, ensuring sure they understood that participation was optional, that they could leave the study at any time without incurring any fees, that their full name and contact information would remain anonymous, that the information they gave would only be used for this particular study's goals, and that it would be stored

in a secure location. Additionally, the researcher requested their consent before using a voice recorder during the session. Most people who were interviewed individually gave their agreement for the voice recorder to be used; for the few people who didn't, the researcher took written notes of the interviews for the sake of data analysis.

CHAPTER FOUR

RESULTS AND INTERPRETATION

4.1. Introduction

The main findings of the current investigation are discussed in this chapter with an emphasis on the study's goals. The chapter specifically looked at the level of farmers' expertise around electronic extension and identified the technologies that farmers employ. The chapter also looked at farmers' access to agricultural innovation and technology as well as how farmers and extension agents employ these technologies and innovations.

4.2. Demographic characteristics of respondents

The table below shows the data that was collected and analysed. According to the findings, 54.4% of the respondents interviewed were males. The average household size in the study was revealed to be approximately 2, implying smaller household sizes in the study area, which may translate to a lower dependency ratio. As a result, there is less strain on household resources. Again, the study discovered that the average farm size of the sampled respondents was 1.8 hectares, which is not surprising given the study's focus on smallholder farmers. Furthermore, the study found that 52.8% of those polled receive remittances, which are expected to smoothen farm household expenditure and provide farmers with the ability to purchase ICT devices, enhancing their access to e-extension. Furthermore, 19.5% of respondents belonged to MoFA groups, while 23.8% of all farmers polled belonged to an NGO group. The study also discovered that 71.8% of the farmers polled kept livestock. Livestock, particularly in rural areas and among smallholder farmers, serves as a store of wealth. As a result,

farmers with livestock are more likely to have a good income, which will make it easier for them to use ICT tools and gain access to e-extension services. Furthermore, only 6.3% of the farmers interviewed had access to credit, which is insufficient and suggests that there may be constraints that limit farmers' ability to access credit. According to the study, 67.1% of farmers interviewed used ICT tools to support their farming activities, and 41% could read alphabets.

Table 4.1: Demographic characteristics of respondents

Variable	Mean	Std. Dev.
Sex	0.544	.499
Household size	2.292	.682
Farm size	1.764	.847
Remittance	0.528	.5
Livestock	0.718	.451
Membership	0.195	.397
NGO group	0.238	.427
Access credit	0.063	.243
ICT Support Farming	0.671	.471
Alphabet	0.41	.493
Age of Respondent	**Freq.**	**Percent**
20-24	21	10.77
25-29	32	16.41
30-34	32	16.41
35-39	41	21.03
40-44	33	16.92
45 and above	36	18.46
Total	195	100.00
Educational status	**Freq.**	**Percent**
No education	105	53.85
Primary	23	11.79
JHS/middle school	38	19.49
SHS	14	7.18
TVET	1	0.51
Tertiary	4	2.05
Non-formal	10	5.13
Total	**195**	**100.00**

Source: Field Survey Data, 2020

In terms of age, the study revealed that majority (81.5%) of the respondents were between the ages of 20 and 45, implying that the majority of the farmers were of a younger age and more energetic to carry out their farming activities given that the necessary conditions were created. The study discovered that a significant proportion

of respondents had no formal or non-formal education (Table 4.1), this can be attributed to the fact that the study was done in rural which naturally reflects low level of literacy and with smallholder farmers, particularly. Previously in Ghana, Doss and Morris (2001) reported that low educational levels of farmers had a negative impact on their technological adaptation, as their ability to read and write as well as apply the technological concepts appears weak. To enhance farmers' adaptation to the use of ICT related farming practices, Perez-Estebanez et al. (2017) posits that extensive training and capacity building are required to provide farmers with the knowledge and skills needed to improve their ICT usage and access.

One of the key drivers of technology adoption is the use of the mobile phone which requires some level of basic education for effective utilisation. However, the higher percentage of farmers (53.85 %) with no education with hinder the utilization and adaptation of electronic extension devices and services.

4.3. Objective 1: Examining the level of farmer literacy in the field of electronic extension.

The objective identified smallholder farmers' literacy level in the field of electronic extension in the study area. The predominant literacy levels studied were farmer's ability to read alphabets and numerals, place phone calls, send and read text messages as well as their ability to use internet services.

4.3.1 Alphabets

In determining the literacy level of farmers, it was revealed that literacy level in the study area was low. The study revealed that approximately 59.0% of sampled farmers could not read alphabets, compared to 41% who are able to read alphabets.

4.3.2 Numerals

Numerals represent one of the cardinal points of literacy. Globally, the smartest and most intelligent people are those with higher skills and lettered with figures. In the study area, for example, the data emerged that most of the smallholder farmers had very high exposure to numerals (Table 4.2). In a key informant interview with the AEA, it was revealed that the high exposure to numerals by the farmers was attributed to local lotto staking and daily money counting. This indicates how African rural communities can grasp concepts by word of mouth, and hands-on practices, below is what an AEA has to say on this phenomenon:

> "*You know, traditionally, the rural people are familiar with numbers because they are involved in lotto staking…. not only that, but money is also identified in numbers or numerals, and they are involved in money issues every day*" ….
>
> (AEA, Yendi municipal, N/R Ghana, 2020)

The above extract corresponds to the two of the dimensions of literacy by (Green 2012) which states that some components of literacy are more prevalent than others depending on the daily activities or lifestyles of a group of people. The model also describes how prowess in certain literacy benchmarks emanated from a contextual understanding of beliefs and practices.

Again, concerning the ability to read figures, 35.4% could not read against 64.6% who could read figures. This result makes sense because a higher proportion of respondents being able to read numerals could be attributed to their everyday involvement in business activities which involves money counting, and other related activities in which they must use numbers could account for why the majority could read numerals.

Regarding placing of calls, it was revealed that 72 respondents representing 36.9% of farmers, could not place calls on their own, whiles 123 respondents representing 63.1% of farmers, could place calls on their own. Again, farmers were asked if they received text messages regarding agriculture on their devices. With this, about 99 respondents representing 50.7%, indicated that they do not receive messages on their devices, whiles 96 respondents representing 49.2%, indicated that they received agricultural messages on their mobile phones. In addition, farmers were asked how they accessed messages via their phones. About 20 respondents representing 10.3%, indicated that they access the messages through the help of others' assistance, whiles 47 respondents representing 24.1%, indicated that they access the information by reading the text message by themselves. Furthermore, farmers were made to show some of the ICT tools they are aware of, out of the 195 farmers, 170 respondents, representing 87.2% farmers showed that they are not aware of any ICT platforms that support farming activities, whiles 25 respondents representing 12.8% farmers show that they are aware of the ICT platforms that support farming activities. Further, 156 respondents representing 80%, reported not having access to the Internet on their own, while 39 respondents representing 20%, reported not being able to use the Internet on their own. This shows that most farmers have been unable to use the Internet to search for agricultural information. This finding confirms the GSS (2014) study, in which peasant communities have limited access to the Internet due to their location, age, etc. (cited in Shaibu et al 2018).

Table 4.2: Farmers literacy level

Tabulation of ALPHABET		
Are you able to read alphabets?	**Freq.**	**Percent**
NO	115	58.97
YES	80	41.03
Total	195	100.00
Tabulation of NUMERALS		
Are you able to read numerals?	Freq.	Percent
NO	69	35.38
YES	126	64.62
Total	195	100.00
Tabulation of CALLS		
Are you able to place phone calls?	Freq.	Percent
NO	72	36.92
YES	123	63.08
Total	195	100.00
Tabulation of MESSAGES		
Do you get messages on your device regarding agriculture?	Freq.	Percent
NO	99	50.77
YES	96	49.23
Total	195	100.00
Tabulation of IF_YES_M		
	Freq.	Percent

If yes, how do you access it?	128	65.64
Help from others	20	10.26
Read the text message	47	24.10
Total	195	100.00

Tabulation of PLATFORM

Are you aware of any ICT platforms that support your farming activities?	Freq.	Percent
NO	170	87.18
YES	25	12.82
Total	195	100.00

Tabulation of INTERNET

Do you know how to access the internet on your own?	Freq.	Percent
NO	156	80.00
YES	39	20.00
Total	195	100.00

Source: Field Survey Data, 2020

4.3.2. Measurement of farmers' literacy level

From the survey, respondents' literacy levels were measured using very low, low, intermediate, high and very high. The results indicate that over half (54%) of the respondents in the sample had very low literacy levels. Approximately 19%, 12%, and 10% of farmers surveyed had low, intermediate, and high literacy levels, respectively. However, about 5% of the respondents were found to have a very high literacy level.

This is consistent with farmers' knowledge and the use of ICT tools within the study area, as explained in the following pages. Most respondents had no access to the tools, and the level of use was low, even with training provided by different institutions in the study area. The results also correlate with the determinants of mobile phone usage among small-scale farmers (Folitse et al., 2019). The low literacy rate realised in this study also correlates to the findings of Shaibu et al. (2018) in their study of peasant communities in the Pru district of Ghana.

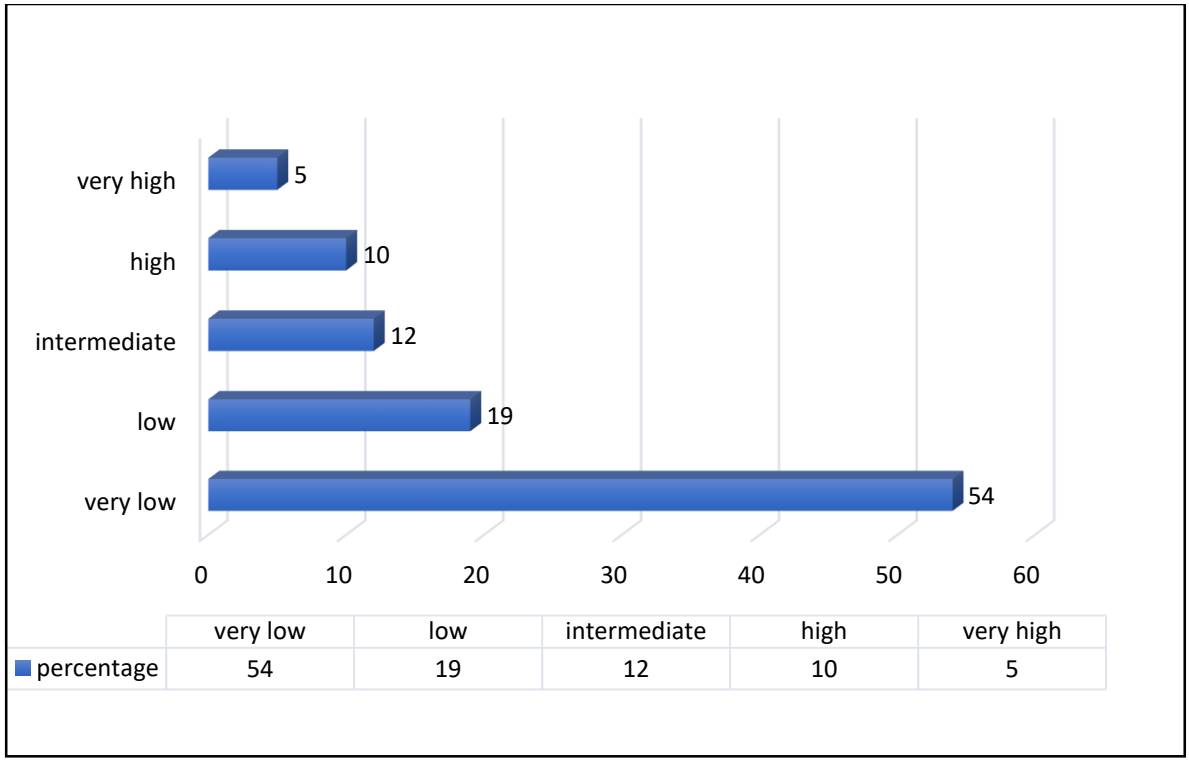

Figure 4. 1: Measurement of farmers' literacy level

Source: Field Survey Data, 2020

4.4. Objective 2: Identification of types of technologies used by farmers

The objective identified several types of technologies used by the smallholder farmers in the study area. The predominant ones identified were radio, mobile phones, and

televisions. These devices were generally used to access weather information, pest and disease management practices, prices of goods and services, including raw materials, agricultural tools, fertilizers, and labour costs, and sources of these goods and services.

4.4.1. Types of gadgets used to access information using the gadgets

The table below shows the devices that farmers use to support their agricultural activities, as well as the information that they access through those devices. According to the findings, approximately 47.5% of farmers use the radio in support of their agricultural activities, 26.3% use mobile phones, and 25% and 1.3% use television and more than one gadget in support of their agricultural activities respectively. A recent review on the use of ICT devices (mobile phone, radio, television and computers) suggest that farmers employ these devices to assess agricultural information such as market prices of farm produce, weather and good agricultural practices, including pest and disease identification and control measures (Etwire et al., 2017; Ayim et al., 2022;).Similar to these reports,, this study found that 21.6% of respondents used the devices to access information on farm product prices, 11.1% used the devices to access weather information, and 19.0% and 48.4% of farmers used the devices to access information on pest/disease outbreaks or infestation and general information respectively.

Table 4. 3: ICT tools used in agriculture

ICT gadgets used in agriculture	Freq.	Percent
Mobile phone	42	26.25
Radio	76	47.50
Television	40	25.00
More than one	2	1.25
Total	**160**	**100.00**
Information access using ICT tools	**Freq.**	**Percent**
Information on prices	33	21.57
Information on weather	17	11.11
Information on pests/diseases	29	18.95
General information	74	48.37
Total	**153**	**100.00**

Source: Field Survey Data, 2020

4.4.2. Other uses of ICT gadgets

According to the results shown in the pie chart below, a majority of the respondents (63%), in addition to using ICT gadgets to support their farming, also use the gadgets to access personal information. Approximately 10% and 9% of farmers use the devices to access social and business-related information, respectively. However, 18% of the respondents used the gadgets to access more than one piece of information at a time, which could be business, agriculture, social, or personal information, as realised by Shaibu et al. (2018).

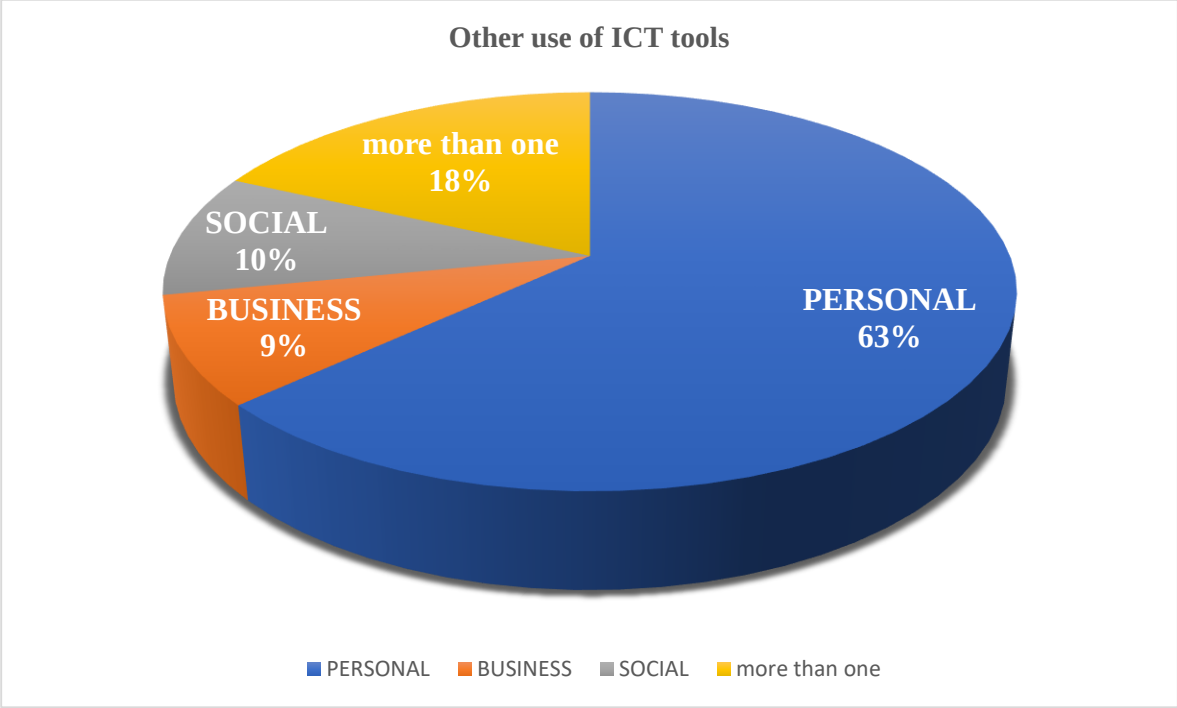

Figure 4.2: Other uses of ICT tools

4.4.3. Time farmers spend using ICT technologies.

The results show that 61.7 per cent of farmers with access to ICT tools use them for 0-3 hours a day. About 12.4% of farmers used technologies from 4 to 6 hours a day, and about 11.1% used technologies up to 7 hours a day. However, a little more than 14.8% of respondents did not know how much time they spent using the technology. Having the majority of the farmers spending between 1 and 6 hours a day using ICT tools validates the results in Table 4.1 and figure 4.4, that more than half of the respondents were within their youthful age and may have other personal uses for ICT devices. This result supports the conclusions of Ocansey et al. (2016), who studied the impact of social media on Ghanaian youth and reported that 65% of Ghanaian youth spend about 1-5 hours a day using ICT devices to access information on social media,

particularly personal information (Nyarko & Kozári, 2020).

Table 4. 4: Time spent using ICTs

Time spent using ICT tools	Freq.	Percent
0-3	100	61.73
4-6	20	12.35
More than 7 hours	18	11.11
Not sure	24	14.81
Total	**162**	**100.00**

Source: Field Survey Data, 2020

4.4.5. Knowledge of the use of ICT tools and sources of training

Many ICT tools, such as radio, television, mobile phones, and the internet, necessitate the use of some skills. The study assesses farmers' ability to use ICT tools to which they have access, and the results show that 90.6% of respondents knew how to use mobile phones, with 1.25% and 8.1% knowing how to use the internet and radio, respectively. This finding clearly demonstrates that the mobile phone is the most common ICT tool that most respondents in the study area are familiar with. The large percentage of farmers with access to and capable of using mobile phone services in the study area may facilitate the development of National Agricultural ICT-based policies to facilitate the dissemination of agricultural information services to farmers (Owusu et al., 2017) and improve food security among smallholder farmer, facilitate participation in radio and television discussions and invariably increase knowledge

and adoption of ICT related techniques (Hudson et al., 2017;Shaibu et al., 2018; Danso-Abbeam et al., 2018).

According to the study, 50.9% of those who answered yes to having the ability to use ICT tools received training on how to use such tools from various sources such as friends, relatives, NGOs, and Extension officers, while 49.1% did not receive training from any of the sources this supports the call by (Trendov et al., 2019) that skills training is a necessary requirement for adequate use of digital technologies. However, this high level of untrained farmers in using ICT tools may retie dissemination of new technologies, reduce adaptation to improved ICT tools and invariable hinders government efforts to change farmers' attitudes (Khan et al., 2012).

The enquiry as to whether farmers have received training on using these ICT devices showed that more than half (58.97%) of the farmers did not receive any training on using ICT devices. Of those who received training, 46.3% received their training from friends, 28.8% from extension officers and 12.5% and 8.8% from relatives and non-governmental organizations, respectively. Nonetheless, as shown in the table below, 3.8% of them received their training from more than one source. Primarily in Ghana, the AEAs, in collaboration with various NGOs, are involved in training farmers on adaptation to new farm practices, including using ICT tools. However, reports on the low ratio of AEA to farmers (1 AEA: 3000 farmers) may account for the low training received by these farmers (MoFA 2017; PFAG and SEND Ghana 2016).

Table 4.5: ICT tools farmers can use

ICT tools farmers are able to use	Freq.	Percent
Mobile phone	145	90.63
Internet	2	1.25
Radio	13	8.13
Total	**160**	**100.00**
Source of training	**Freq.**	**Percent**
Extension officer	23	28.75
NGOs	7	8.75
Friend	37	46.25
Relative	10	12.50
More than one	3	3.75
Total	**80**	**100.00**

Source: Field Survey Data, 2020

4.4.6. Farmers' knowledge of ICT tools

According to the study's findings and as depicted in the bar chart below, farmers' awareness of the availability of ICT tools (radio, television, internet, and mobile phone) was assessed using a semi-structured questionnaire. According to the findings, 36.9% of respondents were aware of more than one ICT tool, 33.8% were aware of mobile phones, and 14.9% and 8.2% were aware of television and radio, respectively. However, only about 2.1 per cent of respondents reported being familiar with all ICT tools.

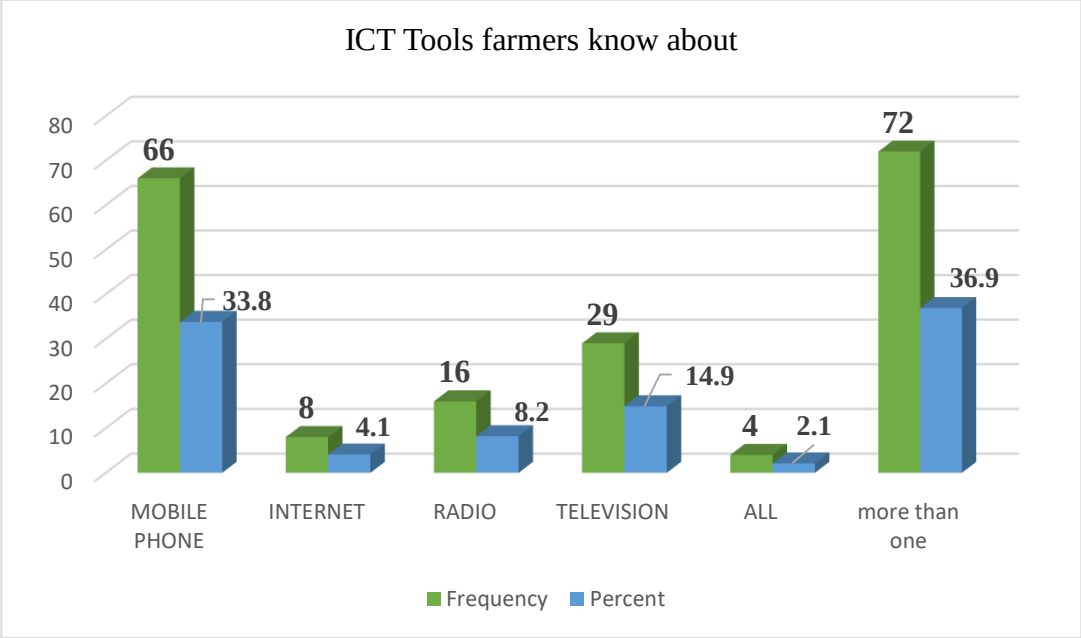

Figure 4.3: ICT tools farmers know about

4.5. Objective 3: Understanding how farmers use technology and innovations

Farming practice technologies used by farmers

Over the last few decades, efforts have been made in Ghana to correlate the provision of extension services with good agricultural practices and crop yields. Among these factors, inadequate AEA and low-capacity building of AEA, climate change, low soil fertility and productivity, pest and disease infestation, low-yielding crop varieties, and wild weeds all limit the success of smallholder farms today (Manteaw et al., 2020; Nyarko et al., 2021). As shown in Table 4.7, the data obtained from this present study point in the direction that various NGOs were the primary source through which farmers receive training on good agronomic practices such as planting distance, fertilizer application, and weed management practices.

According to the study, 93.85% of sampled farm households were familiar with line spacing as agricultural technology, of which 73.85% reported receiving line spacing training. Most farmers (68.67%) cited NGO training as the main training source, while indigenous training was the least reported. However, most farmers indicated that it did not apply to them, with 13.33% and 6% indicating one-week and four-week training periods, respectively.

For fertilizer application techniques, 92.82% of the 195 houses sampled knew the best time to apply the fertilizer, and the majority (73.85%) received training. About 65.97% are trained by NGOs, while 13.33% and 20.14% are trained by Aboriginal and extension workers (Table 4.7).

Regarding weed management techniques, of the 183 farmers who were aware of weed control, 78.14% received training, with 64.86% receiving training from NGOs and 13.51% and 5.41% receiving weekly and 4-hour training, respectively. In addition, 93.85% of the sampled households were aware of the planting date as agricultural technology, and 78.69% of them responded that they had received training in plantation data technology. Of the 78.69% who received training, a majority representing 67.36% received training from NGOs, 13.19% and 19.44% respectively from Indigenous sources and extension workers. However, 80.56% of the respondents indicated not applicable for the time duration and 13.89% and 5.56% for having weekly and 4-hour duration of training.

The study also revealed that out of 195 sampled households, 92.82% of them were aware of improved seeds and out of this percentage, 75.66% received training on the use of improved seeds and their benefits. The study further revealed that 66.90% of the farmers who received training had their training from NGOs, with 13.38% and 19.72% receiving training from indigenous sources and extension officers, respectively. Duration of training, as alluded to, by respondents, were 13.38% and 5.63% for weekly and 4-hour, respectively and 80.99% indicating not applicable.

Furthermore, integrated pest and disease control, which involves using biological and physical measures without the use of chemicals to control pests and diseases, the study noted that about 92.82% of the sampled farmers were aware of the technology, with 79.56% of those who were aware of the technology also receiving training on how to apply in on their farms. The study also added that farmers' training sources for technology were the aboriginal source, NGOs, and extension agents, with about 66.43% of them receiving their training from NGOs. However, according to respondents, the duration of the technology application training was weekly and four hours and over 80% of respondents indicated that it was not applicable.

Table 4. 6: common farming technologies used by farmers

Technologies	Awareness		Receipt for training		Source of training			Duration of training		
	Yes (%)	No (%)	Yes (%)	No (%)	IS (%)	NGO (%)	EO (%)	N/A (%)	weekly (%)	4-hour (%)
Line spacing	183 (93.85)	12 (6.15)	144 (73.85)	51 (26.15)	20 (13.33)	103 (68.67)	27 (18)	121 (80.67)	20 (13.33)	9 (6)
Appropriate time of applying fertiliser	181 (92.82)	14 (7.18)	143 (79.01)	38 (20.99)	20 (13.33	95 (65.97)	29 (20.14)	116 (80.56)	20 (13.33)	8 (5.56)
Weed control	183 (94.82)	10 (5.18)	143 (78.14)	40 (21.86)	25 (16.89)	96 (64.86)	27 (18.24)	120 (81.08)	20 (13.51)	8 (5.41)
Planting date	183 (93.85)	12 (6.15)	144 (78.69)	39 (21.31)	19 (13.19)	97 (67.36)	28 (19.44)	116 (80.56)	20 (13.89)	8 (5.56)
Improved seeds	181 (92.82)	14 (7.18)	143 (75.66)	46 (24.34)	19 (13.38)	95 (66.90)	28 (19.72)	115 (80.99)	19 (13.38)	8 (5.63)
Integrated Pest and disease	181 (92.82)	14 (7.18)	144 (79.56)	37 (20.44)	21 (14.69)	95 (66.43)	27 (18.88)	115 (80.42)	20 (13.99)	8 (5.59)
Use of chemicals	182 (93.33)	13 (6.67)	142 (78.45)	39 (21.55)	18 (12.95)	94 (67.63)	27 (19.42)	109 (78.42)	22 (15.83)	8 (5.76)
Harvesting practices	183 (93.85)	12 (6.15)	142 (77.17)	42 (22.83)	18 (12.77)	94 (66.67)	29 (20.57)	113 (80.14)	20 (14.18)	8 (5.67)
Animal health	181 (92.82)	14 (7.18)	142 (78.45)	39 (21.55)	19 (13.67)	93 (66.91)	27 (19.42)	111 (79.86)	19 (13.67)	9 (6.47)

Source: Field Survey Data, 2020

More so, the use of chemicals like pesticides and insecticides for the control of pests and insects were found to be widely exposed to farmers where over 93% have knowledge about the technology, with over 78% even receiving training on the use of chemicals for controlling insects, pests and other non-beneficial organisms which are detrimental to agricultural production. The study once again noted that out of the over 78% of respondents who receive training on the technology, about 67.63% of them had their training from NGOs, with 12.5% and 19.42% receiving their training from indigenous sources and extension officers, respectively. Also, when respondents were asked about the time duration of their training, about 78.42% indicated not applicable, with 15.83% and 5.76% responding to weekly and 4-hour durations, respectively.

Similarly, harvesting practices which include but not only post-harvest management to reduce post-harvest losses, are a household name among respondents as over 90% of respondents indicated to have knowledge about its application. The study established that about 77.17% of the respondents who indicated yes to awareness of the technology also had training on the application of the technology, with the majority representing 66.67% of them receiving their training from NGOs and about 20.57% and 12.77% of the respondents reported having received their training from extension officers and indigenous sources respectively.

Finally, animal health management as a farming technology which includes vaccination of animals, quarantine, improved breeds, cross-breading, and artificial insemination, among others, was found to be exposed to the sampled respondents. About 92.82% of the farmers responded yes to awareness of the technology, with

about 78.45% receiving training on the technology across different sources, with a majority (66.91%) receiving their training from NGOs and 13.67% and 19.42% respectively receiving their training from indigenous sources and extension officers respectively.

4.6. Objective 4: Examining how farmers access agricultural innovation and technology

The objective identified smallholder farmers' access to agricultural and innovation technologies in the study area. The common means used to access agricultural innovation and technology were using basic ICT gadgets such as mobile phones, radio and television.

4.6.1 Access to ICT gadgets

After establishing awareness of ICT tools among the sampled respondents, the study assessed their level of access to such tools. According to the findings, 39.4% of respondents have access to a mobile phone, 39% have access to a radio, and 20.5% and 1.1% have access to television and more than one tool, respectively. It has been established that telecommunication facilities such as mobile phones and radio are the major ICT tools available to agricultural extension officers, research institutions and other stakeholders that aid in the transfer of new technologies and information to farmers in Ghana (Annor-Frempong et al., 2006). Similarly, in South Africa, Tata, and McNamara (2016) reported that radio and mobile phones are important instruments for agricultural extension agents and farmers to share knowledge.

Table 4.7: Farmers' access to ICT gadgets

ICT gadget access	Frequency	Percent
Mobile phone	77	39.4
Radio	76	39.0
Television	40	20.5
More than one	2	1.1
Total	**195**	**100.0**

Source: Field Survey Data, 2020

Access to agricultural information

Access to information is critical in agriculture because farmers' ability to implement strategies or adopt technologies that will help mitigate the impact of change can only be improved with readily available and accessible information. According to the study, 82.1% of the farmers polled had access to agriculture information through basic ICT tools such as television, radio and mobile phones, with the remaining 17.95% reporting no access to agriculture information (Figure 2). This was however expected due to the wide use of mobile phones and radio among farmers that facilitate and make dissemination of agricultural knowledge, new technologies and information within the study are easy (Tata & McNamara, 2016).

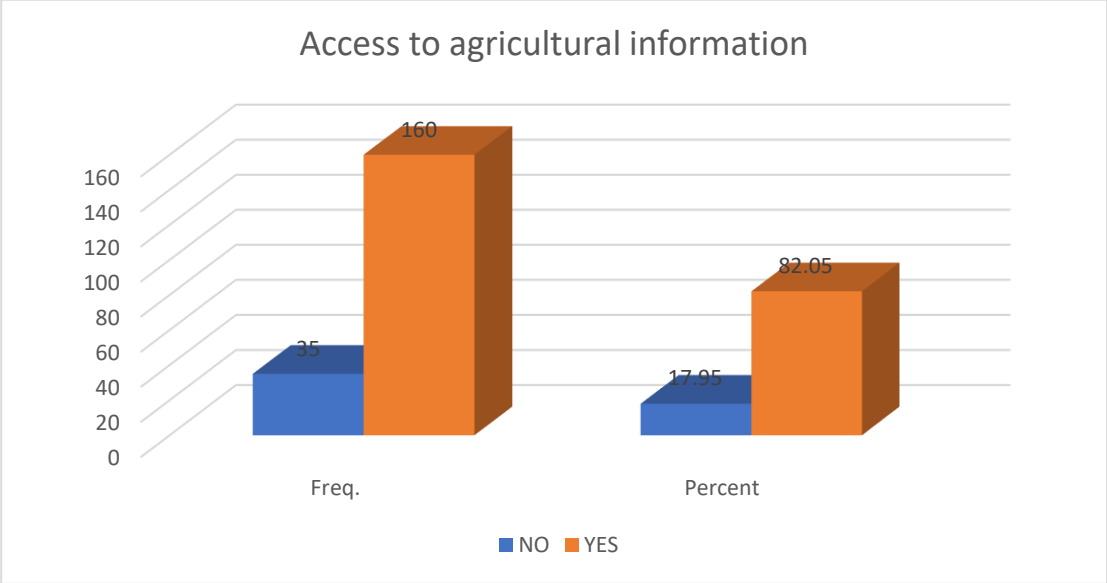

Figure 4.4: farmers' access to agricultural information

ICT tools farmers use to access agriculture information

The limited number of extension officers deployed in Ghana has hampered access to agricultural information over the years. As a result, Telecommunication devices and radio have become a saviour in all sectors, including agriculture, by accelerating information delivery and access. Using questionnaires, the study assesses farmers' use of ICT tools in agriculture/farming. According to the data, approximately 78.5% of respondents used ICT tools to access agricultural information, while 21.5% said they did not use ICT tools to access agricultural information.

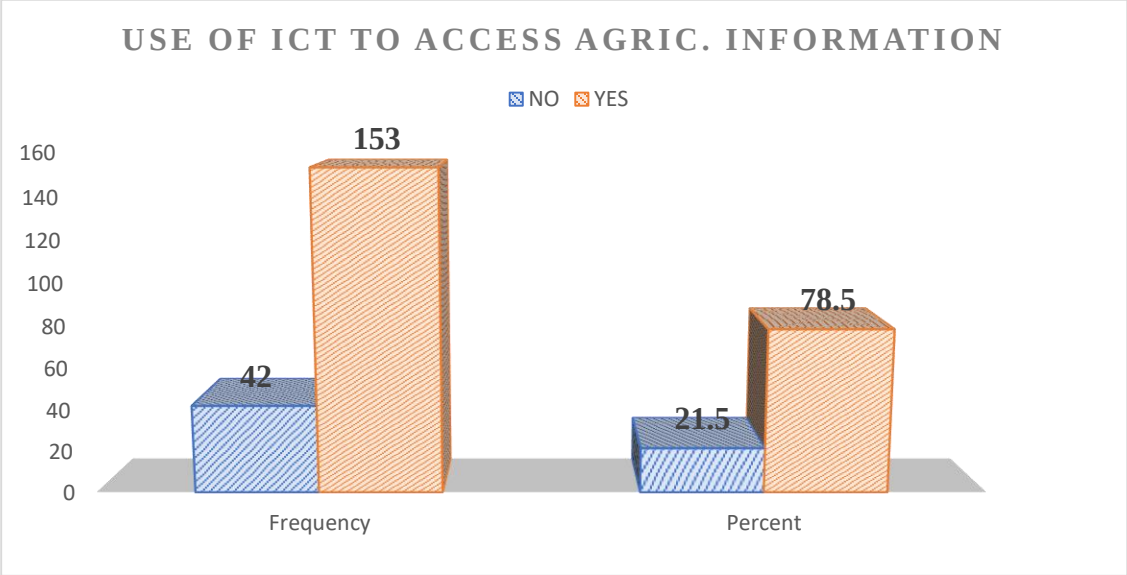

Figure 4.5: Farmers use of ICT tools to access agric. Information

Access to agricultural extension services and the Gadgets used

According to the study, 67.7% of the sampled respondents had access to agricultural extension services, while 32.3% of the respondents interviewed indicated that they did not have access to agricultural extension services. Again, the study attempted to determine the medium through which farmers obtain extension services. The results show that 24.6% of farmers questioned receive extension services from extension agents. The low access to extension officers in the study area may be attributed to certain challenges such as lack of transportation facilities for agricultural extension officers, little or no motivation, communication barriers (Belay and Abebaw, 2004; Baah et al., 2009).

Table 5.8: farmers' access to extension services

Access to agric. Extension service	Freq.	Percent
No	63	32.31
Yes	132	67.69
Total	**195**	**100.00**

Source: Field Survey Data, 2020

Sources of agriculture extension services

Approximately 14.3% of farmers' access extension services through radio, 3.9% through television, 4.8% through NGOs, and 3.2% and 1.6% of respondents' access extension services through mobile phones and posters, respectively. However, nearly half of those who have access to extension services do so through more than one medium this correlates with (Shaibu et al., 2018) that rural farmers have access to the basic digital tools such as mobile phones and television sets.

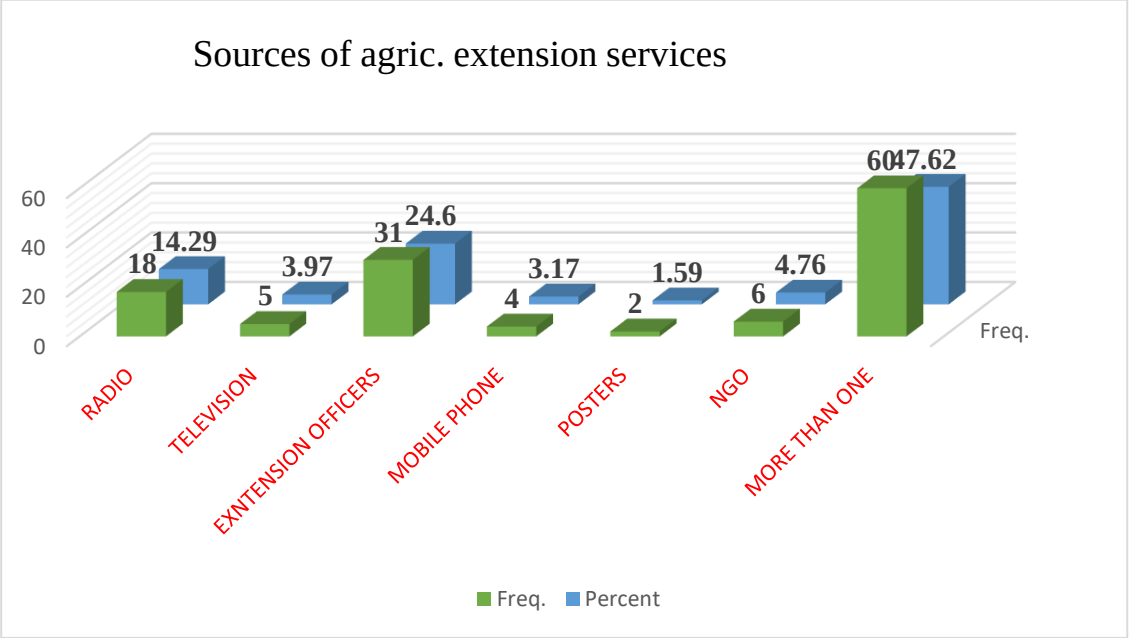

Figure 4.6: Sources of agric. Extension services

Frequency of extension access

Farmers' ability to understand and apply technologies introduced to them by extension agents or institutions is greatly influenced by the frequency with which they access extension services. According to the study, 32.1% of the sampled farmers who had access to extension services did so on a weekly basis, 38.3% had quarterly access, and about 19.9% had monthly access, with 7.9% and 1.5% having yearly and very often access, respectively. In general, the findings indicated that farmers in the study area had easy access to extension services.

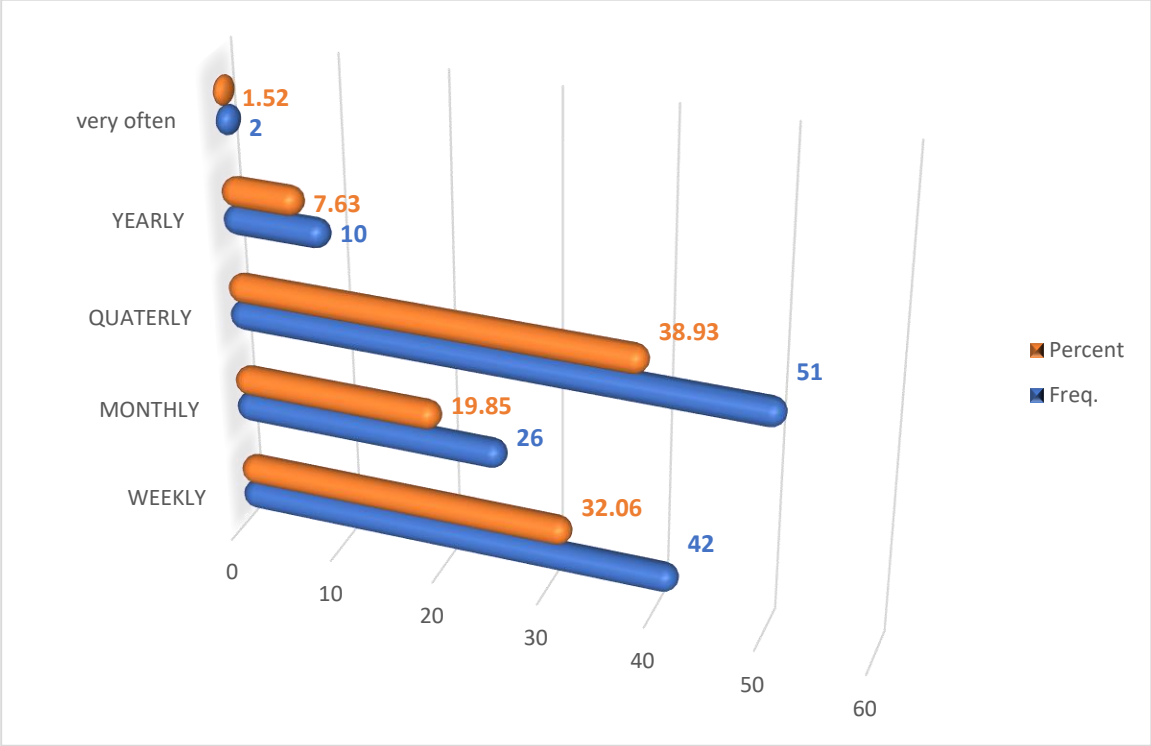

Figure 4.7: Frequency of access to agricultural extension services

4.8 Factors influencing farmers' access to e-extension

The table below presents both marginal effects and coefficients of the determinants of e-extension access. The explanatory power of the model which is the Pseduo R-square is 57.9% which implies that the independent variables are responsible for 57.9% of the variation in the dependent variable and this is significant at 1%. Unlike the coefficients which show the direction of change, the marginal effects represent the magnitude of change in the dependent variable (e-extension access) when the covariate changes by a unit. Thus, interpretations are based on marginal effects. From the analysis an increase in the age of a smallholder farmer by a year decreases the probability of the farmer having access to e-extension by 4.1% all else equal and this was significant at 1 percent. This study confirms the results of Atsan et al. (2009) who reported that an

increase in age of farmers will significantly (coefficient = -0.01, P < 0.00) affect their choice of using extension services. Similarly, in the Pru District of Ghana, Shaibu et al (2018) also observed that younger farmers had a higher probability of adopting digital technology than older farmers. This makes sense because younger farmers are expected to have access to electronic devices and able to use them to access information online which enhances their e-extension access. According to Rogers diffusion theory,

Apart from age, smallholder farmers who received remittance were more likely to have access to e-extension than their counterparts who did not receive it and this was significant at 10%. It is understandable because farmers who receive remittance may have the financial ability to purchase ICT tools (radio, phone, television) that will enable them to access e-extension services (Okello et al., 2020). Receiving remittances will also help such farmers purchase bundle, battery, pay their light bills, which will give them more access to e-extension services.

Also, being a member of MoFA group increases the likelihood of having access to e-extension than non-members. However, being a member of an NGO group decreases the probability of accessing e-extension by 22.9% and this was significant at 1% this may result from relying on the training and visits by the extension officers. This is contrary to prior expectations because we expect that farmers who are members of NGO groups will be exposed to trainings, capacity building programs and more which will equip them with the necessary skills and knowledge that will enhance their access

to e-extension. However, most of the farmers who belong to NGO groups in the area have low literacy rates and old. Thus, limiting their ability to access e-extension.

Furthermore, access to credit by smallholder farmers was found to be significant at 1 percent and positive, which means that farmers who have access to credit were more likely to have access to e-extension than their counterparts who do not have access (Atsan, 2009). Logically, this makes sense because farmers who have access to credit are more likely to channel more resources to their products which will, in turn, increase their output and, by extension, income. Thus, it will afford them the financial muscle to own and use devices that will give them access to e-extension.

Additionally, having no formal education was found to be significant and negative to e-extension access which implies that farmers who have no formal education were 18.8 percent less likely to have access to e-extension as compared to their counterparts who have some form of education. This is in line with prior expectations because farmers who do not have formal education are likely to be limited by language, knowledge of ICT devices or limited to one device and the ability to use electronic devices in their attempt to access e-extension, whereas farmers with formal education can access information across several platforms including WhatsApp, Facebook, telegram etc.

More so, farmers' use of ICT tools to support their agricultural activities increases their probability of having access to e-extension than their counterparts who do not. This was significant at 1 percent level of significance. This makes sense because those who use devices, likely phones in support of their farming, are more likely to access

e-extension than their colleagues who do not use them. Finally, being literate or able to read alphabets increases the probability of accessing e-extension by 20.2% and is significant at 1% (Table 4.9). This is in line with prior expectations because farmers who can read would be able to access, read and understand information from electronic platforms, of which e-extension is not an exception.

Table 4. 9: Probit regression of factors influencing access to e-extension

E-extension	Coef.	St.Err.	dy/dx	Std.Err.	Sig
Sex	0.39	0.35	0.046	0.039	
Age	-.346	0.122	-0.041	0.014	***
Household size	0.187	0.256	0.022	0.030	
Farm size	-.1	0.237	-0.012	0.027	
Remittance	0.674	0.39	0.079	0.044	***
Livestock	0.319	0.457	0.037	0.053	
Membership of MoFA group	2.71	0.717	0.318	0.066	***
NGO group	-1.952	0.715	-0.229	0.073	***
Access credit	1.884	0.607	0.221	0.059	***
No education	-1.606	0.67	-0.188	0.071	**
ICT tools to support farming	1.147	0.394	0.134	0.040	***
Able to read Alphabet	1.724	0.596	0.202	0.064	***
Constant	-2.833	0.797			***
Mean dependent var		0.200	SD dependent var		0.401
Pseudo R-squared		0.579	Number of obs		175
Chi-square		51.653	Prob > chi2		0.000
Akaike crit. (AIC)		99.705	Bayesian crit. (BIC)		140.847

Source: Field Survey Data, 2020

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1. Conclusions

Prior studies on agricultural-based extension services in Ghana have focused much on the extension officers and its mechanisms, without equivalent attention to farmers' needs and perspectives on electronic agricultural extension services. They have been oriented to agricultural extension officers and larger farms, to the relative neglect of smallholder farmers. This study was designed to evaluate how well smallholder farmers' farming needs were met by electronic extension services in Northern Ghana, particular Yendi Municipality, using particular crop sectors, maize, soybean, and rice, which were mostly grown by these smallholder farmers. The study used focus group discussion and in-depth interviews to collect data on the types of technologies farmers use, their perception of these technologies, farmers' farming needs related to electronic extension, and how accessible these electronic extension services and new technologies are available to farmers.

The finding showed that electronic extension services matched farmers' general needs. However, these services are not readily available to most farmers in the study area, for instance, a significant number of the farmers (n = 170, 87.18 %) are not of any ICT platforms that could support their farming activities, 11 % used ICT tools to access weather information, of which only 28.75 % of them received training on how to use ICT tool to meet their farming needs, 67.7 % of farmers have access to agricultural extension officers. The majority of the farmers receive agriculture-related information through multiple sources such as radio sets (14.29 %), television (3.97 %), NGOs (4.76

%), and mobile phones (3.17 %). Age, remittance, membership of MoFA groups, NGO groups, and access to credit and education were the significant factors influencing farmers' access to electronic extension services. While line spacing (93.85 %), appropriate time to apply fertilizer (92.82 %), weed control measure (93.85 %), use of improved seeds (92.82 %), integrated pest and disease management (92.82 %), chemical usage (93.33 %) and animal health (92.82 %) were the common farming technologies farmers' use.

The principal conclusion was that smallholder farmers were active agents in addressing their extension service's needs. While they lacked access to electronic extension services, they were not wholly dependent on services. Farmers solved their farming problems through observation, comparison and sharing of knowledge and experience, mainly through radio and NGOs.

5.2. Contributions to Knowledge

The knowledge on the literacy levels of small holder farmers in the northern region have been expanded, and co-created in the areas of text, numeracy, and extension in formation exchange.

Secondly, the studies have also broadened the concept of electronic extension and the experiences of farmers in the growing extension services system, added to the conventional extension delivery systems.

This research has expanded the previous reach in terms of theoretical and conceptual frameworks like the Technology Acceptance Model and Rogers' Innovation Diffusion Theory through the modification of the model with local realities.

5.3. Recommendations

1. The ability to read texts as a benchmark for literacy in the study was realised to be low, and it will be prudent if stakeholders of extension service providers channel more efforts into expanding the ability of farmers to read and make meaning out of the information provided.
2. Numeracy levels were realised to be relatively predominant in the study area resulting from the prevalent use of numerals in the daily socio-economic activities of the respondents. Therefore, stakeholders must design electronic extension deliverables along the prevailing daily activities of intended targets. This approach will make it faster, easier and more collaborative for intended targets. New technologies or socialisations that relates to the practices of its intended targets tend to yield desired results within a shorter time than none conforming ones.
3. To enhance structures for effective implementation of electronic extension services, the private sector, including the agricultural input dealers operating within the formal extension services, can also be deployed in the system, farmers expressed a preference for their activity in the Municipality.
4. The farmer associations (both NGO and MoFA led) should also be resourced to support training of farmers to electronic devices efficiently in order to improve their communication through the devices.

5. To further root the acceptance level of electronic extension services for mass implementation, systematic institutional changes at the Ministry of Food and Agriculture, FAO and the numerous non-governmental organisations that operate in the extension sphere are required to reshape the extension delivery system and services to meet smallholder farmers' needs, towards the adoption of new digital technologies that enhances their farming practices towards effective management of their activities.

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APPENDIX 1

UNIVERSITY FOR DEVELOPMENT STUDIES

FACULTY OF AGRIBUSINESS AND APPLIED ECONOMICS

DEPARTMENT OF AGRICULTURE EXTENSION, RURAL DEVELOPMENT AND GENDER STUDIES

Dear respondent,

This research is part of a study investigating *"Electronic agriculture and the small holder farmer: the nexus of technology and literacy"*. The research is purely for an academic exercise and all information given shall be used solely for this purpose. The researcher, therefore, wishes to have your personal views on the study and will adhere to the principles of confidentiality and anonymity.

Thank you for your consideration

Instruction: please fill in the spaces or thick where necessary

Name of respondent ……..

Name of community …….

Date ……..

A. DEMOGRAPHIC CHARACTERISTICS

1. 1. Sex of respondents 1. Female [ ] 2. Male [ ]
2. Age of respondent ……..
3. Marital status 1. Married 2. Divorced 3. Separated 4. Widowed 5. Single

4. How many people do you have in your household? ……..
5. What is your level of education? 1. Primary [ ] 2. JHS/ Middle school [ ] 3. SHS [ ] 4. Technical/ vocational 5. Tertiary/College 6. Other (specify) …….
6. What is your total farm size? ……
7. Aside farming, do you have any job or form of employment? 1. Yes [ ] 2. No [ ]
8. Do you get remittance from it?

B. FARMING SYSTEMS

9. What type of crops do you cultivate? 1. Maize [ ] 2. Yam [ ] 3. Groundnut [ ] 4. Others (specify) ……
10. Do you rear livestock? 1. Yes [ ] 2. No [ ]
11. What type of livestock do you rear? 1. Cattle [ ] 2. Goats [ ] 3. Sheep [ ] 4. Poultry [ ]
12. What is your source of farm labour?
    1. Family [ ] 2. Hired [ ] 3. Communal [ ]
13. How many acres of land do you cultivate?
    1. Less than one [ ] 2. 1-3 acres [ ] 3. 4-6 acres 4. Above 6 acres
14. How many years have you been farming? ……..
15. Why do you engage in agriculture? 1. Household consumption [ ] 2. Income [ ] 3. Others (specify) ……

C. SOCIAL ECONOMIC CHARACTERISTICS OF FARMERS

16. Are you a member of any project by MOFA? 1. Yes [ ] 2. No [ ]

17. If yes, which one? ……..

18. If yes to 16, do you occupy a leadership position? 1. Yes [ ] 2. No [ ]

19. If yes to 14, what position? 1. Chairman [ ] 2. Secretary [ ] 3. Magazia [ ]
    4. Treasurer [ ] 5. Others (specify) …….

20. How much do you earn as annual income? 1. Less gh500 [ ] 2. Gh 500 – 999
    [ ] 3. Gh 1000- 1,499 [ ] 4. Gh 1500- 1999 [ ] 5. Gh 2000 and above [ ]

21. Have you had access to credit in the past five years? 1. Yes [ ] 2. No [ ]

22. If yes to 17, please state the type of credit received, source and amount below

Type of credit	Source	Amount (GH)

D. KNOWLEDGE OF ICT

23. Which ICT tools do you know about?

    1. Computer
    2. Mobile phone
    3. Internet
    4. Radio
    5. Television
    6. Others ……..

24. Which ICT tools do you have access to?

    1. Computer

2. Mobile phone
3. Radio
4. Television
5. Others ……

25. If you have a mobile phone, which mobile operator do you use?
    1. Vodafone
    2. AirtelTigo
    3. MTN
26. How do you pay for your connection?
    1. Prepaid
    2. Contract
    3. None
27. Do you have access to agriculture information? 1. Yes [ ] 2. No [ ]
28. If yes to 27, which ICT gadgets do you use to access it?
    1. computer
    2. mobile phone
    3. radio

E. ICT AWARENESS AND USAGE

29. Which of the following ICT tools do you know how to use?
    1. Computer
    2. Mobile phone
    3. Internet
30. Did you receive any training to use any of tools in the question above?
    1. Yes [ ] 2. No [ ]

31. If yes to 24, who trained you?

    1. Extension officer [ ] 2. NGO [ ] 3. Friend [ ] 4. Relative [ ]

32. Do you use ICT tools to support your farming activities?

    1.Yes [ ] 2. No [ ]

33. What else do you use ICT tools for?

    1. Personal
    2. Business
    3. Social

34. How many hours do you spend using ICT tools in a day?

    1. 0-3 hours
    2. 4 – 6 hours
    3. 7+ hours
    4. Not sure

35. With regards to farming, what do use ICT tools for?

    1. Information on prices
    2. Information on weather
    3. Information on pests/weeds
    4. Purchases

36. Which of the following ICT tools do you use to assist you in farming?

    1. Computer
    2. Mobile phone
    3. Television
    4. Radio

37. Do you have access to agriculture extension service? 1. Yes [ ] 2. No [ ]

38. How do you access agriculture extension services?

1. From radio 2. From television [ ] 3. Extension officers [ ] 4. Extension officers [ ]
5. From phone [ ] 6. Posters [ ] 7. NGOs [ ] 8. Researchers [ ]

39. How often do you access agriculture extension service?

1. Weekly [ ] 2. Monthly [ ] 3. Quarterly [ ] 4. Yearly [ ] 5. Never [ ]

F. LITERACY ISSUES

40. Are you able to read alphabets? 1. Yes [ ] 2. No [ ]

41. If yes to 40, mention these alphabets

C D a g I u r e B Z

42. How many could be identified? ……

43. Are you able to read numerals? 1. Yes [ ] 2. No [ ]

44. If yes to 42, please mention the numbers below

1 7 4 6 3 9 11 50 43 23

45. How many numerals could be identified? …….

46. Are able to place phone calls? 1. Yes [ ] 2. No [ ]

47. If no, how do you use your phone?

……

……

……

48. Do you get messages on your device regarding agriculture? 1. Yes [ ] 2. No [ ]

49. If yes, how do you access it?

……

……

……

……

50. Are you aware of any ICT platforms that supports your farming activities?

1. Yes [ ] 2. No [ ]

51. If yes, please name it/them?

1. ……..
2. …….
3. ……

52. What does the platform(s) do?

……

……

……

……..

53. What do you use the platform for?

……

……

……

……

54. Do you know how to access internet on you own?

1. Yes [ ] 2. No [ ]

If yes, what do you use it for?

……

……

……

……

If No, why?

55. ……

……

……

……

Adoption of farming technologies

Technologies	Awareness		Have you received training on it?		Source of training	Duration of training
	Yes	No	Yes	no		
Line spacing						
Appropriate time of applying fertiliser						
Weed control						
Planting date						
Improved seeds						
Pest and disease						
Use of chemicals						
Harvesting practices						
Animal health						