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ANTALYA BILIM UNIVERSITY

INSTITUTE OF POST GRADUATE EDUCATION

THESIS MASTER'S PROGRAM OF BUSINESS ADMINISTRATION

FACTORS DRIVING THE ADOPTION OF SMART FARM IN MALI

DISSERTATION

PREPARED BY

KATIMI BERTHE

ANTALYA – 2021

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APPROVAL FORM

ANTALYA BILIM UNIVERSITY

INSTITUTE OF POST GRADUATION

I Katimi BERTHE, a master student of Antalya Bilim University, Institute of Post Graduate Education, Masters in Business Administration with student ID 181121023 successfully defended the thesis titled “Impact of social media usage on social media fatigue and employee productivity: Moderating role of gender” which he prepared after fulfilling the requirements specified in the associated legislation, before the jury whose signatures are below.

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Date of Submission …………………………….

Date of Defense ………………………………..

ACKNOWLEDGMENT

This lookup is the corn concerning my passion for modernization and the development of the agricultural sector in my country “Mali”. With a dead amazing development in science within the world, then also a great upward shove in the quantity of population, it’s essential to turn to a much-modernized agriculture system to satisfy everyone in terms of food.

This work was made possible thanks to the help of several people to whom I would like to express my gratitude. I would like to especially thank Assoc. Prof. Dr. Abubakar Mohammed ABUBAKAR, who was the first to make me discover my thesis subject. I thank you for your contribution which has fueled my reflection, your availability and especially your patience.

I thank my dear parents, ADIARATOU and BAYA who have always been there for me, "You sacrificed everything for your children, sparing neither health nor effort. You have given me a magnificent model of toil and perseverance, I’m indebted”.

I would like to express my thankfulness to all my friends who have provided me with moral and intellectual support throughout my process. To all of the jury members, I offer my thanks, respect and gratitude.

.... / .... / 2021

Katimi Berthe

Signature:

ACADEMIC DECLARATION

I by means of this announce that this graduate master's thesis with the titled "Factors Driving the Adoption of Smart Farm in Mali" has been written by myself according to the institute academic rules and ethical conduct of Antalya Bilim University.

I also declare that the materials used for this graduate thesis are all mentioned resources in the list of references. I testify all this with my integrity.

…./….2021

Katimi Berthe

ÖZET

Mali'de akıllı çiftliğin benimsenmesini sağlayan faktörler

Akıllı çiftlik ve modem teknolojik aletlerin ve uygulamalarının tarım üzerindeki etkisi hafife alınamaz Çalışma Mali'de akıllı çiftlik ve modern teknolojinin benimsenmesini sağlayan faktörleri keşfetmeyi amaçlamaktadır. çiftçiler, çiftçilik faaliyetlerinde akıllı çiftlik veya modem teknolojik uygulamaları ve aletleri benimseme niyetindedir. Çalışma, ülkede akıllı çiftlik kullanma niyetini veya kararını yönlendiren temel faktörlerin, bu teknolojiler hakkında korku ve yanlış anlama, mevcut ve gelecekteki ekonomik koşullar, bu teknolojilerin maliyeti, bu teknolojilerin nasıl çalıştığını göstermek için yetersiz deneyler olduğunu ortaya koydu. Çalışma, akıllı çiftliklerin ve modern teknolojilerin tarım üzerindeki faydalarının kolay anlaşılması için yerel lehçelerde hazırlanan daha hedefli eğitim ve kamu kampanyaları önermektedir.

Anahtar Kelimeler: Tarım, Bilgi ve İletişim teknolojisi, Akıllı Çiftlik, Mali.

ABSTRACT

The impact of smart farm and modern technological appliances and applications on agriculture cannot be underestimated. The study seeks to explore the factors driving smart farm and modern technology adoption in Mali. In doing so the study employed three objectives and hypotheses in establishing the factors that affect or drive farmers' intentions to adopt smart farm or modern technological applications and appliances in their farming activities. The study revealed that the key factors driving the intention or decision to use smart farm in the country are fear and misconception about these technologies, current and expected future economic conditions, cost of these technologies, inadequate experiments to illustrate how these technologies work among others. The study recommends more targeted education and public campaigns drafted in local dialects for easy understanding on benefits of smart farms and modern technologies on agriculture.

Keywords: Agriculture, Information and Communication technology, Smart Farm, Mali

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LISTE OF ABREVIATIONS

SF:	Smart Farm
ITC:	Information and Communication Technology
COMP:	Compatibility
TRI:	Trialability
OB:	Observability
PUSE:	Perceived usefulness
PEU:	Perceived ease of use
P Cost:	Perceived cost
PINV:	Consumer perceived innovativeness
INT:	Intention to use

CHAPTER 1

1 INTRODUCTION

1.1 Background to Study

There are many identified challenges confronting agriculture across the world making it a center of debate, from the green revolutionary ages in the years 1960 and 1970 as well as in recent times (Mutabazi, Sieber, Maeda and Tscherning (2015). These identified challenges resulted in the focus on agriculture technology in related research aimed at increasing production to meet demand (Gebremariam and Tesfaye, 2018). According to Ogilvie et al., (2013), regardless of the green revolution in 1960 and 1970 which were aimed at increasing food security to meet the growing population, the world as at now is still far from achieving these goals. The agriculture and the environment sectors form the foundation of economic strength in many African countries and the continent as these areas provide employment for the majority especially those in the marginalized areas (Gebremariam and Tesfaye, 2018). Regardless of these potentials, there is still high food shortages and poverty in most sub-Saharan countries as a result of the improper exploration and management of the resources coupled with increasing deterioration of the climate and many more (Berazneva et al., 2018).

The issues of climate change and harsh weather conditions like increasing and prolonged crop failure, pest infections and droughts create serious concern about the sustainability of agriculture and economic growth on the continent (Anand, Bansal, Agarwal and Aggrawal 2018). Also, the continent agriculture sectors are highly dependent on rainfall especially in the sub-Saharan African states (Arslan et al., 2020). There is the need for these countries to meet the global food security targets hence serious attention must be directed to boost and improve the various agriculture systems on the continent, (Arslan et. al., 2020). To meet this challenge and improve the agriculture systems, there is the need to adopt and integrate Information and Communication Technology in the agriculture systems to enhance efficiency and effectiveness by establishing respective databases aimed at disseminating information on fertility of land, temperature, lightening and humidity levels (Lee, Kim and Yoe, 2018). According to Krintz et al., (2016) the inclusion of information and communication technology in agriculture can be referred to as “smart farm”. Krintz et al., (2016), explained “smart farm” to be a modern system established to assist everyone in the field of agriculture and aimed to aid in making analysis, improve efficiency and effectively in food production. Further, “smart farm” is an agricultural system created and installed to function with the hardware and software systems by conducting analysis for enhancing farm equipment processes (Krintz et al., 2016). According to Lee, Kim, and Yoe, (2018), “smart farm” produces an automatic analysis used to support decision-making by assessing the recorded data analysis by applications. Simply put, it is designed to resolve the information technology systems management needs in the agricultural environment.

Agriculture smart technology plays a significant role in the reduction of poverty either through direct means which involves what the participants gain from their agricultural products and indirectly involves the way these agricultural technologies impact positively on food prices, create additional jobs and ensures food security especially on the African continent (Arslan et al., 2020). These direct and indirect impacts extensively benefit other neighboring countries but especially the main country whose major source of revenue comes from agriculture just like Mali.

1.2 Statement of the Research Problem

The Republic of Mali is situated in the Sahel Region in West Africa and has a population growth rate of about 3.6% and regarded as one of the foods insured country whose economy is primary supported by agricultural production with about 80% of the population involved in agricultural activities which contributes about 35% of their gross domestic product (Food and Agriculture Organization, 2013). The country produces sorghum, rice, tomatoes, onions, millet and maize, about seventy percent of Mali’s total nutritional needs is from grains but only about twenty percent of this total production goes to the market (Dembélé and Staatz, 2002). Interestingly, for the past five years, the country has been confronted with increasing malnourishment as a result of decreased food production and poor climate conditions (Food and Agriculture Organization, 2013). Although agriculture is the major source of income for the country, the adoption of smart technologies in the field to improve the sector has not been the best. Indeed, this study is very frequently accentuated on the factors which influence the decision of the user of the smart farm to adopt or not to adopt the technology.

Highly dependent on rainfall for agriculture has led to, grains production has slowed down drastically due to the inconsistent rainfall partners and this has also affected the rivers putting pressure on farming activities around the Niger River Basin (Ogilvie et.

al., 2013). Coupled with this challenge is the absence of modern technologies which is also a major challenge confronting the entire country making some companies solve these issues by investing in some form of technologies which is innovating in ascertaining the issues which relates to environmental regulations and climates issues (Berry and Dean (2015). Regardless, rural and petty farmers are the most exposed when it comes to poor farm yield due to climate changes and other factors. These factors resulted in the depletion of their hard work resulting in their inability to save increasing their poverty levels (Mutabazi, Sieber, Maeda and Tscherning 2015). Also, the Food and Agriculture Organization, (2013) indicated that although the production of food is estimated to increase by sixty percent soon, this target is not achievable as it adds to the usual promise by stakeholders. Hence, to address these challenges the farmers themselves must adopt active means that will reduce the negative impact of climate changes and other factors on their farming activities. It is in this regard and many more that this study seeks to assess the factors driving the adoption of smart farm in Mali.

1.3 Research Objectives

The overall objective of this thesis is to identify and explain the factors driving the adoption of smart farm in (Mali) in West Africa. To address this broad objective the thesis will explore the following specific issues:

1. Identify the key factors influencing farmers' decision to adopt smart farm technologies in the agriculture sector.
2. Explain how these factors affect the entire sector in the region and in Mali in particular.
3. Use the results from the theoretical and statistical analyses to recommend policy strategies that may be used to increase technological adoption to boost rural incomes and enhance food security in Mali.

1.4 Research Questions

1. What are the key factors influencing farmers' decision to adopt smart farm technologies in the agriculture sector?
2. How do these factors affect the entire sector in the region and in Mali in particular?
3. What policy strategies can be adopted to increase technological use to boost rural

incomes and enhance food security in Mali?

1.5 Relevance of the Study

The study shall be of great importance to various bodies in academia, farming groups and citizenry, businessmen and women, investors, financial service providers, marketers, government and agriculture reform bodies. The respective benefit is further highlighted below:

First of all, the study will contribute to the body of literature serving as a reference and guidance document. Also, the study is very relevant as it will assist the local farmers with ideas and courage to improve their operations and overcome hidden barriers affecting their quest to expand the farms and digitization process. This will go a long way to help them accept the need to digitize their farm operations in any small means available.

Again, the study will inform and enlighten investors and citizens on the benefits of smart farming so they can be motivated to assist and invest in the local farmers to help them expand and produce quality foodstuffs to meet the country's needs.

Further, the study will contribute by way of input to the government, agriculture and economic bodies concerned with designing interventions, programs or activities aimed at effectively improving the food and agriculture situation in Mali. In this regard ineffective mechanisms will be eliminated, and current and effective strategies adopted and implemented.

1.6 Structure of the Study

The study is structured under five chapters with each chapter focusing on a particular concept and information to aid in the overall achievement of the objectives. The first chapter consists of the background to the study, statement of problem to highlight trends of events which necessitated the study, research objectives and questions as well as the significance of the study. The second chapter deals with literature review which assesses various concepts, theories and studies conducted in similar instances. Also, the third chapter focuses on the methodology, approaches, instruments and tools employed to carry out the study. The fourth chapter shows the presentation and discussion of results of the findings of the study. The last chapter presents a summary of the findings, conclusions made based on the findings and recommendations and suggestions for future research.

CHAPTER 2

2 LITERATURE REVIEW

2.1 Introduction

The literature review chapter explores various literatures and concepts related to the way smart farming impacts farms and livelihoods as the respective objectives of the study. Accordingly, the chapter is classified under two sections namely the theoretical literature review and the empirical literature review. The theoretical literature review deals with various theories, concepts, definitions and ideas related to the subject area while the empirical literature reviews look at testing of hypotheses and highlights of similar studies conducted by other researchers to throw more light on the situation. Indeed, the implementation of new technologies and research in the agriculture sector in Mali is gradually improving and has caught a relatively fair degree of attention in African where agriculture is largely the major source of economic resources, (Ziberman et al 2001).

2.2 Theoretical Overviews

2.2.1 Theoretical Model of Technology Adoption

Applying the theory of behavioral economics, the decision on whether to implement modern agriculture technology or technique is assumed to be a rational decision hence farmers confronted with these decisions seem to be making rational decisions and seeking greater personal interests. Regardless, the argument was made for a bounded rationality theory which pushes the decision maker closer to the reality or real world. These theories are centered on the assumption and premise that the decision makers are not having full information as well as having cognitive limits or boundaries which makes them look for "good enough" solution and decision. In this regard, the decision by a farmer on the adoption of a new technology or technique is influenced by information acquired, the person's attitude about technology and the person's cognitive level, (Li et al., 2019)

Rogers' innovation diffusion theory proposes five stages a farmer goes through when he or she wants to adopt a new technology. These stages are: The farmer acquires the knowledge of technological adoption. Afterwards the farmer processes and creates an attitude around the technology. Thereafter, the farmer plans to adopt the technology. In regards, the farmer implements the technology and finally confirms the technology, (Li et al., 2019). Also, the information on agriculture technology is diffused either consciously or through formal means like training or unconsciously and through informal means like interacting with neighbors. In addition, the ability of a farmer to acquire information is influenced by the farmer's ability to access the information in the first place in the form of his or her social capital. Further, a farmer's level of cognition is influenced by family and personal traits or features. The behavior or attitude of adoption is a function of dynamic technology diffusion together with a psychological process from cognition to decision, influenced by several other factors (Li et al., 2019).

2.2.2 Concept Model and Application of Smart Farm

According to Pivoto et al. (2019), smart farm technology as a new trend in agriculture will become a future integrated farm method which connects information and communication technologies as it started from the industry sector and later to the environmental sector. The embracing of this technology in the sector is due to farmers' quest to increase profitability and escape poverty. Moreover, early adoption of the smart farm technologies puts a farmer in a more competitive position than those who shall adopt it afterwards.

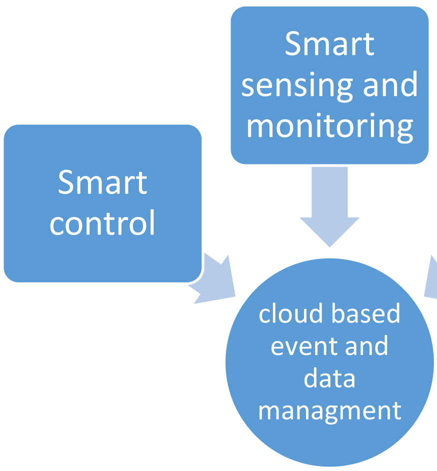

Figure 1: Smart farming concept.

2.3 Challenges Linked to Smart Farm Adoption in Mali

According to African Development Bank group highlighted by Aksoy et al., (2008) most of the lands in Africa are uncultivated, have adequate freshwater and estimated 300 days of sunshine per year. In this regard, about 60 percent of the population in Africa are likely to be employed in the agriculture sector. Regardless of these favorable farming climates on the continent, the continent is continuously a net importer of food products especially those constituting the Sub-Saharan part of the continent (Aksoy et al., 2008). Nevertheless, they indicated that there is great potential for the adoption of new and modern agricultural systems which are linked to smart agriculture as the agriculture sector of the continent has great business potentials for the commercial sector.

According to Schader et al., (2016), one of the purposes for the smart farm innovation is to provide a consistent approach to production-system specific, indicator-based which follows a multi-criteria framework worldwide. The most challenging factor to smart farm adoption in African's agriculture sectors is land tenure as most lands on the continent are unregistered, (Kariuki et al., 2011). Also, Cornea, (2010), indicated that over eighty percent of lands in Africa fall under family ownership creating a bottleneck to the expansion in agricultural production especially when the investors and farmers are scared of investing and farming on an unsecured or family land. According to Aggarwal et al., (2018) and Ubilava, (2018), the agriculture activities on the continent are confronted with bad weather or climate change causing greater food insecurity or crises. For instance, the El Niño droughts which occurred in southern Africa recently destroyed most maize yields which resulted in serious food crises in the region (World Food Program, 2017). Also compounding the agriculture challenges in Africa and Mali are poor and inconsistent government support and direction on agriculture related investment or research, lack and inadequate capital to support those in the sector as well as poor technology and infrastructure installations in the sector.

2.3.1 Lack of Government Support, Research in the Agriculture sector

Undoubtedly one of the main sources of livelihood to most Africans is agriculture; regardless, the sector is characterized by high unproductivity. Despite huge agricultural potential, African countries especially in the sub-Saharan are yet to enjoy these benefits resulting from the increased importation and dependence on external suppliers which further add to their economic woes. The increasing rate of agricultural product importation is largely due to the systems integrated to produce enough food crops to satisfy the population need and support the country's economy by exporting more agricultural products. So, improving such agriculture systems by the integration of new technology will improve the sector. However, the implementation of new agriculture technology especially the information and communication technology (Smart Farm) is linked to several supplies already established (including, government support, education, financial support, electricity, technology and more) (Diallo, Aman, and Adzawla (2019). Also, according to Pernechele, Balié, and Ghins (2018), to improve smallholder farmer's access to agricultural services and technologies with effective coordination among these farmers needs a review of current studies and experiences in the sector and this requires significant government support and research.

Many strategies and research plans have been established by the Mali government to promote agriculture development. One of the strategies has been to focus on investors. From a simple common-sense observation, most donors and governments during implementation overlook the demands or expectations they put on farmer groups which largely exceeds the management skills of these groups (Oshikoya and Hussain 1998). hence a proper and well-structured research by states and governments will shed more light on these challenges.

2.3.2 Access to Financial support by Malian farmers

Agriculture Modernization has been the central debate of many official achievements about Mali strategies for Agriculture development. It remains the third principal intention regarding the rural development master design (Schema Directeur du Développement Rural SDDR) and also taken into count in the framework of the law on agriculture (LOA) which was adopted in 2006 stated in article 3 that "agriculture development policy shall be based on voluntarist promotion of the modernization of family farming and agro-business, to foster the emergence of a structured, competitive agro-industrial sector integrated within the sub-regional economy" (Djiré, 2010, Keita and Diawara 2012). However, those desires are reachable by means of financial cost. According to Djiré et al., (2010), Keita and Diawara (2012) the republic of Mali does not hold sufficient monetary potential have enough financial capacity to come across its desire for agriculture modernization and so far the cost have been estimated by (Cadre Stratégie pour la Croissance et la Réduction de la Pauvreté, CSCRP) at 153 648 000 000 which is equal at 307 296 000 dollars in the exchange rate of USD 1 = 500 FCFA (CSCRP 2007-2011, annexe III). So, absence of budget remains a considerable issue limiting the technology adoption not only for farmers but also for the government in general. Looking at the country's total revenue per year, in 2019 Mali’s national budget was about 2 388 billion of fcfa, divided between the following functions: (Ministry of Economy and Finance of Mali report).

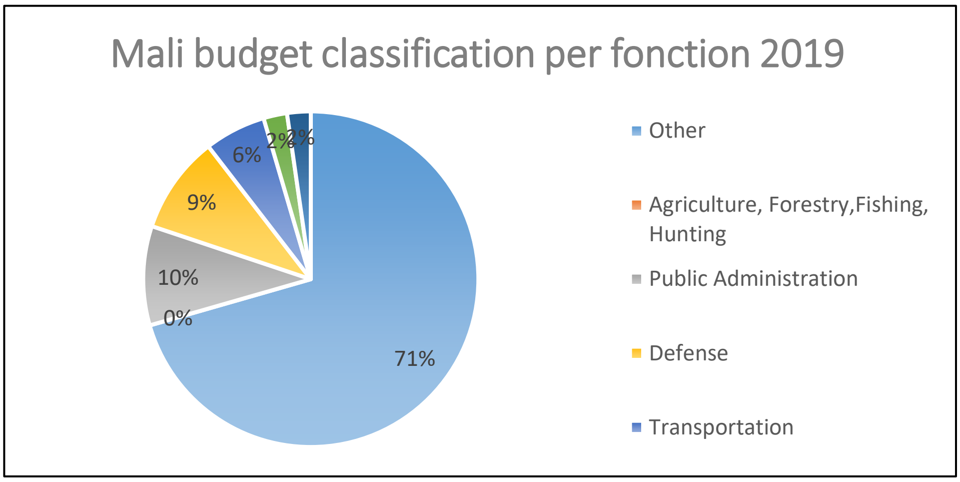

Figure 2: Mali Budget classification per function. (World data)

The issues of inadequate financial support to the agriculture activities and expansion in the country has been well documented by some other bodies like the Food and Agriculture Organization and the United Nation Development Programme which also recommend as a necessity for the country to have a rural load demand and supply mechanisms. Regardless, some efforts have been made to improve the situation like the institution of the National Agriculture Bank (BNDA) to assist petty farmers with some loans to invest in their farming through their respective Village Association (AV), (Konare, 2001).

Despite all these strategies, Access to financial support and credit from commercial banks especially by small and medium scale farmers in Mali is a very difficult task and worries the farmers as well as to the realization of diversification and modernization through implementation of smart farm or technologies (Konare, 2001).

2.3.3 Mali Infrastructure Contest

Many researches in developing Asian countries revealed that infrastructure development in areas of roads, transport, electricity, and technology assist in the reduction of poverty drastically in the rural areas (Konare, 2001). Development in infrastructure contributes significantly in ensuring sustainable economic growth through an allinclusive approach which benefits Farmers by linking them easily to major markets and developed areas where they can access skills and technologies meant to promote their livelihoods and farming activities. It also offers the investors in the developed part the needed confidence to invest in the local farming communities. Sadly, the issue of infrastructural development is nothing to talk about in Africa and Mali especially. Even between the various African countries, infrastructures are poorly designed to the extent that there is no consistent and reliable flow of farm produce from fairly advanced production countries to countries that are lacking behind. These infrastructures if done shall make Africa and African countries compete effectively into regional and external markets through globalization by ways of investment and trade while reducing and improving the poverty situation among its farming and rural folks. In regards, there is the need for the construction of a more efficient and well secured national, regional and cross-border infrastructure both physical and systematic coupled with good legal regimes for business operations (Ondiege, Moyo and Verdier-Chouchane, 2013).

2.3.3.1 Technology Situation

The current era of consistent evolution in information and communication systems create a unique potential which can significantly increase the development of all continents especially in agriculture production on the African continent which is still unable to meet most of its development challenges which are basic to fighting poverty (Oshikoya and Hussain, 1998). Most importantly, countries on the continent must begin to establish and prioritize systems aimed at using newly improved technologies to enhance production between the short to medium term as the continent's population is expected double from 1.1 billion to 2.4 billion people between 2013 and 2050 which will require a sustainable food production to increase by 70% (Mvumi and Stathers, 2015). However, these technologies integration depend on a high level of telecommunication settings such as the internet. Access to the internet for various researches and engagements results in economic opportunities. These opportunities are difficult to access in Africa. It is noticeable that lots of people across the world in one way or the other have access to the internet since the establishment of the World Wide Web in 1991 but in several rural areas in Africa, majority of the citizens do not have access (Draper, 2017). In Mali for instance, only 12 percent of the whole population have access to the internet (world data).

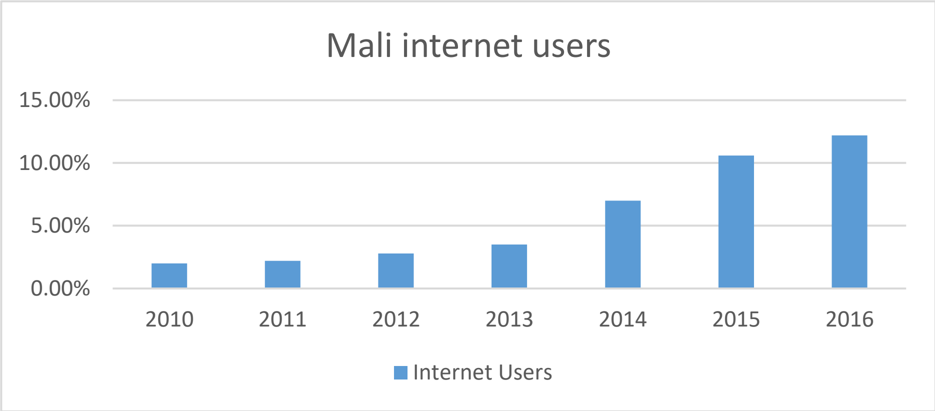

Figure 3: Mali internet Users from 2010 to 2016. (World data).

The ignorance about the application of technology in agriculture remain also one of the biggest challenges for new agriculture technology integration Draper (2017) indicated that the African continent appears to be unaware of the usefulness of information technologies hence their inability to establish and implement an effective and efficient information technology security and implementation programs.

2.3.3.2 Transportation Challenges

Transportation plays a critical role in the economic growth of African countries hence must be significantly improved. Various types of transportation ranging from road, air transportation, rail transportation, and water transportation are available in poor integration and inadequacy in Africa. Indeed, the most used system of transportation in Africa for the transport of food both intra and inter countries is road meanwhile the roads infrastructure is one of the poorest on the continent (Afolayan et. al., 2009).

Adero and Aligula (2012) demonstrated the function transportation costs play in the composition of Gross Domestic Product by developing a generalized multi-sectorial equilibrium model of cross-regional trade while focusing on intra country transport productivity. Each country was considered as a closed economy which is made up of two regions. In regards, one region is agriculture productive while the other is non-agricultural productive. It was realized that effective cross-regional trade requires an efficient transportation service established in the transport sector of that economy. Also, it requires individuals in the economy to freely move across locations to access subsistence food needs. Again, transport frictions are significant in this regard especially as income levels are low with individuals are near to subsistence (Adams, 2008).

2.3.3.3 Electricity Challenges

There are many unexplored renewable energy opportunities available in Mali and across the African continent, yet many the population finds difficulty in accessing electricity. In regards, Mali's primary energy source is biomass which represents about seventy-five percent of the energy consumed (Karekezi and Kithyoma, 2002). The renewable energies potential of the country includes solar, biomass, wind, and geothermal energy sources making the country very strategic when it comes to having all sources of renewable energies. They also rely on power from hydro dams which are partially not very reliable due to climate changes just like those of river or tidal power plants. The country needs to invest in diverse forms of energy to boost its availability for agricultural and other industrial purposes, Karekezi and Kithyoma, (2002) as from now the country is not electrified especially in the rural area.

Figure 4: Mali electricity Statistics (World data).

2.4 The Role of Technology in Modern farming

The rural electrifications levels in the sub-Saharan regions normally fall below five percent showing that sub-Saharan Africa is the poorest electrified region of the world especially as the majority of settlements in the region are rural and scattered driving the conventional grid electrification cost to be seen as very costly. Since the grid electricity transmission and distribution costs to these settlements are considered very expensive, investment and research in alternative markets and technologies in environmentally friendly energy sources like solar which meets this type of situation is much needed, (Karekezi and Kithyoma, 2002).

In recent times, Mali is confronted with major problems related to climate change and poor methods and technological applications in their agriculture sector. In other to address this challenge the need for the adoption and implementation of systems of the smart farm is we advised although there are anticipated challenges with the adoption of this smart farm technologies like solar irrigation, internet, and storage facilities among others as inadequate support from the government, poor infrastructure systems and difficulty or inadequate capital, (Afolayan, 2009).

2.4.1 Facilitate Productivity

There is a significant technological evolution in agriculture all over the world especially with the invention of intelligence technologies like robotics, artificial intelligence systems, and the internet which are contributing immensely to agricultural productivity (Rose et al., 2021). Alexandratos (1995) stated that growth in technology in the past decades has increased the supplies of food for direct human consumption by eighteen percent better than thirty years ago because modern technology application in agriculture reduces the losses in agricultural processes while enhancing speed in the cultivation and harvesting of the produces. Also, Goodman, Rosenberg, Mueser and Drake (1997) indicated that the adoption of technology serves as the push for increasing productivity in agriculture and enhancing agriculture development in all Organization for Economic Cooperation and Development countries. Hence, the driving of agriculture by using modern technology is a basis for reducing poverty in all countries especially those in the sub-Saharan African regions (Goodman, Rosenberg, Mueser and Drake, 1997). Unfortunately, most of the sub-Saharan African countries seem to be lacking behind with the modernized farm concept by adopting and applying modern technologies while other European, Asia, and America are continuously reviewing their practices in Green Revolution which transformed their agriculture positively (Mkandawire and Soludo, 1999). Recent studies by Weyori, Amare, Garming, and Waibel (2018) stated that poor agriculture productivity in many developing countries can be linked to inadequate innovation and will to embrace new technologies. Although Africa is tagged as the hub for agriculture, its performance in realizing this mile is far from now and this explains why most African countries still have a high importation rate of agricultural products from Europe and why the continent is still struggling with resolving hunger and poor nutrition, (Kariuki, 2011). Regardless, some African countries just as Mali are making various efforts to adopt new technologies into their farming systems.

2.4.2 Increase Productivity

To remain sustainable and relevant in a highly competitive and fast-changing agriculture environment in this era: farmers must, first of all, have the passion to work on farms with greater determination while embracing innovative smart farm technologies which need good professional skills and knowledge in regulations, data analysis, communication and accounting (Kariuki, 2011). In doing so, the quality and quantity of agricultural products shall increase significantly. This application of smart technology will result in the effective use of pesticides and fertilizer hence making agricultural products better and safer.

2.5 Empirical Overview

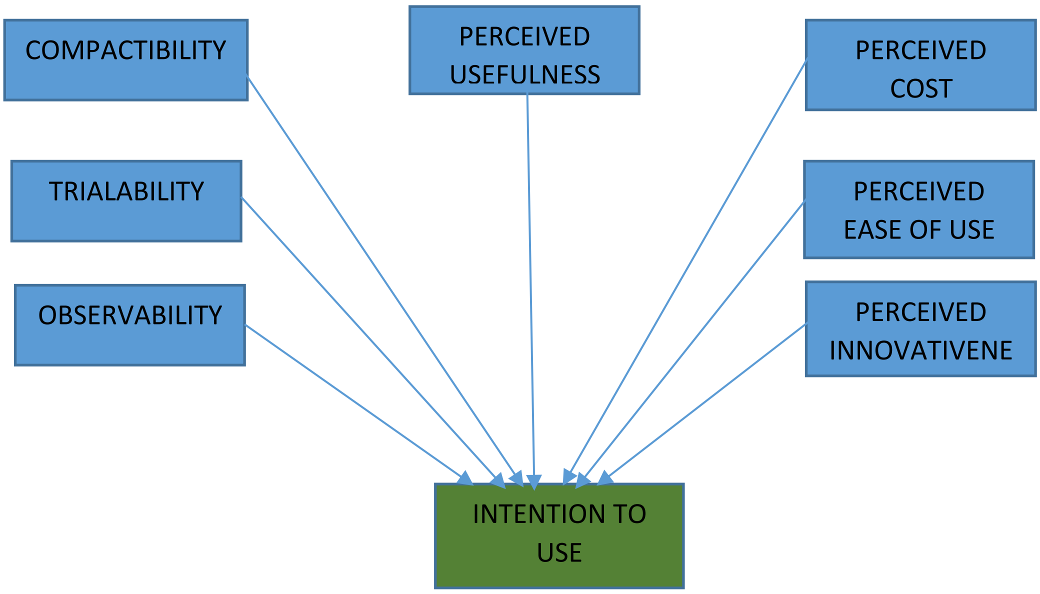

Figure 5: Conceptual Research Model

2.6 Testing of hypothesis

According to (Wigmore, 2013), compatibility deals with the ability of different systems to work together without any adjustments and issues. It also looks at the capacity of the two systems to interoperate without difficulties. Li et al., (2019), in their study on the factor influencing technology adoption behaviors among Litchi farmers, revealed that although the experience of farmers, training, and size of farm highly influences their intention to adopt smart technology on their farms, the compactible nature of these technologies with other systems to increase yield both in terms of quality and quantity averagely and positively related to their intentions, acceptance, and decision to use smart technology. In a related study by Diallo, Aman, and Adzawla (2019)on the factors influencing the adoption of climate-smart agriculture by farmers in Mali, it was discovered that the ability of technology to work well on the farm of grain farmers to gain desire results influences their decision to use smart farm technology. This study showed that farmers are ready to adopt smart technologies on their farms if they are compatible with their farm structure and processes. Similarly, Aryal, Rahut, Maharjan, and Erenstein, (2018) in accessing the factors which affect the adoption of multiple climate-smart technologies in India discovered that household characteristics, plot characteristics, market characteristics, and major climate risks are the leading factors influencing the farmer's intention to use smart technologies. This is followed by how well and interrelated the technologies will fix into their farming set-up. It was seen that the compatibility of these technologies played a positive and significant role in the final decision of the farmers as to whether to adopt the particular smart technology on their farms or not. It is clear from all the reviews that, compatibility of technology is positively related to the intention of the farmers to adopt a technology as the inability of the technology to work together with existing structures and systems makes their adoption wasteful (Diallo, Aman, and Adzawla, 2019). Based on these extend argument, the following hypothesis propose:

H1: Compatibility will have a positive effect on the intention to use smart farm technology.

Observability is very crucial in the modern-day considering the characteristics of modern applications and the fast pace at which new technologies are been developed. The principles of observability afford users the opportunity to look at how the internal state or ability of a system and technology can be measured through inferring from gained knowledge of the system or technology’s output. Hence to improve observability, a farmer must keep watch over all the applications or innovational components to be able to satisfy him or herself of its wealth and value (Waterhouse, 2018).

Clearly, observability looks at giving the opportunity to the farmers to watch or views how some of these smart farm technologies are been used as well as how they operate over time. According to Li et al., (2019) the ability of people to observe others using various tools and processes also positively affects their intentions to use the same or similar tools and processes especially when they view these tools and processes to be very impactful.

Also, Diallo, Aman, and Adzawla (2019) in their study to access the factors influencing smart farm climate technology in the Segou region of Mali discovered that observability is very significant in determining whether a farmer would like to adopt a smart farm agriculture technology or not. It is relatively significant to observe how these technologies operate to be able to effectively operate them as well. In addition, Bradford et al, (2019) all reaffirmed the position that, observability has a positive impact on farmers intention to adopt a technology as the more the farmers observe others who employ these technologies on their farms and the benefits, they get overtime, the more they are encouraged to also implement same on their farms. Observation they suggested makes farmers more attracted to new technologies and ways of doing things hence they went further to encouraged suppliers to use more illustrations to market smart farm technologies. However, the study leans towards the following hypothesis:

H2: Observability will have a positive effect on the intention to use smart farm technology.

According to Phonthanukitithaworn, Sellitto, and Fong (2015), the degree to which an individual believes that the usage of a particular technology will cost money can be described as the perceived cost of such technology. It also deals with the second attribute of how consumers will consider prices of products relative to their disposable income which is important. In regards, the perceived cost looks at how the farmers view or the impression formed by farmers about how expensive or not expensive a smart technology costs or might cost them when they finally make up their mind to adapt it for their operations.

Accordingly, Konare, (2001) in a study realized a link between cost and adoption of new technologies such that the perceived cost of new technology directly influences the users' decision to use such technology. Also, Baker et al., (2002) indicated in a study that cost as perceived by users has a significant effect on their purchasing decisions especially when the user is not from a financially stable environment. According to Jahangir and Begum (2008), although the study revealed some respondents were not bothered by perceived cost as far as the technology is useful, a majority still believes the perceived cost of the product will harm their intended usage. Although the cost of a product or smart technology is a financial sacrifice it as well as some positive effects on the perceptions of value through increased product quality perceptions, regardless, the overall effect of cost on perceptions of value seems to be negative as it discourages the intention to usage among the majority (Agarwal and Teas 2001).

Phonthanukitithaworn, Sellitto, and Fong (2015) in their study support the assertion that customer's perceived cost harms their intention to use technology, product, or service. This is further support by the study of Diallo, Aman, and Adzawla (2019) which suggested that farmers especially those from underserved communities critically consider the cost of a smart farm technology before they declare their intentions to adopt such technology or innovation. Succeeding, the study hypothesis suggest that:

H3: Perceived cost will have a negative effect on the intention to use smart farm technology.

Al-Gahtani, (2001) indicated that the perceived ease of use represents the extent to which people acknowledge as the truth that using an exacting method and technology will come at no cost or stress to them. Also, perceived ease of use is used represents the level to which an innovation is viewed to be understood easily, learned, and operated (Jahangir and Begum, 2008).

Rogers (1983 cited by Jahangir and Begum, 2008) again established that the perceived ease of use is used to show the degree to which an innovation is seen not to be difficult to understand and the degree to which consumers view new products or services to be better than other substitutes.

In regards, Chen and Barnes, (2007) through their study empirically established that the technological aspects of perceived ease of use positively or significantly affect customer adaptation intentions. In a related study by Hernandez and Mazzon, (2007) it was discovered that perceived ease of use on usage intention is positively and directly related as most users will readily accept products and services which they can operate without any doubts and stress. In support Saunders and Lewis, 1997, Thornhill, 2009 also discovered that people perceived ease of use of technology motivates them to patronage such products and services. This position was reaffirmed by Diallo, Aman, and Adzawla (2019) when they indicated that farmers in the Segou region are positively influenced by perceived ease of use of technology. In view of all these argument the study defends the following hypothesis:

H4: Perceived ease of use will have a positive effect on the intention to use smart farm technology.

An action that creates new ideas, processes, or products and when put into implementation results in a positive effective change can be described as innovativeness: alternatively, it deals with the creating and capturing of new ways of doing things which results in speed and quality (Chuck F., 2008). Perceived innovation on the other hand looks at how individuals view the new product or idea compared to the current or old one or idea.

According to the study of Hirunyawipada and Paswan (2006) it was discovered that there is a positive relationship between user's perceived innovativeness and their intention to use. The study added that innovations about cognitive and domain-specific enhance the actual intentions to adopt new smart technology or products and sensory innovativeness and perceived social and physical risks encourage users' desire to acquire novel information about these new products or smart technologies. Similarly, Kunz, Schmitt and Meyer (2011) also confirmed that perceived innovativeness about technology or product significantly influences the intention of users to adapt them to their activities as every user will want something new which eliminates any stress or challenges, they face. Further, Lowe and Alpert (2015) also discovered that there is some positive relationship between perceived innovativeness and the buying behavior of consumers such that when the perceived innovativeness is higher, the desire and acceptance to use such technology or product is also higher and when the perceived innovativeness is low, there is decreased attempt to use such technologies or products. However, the study consents to the following hypothesis:

H5: Perceived innovativeness will have a positive effect on the intention to use smart farm technology.

Mathwick, Malhotra and Rigdon, (2001) explained perceived usefulness to be the degree to which a person views a particular system to improve their job performance. Tan and Teo (2000) after their study stated that the perceived usefulness of innovation is an important factor in determining adaptation of innovations as they realized that most of the respondents agreed to use new smart innovations if they see them be very helpful. As an effect, Polatoglu and Ekin (2001) stated that the higher the perceived usefulness of using services and technologies, the higher it is likely that the services shall be adopted by users when they realized that perceived user usefulness about a service or product influences their choices or decisions. Furthermore, Pikkarainen et al., (2004) in a study in Finland discovered that perceived usefulness is a determinant of the actual behavior which encourages the use of the modern era to use more innovative and user-friendly self-service technologies that give them greater autonomy in performing their task. To support these findings, Saunders and Lewis, (1997), Thornhill, (2009) indicated that, the way institutions and users view how significant an application or technology might help with their operations positively influence their intention to adopt these technologies in their study on the role of perceived usefulness and whether it significantly and positively related to users' adaptation of new technologies. They also as a result proposed that since the way users view an innovation or smart technology influences their degree of adapting the technology there must continue awareness creation about these technologies. Similarly, Chen and Barnes (2007), also acknowledge before that the perceived usefulness of a product significantly affects its choice by the user or customer. In all, the degree to which a farmer perceived a technology to influence his or her farm operations significantly will positively influence the intention of the farmer to adopt smart technology. Yet the study suggest the following hypothesis:

H6: Perceived usefulness will have a positive effect on the intention to use smart farm technology.

Jahangir and Begum (2008) indicated that Trialability deals with how easy it is for a customer to try a new product or service as it is very significant for new innovations to be experienced to see their wealth and value. This experience needs to be compared with the words or statements made about the products to be sure there is no exaggeration of facts and value. Accordingly, in this study the researcher sort to access how trialability could influence farmers' intention to use smart farm technologies on their farms. In support, Jaleh (1977), in a study on the factors influencing farmers' adoption of agricultural technologies revealed that the access to the trail by the farmers makes them more willing to adopt a technology. This is because they have personally used the technology and experienced how effective they work or do not work. Also, the study by Diallo, Aman, and Adzawla (2019) again supports the position that the trialability of new innovations and technologies affects the intentions of farmers to either use or not to use a particular technology on their farms as this affords them the opportunity to see how things work for themselves.

Bradford et. al., (2019) in their study on the factors influencing the adoption of smart farming by Brazilians into grain farming discovered that the ability of the farmers to use or experience the way technology works through training and trial over some time influences their intentions to use new smart farm technologies as part of their operations especially as they can now be sure on their ability to use the technology and the quality and usefulness of such technology to their work.

To affirm, Santisi, Lodi, Magnano, Zarbo and Zammitti, (2020) in their study indicated that possessing the courage to try new innovations and practices proves to positively affect several work behavioral outcomes, personal identity, and actions hence the intention of people to always keep trying and adopting new trends, technologies and innovations. All these arguments result to the following hypothesis:

H7: Trialability will have a positive effect on the intention to use smart farm technology.

CHAPTER 3

3 METHODOLOGY

3.1 Introduction

Methodology of a study deals with concepts of approaches using in undertaking the research: thus, it is not only about the justification of the choices made with regards to the general design of the study but rather it encompasses the philosophical assumptions and underpinning upon which your research is based and the implication of these for the method or methods you have used (Rojon & Saunders, 2012). The methodology of this study focuses on research design, population and target population of the study, sample procedures and techniques employed, the sample used for study, the method used to collect data, source of data for the study, instrumentation, validity, and reliability of the instrument used and ethical considerations employed in the study to investigate, explore and analyze the various objectives.

3.2 The Agriculture Sector in Mali

The Republic of Mali is a West African country without any access to the sea, sharing borders with Mauritania and Algeria to the North, Niger to the east, Burkina Faso, and Ivory Coast to the south, Guinea to the southwest and, Senegal to the west.

Source: Encyclopaedia Britannica, Inc

The French language is supposed to be the country's official language, but it's only understood by 5 percent to 10 percent of the population. The country is home-based to many ethics' groups and tribes with various languages spoken (including, Bambara, Fula, Dogon, Maraka, Songhai, Mandinka, Bobo, Bozo, etc…), however, 80 percent of the population speaks Bambara. Mali is a majority Muslim country, where 80 percent are Muslims, 15 percent are Christian, and 5 percent belong to indigenous believers. 70 percent of its population leave in the rural area and, the education level in the country is estimated to be very low, according to UNICEF[1] more than two (2) million children age 5 to 17 does not have access to school, and over half of the country young generation aged 15 to 24 are not literate.

With a population of 19,658,032 people, a land superficies of 1,241,238 square kilometres and an annual growth rate of 3 percent, Mali is amongst the poorest country around the world with a poverty rate of 50,3 percent in 2009 (20.3 percent in urban area and 73 percent in rural area) (World Bank, 2018). The country is divided into eight (8) regions plus the district of Bamako namely, Kaye, Koulikoro, Segou, Sikosso, Mopti, Gao, Kidal and Timbuctou (Lyche and Skattum, 2012). Mali is divided into three climate zone, the Sahara Desert in the north, the semi-desert Sahel in the centre and, the Sudanese savannah in the south.

Mali's economy is dominated by gold, but agriculture is the critical sector to its economy and social stability, for the reason of its central role in the country national economy, job creation and food security. About 80 percent of Mali's population are involved in agriculture activities which contribute of about 35 percent of the country Gross Domestics Product (GDP) (Kelly et al., 2006). The economy of Mali is therefore is heavily dependent on the performance of agriculture sector which is particularly sensitive to climatic variation during period of long drought and continuous slide of de desert toward the south since decade. Simply put, the production and the productivity of agricultural and pastoral system depend on the evolution of the climate (Ministry of equipment and of the planning of the territory, rapport 2012). In fact, the agricultural sector of the country is largely dependent on the rainfall system which is a seasonal model allowing farmers to produce only during the rainy season (3 to 4 months per year). This rainfall is dominated by their inability to get enough water during other period of the year.

[1] UNICEF: United Nation International Children's Emergency Fund.

To solve this problem and ameliorate the country agriculture systems, several attempts have been introducing without success. According to USAID[2], during the French colonial period, to modernize the sector, some modern techniques developed in Europe have been introduced but were largely unsuccessful by farmers.

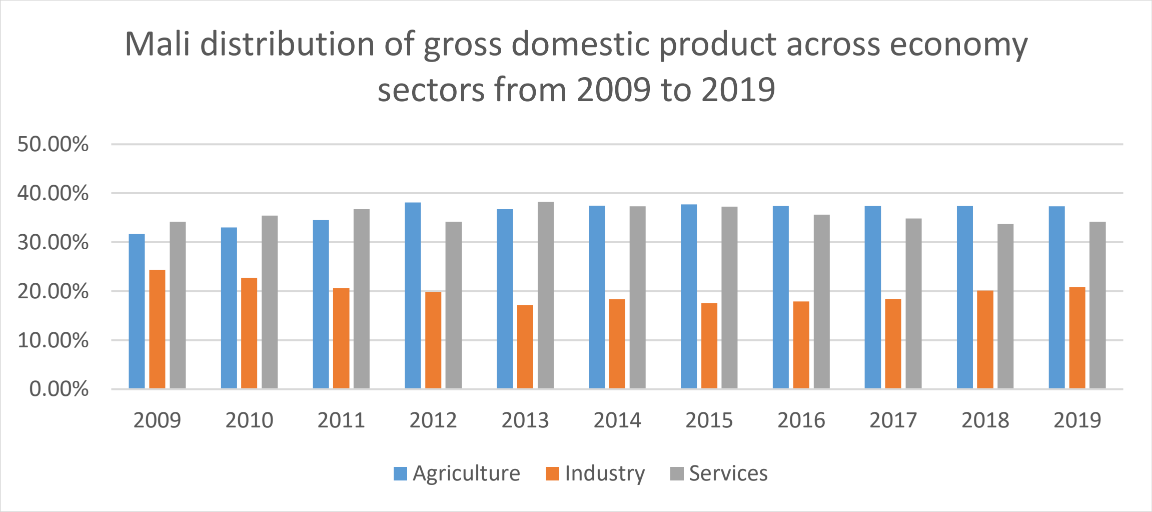

Figure 6: Mali GDP sub-sector Distribution (Statista).

The country has a great latent of agriculture development and enlargement, and so as it presents a considerable agricultural, forestry, and pastoral potential. The Rural land counts about 46.6 million hectares including 12.2 million ha of arable land, 30 million hectares of grazing land, and 3.3 million hectares of wildlife reserves and, 1.1 million hectares of forest reserve (Ministry of Agriculture 2008). The country has also suitable water resources, it is irrigated by the two largest rivers of West Africa, the Niger River with 4200 kilometers long containing 1780 km in Mali and, the Senegal River 1800 km of which 669 km flows through Mali (Pernechele et al., 2018).

The climate and soil condition of Mali is favorable to grow cash crops and food crops. The cash crops constitute Cotton and the food crops are dominated by rice and coarse grains (including Maize, Corn, Beans, Sorghum, Millet, Wheat, and much more). The country produces also Shea, Gum Arabic, Mango, and Cashew. However, cotton is the second largest exported product after gold, accounting for 4 percent of the national GDP (OECD[3], 2011). In the year 2019, 710731 tonnes of cotton have been producing by the country (FAOSTAT[4]). However, since the year of 2002 according to Kelly et al.,

[2] USAID: United State Agency for International Development.

[3] OECD: Organization for Economic Co-operation and Development.

[4] FAOSTAT: Food and Agriculture Organization Corporate Statistic Database

(2006) the cotton sector has been facing a major crisis with a very negative impact on its value due to declining soil quality and inadequate crops management system.

Food corps also play an important role in Mali agricultural product especially coarse grains. According to Samake et. al., (2008), in 2017 grain production covered 72 percent of the cultivated area in Mali, but it constituted of a large part of the population consumption, the surplus is sold on domestic market and the few among is exported to the neighborhood countries.

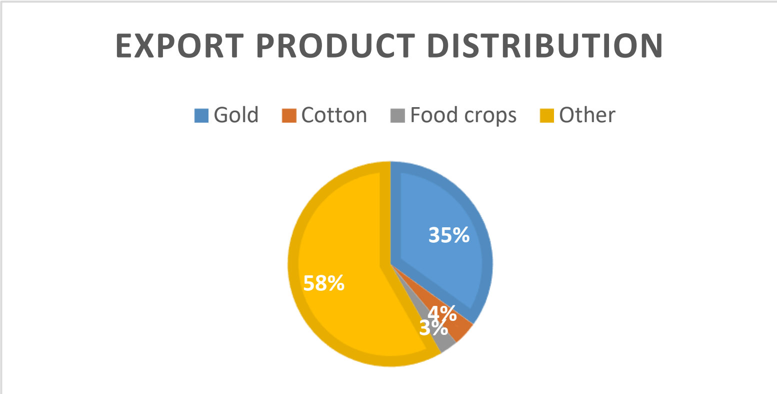

Figure 7: Export Product Distribution (UN Comptrade Data base)

Table 1: Crops production in Mali

ITEM	YEAR	UNIT	VALUE
Beans	2019	tonnes	26076
millet	2019	tonnes	1878527
seed cotton	2019	tonnes	710731
sorghum	2019	tonnes	1511110
wheat	2019	tonnes	8226
Rice	2019	tonnes	2131956

cashew nuts	2019	tonnes	167621
shea nuts	2019	tonnes	226094
mangoes	2019	tonnes	814920

Source: FAOSTAT - data- 6.21.2021

3.3 Study Location

The study was conducted in the Kaye region in Mali. The population around this area cover about 78,406 people with a land superficies of 119,743 square kilometers. Kaye is lain along the Senegal River and has an economy based on subsistence agriculture. The region is known for its large quantity of food crops productivity. Historically, the city has been home to Soninke folks, living in the upper Senegal River valley, which is currently the Eastern Senegal, Southern Mauritania and, Western Mali. In the 18th century, the region of Kaye has been the dominant grain producer in West Africa (Azam and Gubert, 2004). Presently, the region alone is home to enormous development projects such as fishing, forestry, agriculture, water sanitation, and health, meanwhile, Kaye is the second greatest contributor to Mali gross domestic product (GDP), at 18 percent through Agriculture activities and mining sector (Johnson et al.,2019). The crops produced in the region reside principally in Sorghum, Maize, Rice, and groundnuts. Kaye is one of the regions with the best suitable irrigation area with 90 000 hectares of irrigable land area in which just 12 963 hectares are cultivated. Unfortunately, since the year 1970 and 1980, the events of climate change has drastically affected the agricultural production in the area. According to Azam and Gubert, (2004) yields production in the region became extremely irregular due to drought or insect invasion affecting population income.

The research is purposively oriented in the Kaye region for the study due to the high marginalized farming communities and unstable climate conditions in the area for some time now. The study area was finally limited to Founia Moribougou a village in the Kita Cercle closer to some dams and is noticeable for its food crop production. Some of the crops cultivated in this area include rice, tomatoes, onion, and mangoes. This area is closer to the site where two dams were constructed. These dams over the years have helped to improve agriculture activities to some extent, (Diallo, Aman, and Adzawla 2019).

Source: Wikipedia

3.4 Research Design

According to Grove, Burns, and Gray (2012) the research design is a draft used to conduct a study that gives greater control over the factors that might interfere with the authenticity of the findings. Depending on the type of information required for a study, people may be interviewed, questionnaires distributed, visual or audio records taken, and even sounds and smells recorded (Williman, 2011). This study employed the quantitative method of research which according to Dawson, (2002) helps to develop statistics using large-scale survey research using questionnaires or structured interviews. This type of research deals with the usage of numerical and quantitative data which can be objectively analyzed without any bias. A structured questionnaire was the survey instrument that enables the researchers to solicit information considering the objective of the study, the resources available, target population, and the pandemic confronting the world: it served as the most appropriate and efficient technique that assists us to achieve the purpose of the study.

As expressed earlier, this type of research is used alongside questionnaires to gather data and descriptive analysis to enhance easy and fast comparison (Saunders and

Lewis, 1997, Thornhill, 2009).

3.5 Population and Target Population

According to Ngechu, (2004) a population is a well-defined group of persons, elements, and events, things, or households that are being investigated. Mugenda et al., (2003) also defined a population as an entire group of individuals, objects, or events having observable characteristics**.**

In this regards the population of this study comprises the farmers in Mali. Nevertheless, Punch, (1998) stated that one cannot study everyone in a population hence a set of decisions needed to decide persons administer questionnaires and processes to engage them. A target population is a set of elements different from the population and to which the researcher would generalize his or her findings. Accordingly, the population for this study was purposively targeted at farmers in and around Founia Moribougou Village in Southwestern Mali in the Kaye Region.

3.6 Sampling Procedure and Technique

According to Polit and Beck (2006), sampling is the practice of choosing a part that represents the overall study population. The sampling procedure presents the sample size for the study and the sampling technique that will be used in drawing the sample size. The research employed purposive sampling in the selection of the Kaye region (out of the eight regions) and the Founia Moribougou within the Kita circles where the farmers are located. In selecting the respondents, a simple random sampling technique was employed. In this regard, a general meeting was held with the respective farming groups at which balloting was carried out. The expressions “Yes” and “No” were written on different papers and folded. These papers were then poured into a basket and the members present took turns to pick one each. After the picking was done, they were asked to open their papers, and those with “Yes” were registered to be interviewed for the study. Based on their convenience and availability, an arrangement was made with the respective respondents to be interviewed using the questionnaire. A simple random sampling method was also used due to its ability to give an equal opportunity to each respondent or farmer in the target region of been selected for the study. It is widely used because it is easy to implement and also allows researchers to use statistical methods to analyze sample results devoid of bias and based on their willingness to contribute to the study.

3.7 Research Sample

It is undeniable that the total population for this study cannot be reached due to difficulty in accessing the entire population target by ordinarily considering the population size, the time constraints, and the cost involved (Mireku, 2015). Sample can be explained to be the finite part of a statistical population (Somuah, (2011).

Saunders and Lewis (1997), Thornhill, (2009) indicated that the size of the sample and the way it is selected have some implications for the confidence you can have in your data and the extent to which you can generalize.

Through engagement with the respective farming groups in the area, the researcher ascertained a total of about one hundred and twenty (120) farmers. Out of these numbers a representative sample size of ninety-two (92) was selected using the Krejcie and Morgan sampling table. Regardless, the study at the end exceeded this number by 2% which still puts the sample more relevant and in accordance with the Krejcie and Morgan principle. The table is well tested and widely accepted across the world as it presents ranges of populations and suitable sample sizes by putting into consideration a confidence level of about 3.841 and a degree of accuracy expressed as a proportion to be (.05). Although this sample size may be reflective of the area, it is not a full representation of the entire country, but it has a significant impact to play in the decision-making when it comes to agriculture in the country. Accordingly, Somuah (2011) in a study used a representative sample size of as little as seventy-five (75) due to the difficulty in accessing the entire population as a result of resource constraints**.** Similarly, Egyin (2011), also employed a sample size of one hundred and twenty (120) to represent an entire population of the country and the views of the respondents significantly revealed the exact situation**.** Some of the factors considered by the researcher in selecting the target population and samples include financial and legal situations. Also, since the area is predominately a farming area, the information from this respondent has a high potential of revealing the exact situation other farmers might be confronted within other parts of the country.

3.8 Methods for Data Collection

According to Burns and Grove (2009), data collection is a process of collecting raw information using questionnaires, interviews, or observation.

In this regard, an appropriate online questionnaire with clear instructions was drafted in accordance with the study objectives, explained, and administered to respondents by volunteered field assistance. The data that was gathered was the feedback from the respondents according to predetermined questions in the questionnaire. The respective research field assistants were trained by the researcher via Skype meetings on the entire research objectives and questionnaire. The research field assistance then assisted the respective farmers selected to fill the online questionnaire. The reason for engaging research field assistants was due to circumstances beyond the control of the researcher which made it impossible to be physically present in the study area. These circumstances include a time limit for the study, financial constraints, and difficulty in physically been present due to the Corona Virus pandemic and its restrictions.

The validity of the instruments used in this study was directly controlled by the researcher. There was clear information guiding how the respondents should answer and complete the questionnaire. Also, each respondent was engaged extensively, and the various questions well explained in a clearly understood language to make sure the information provided is a true reflection of what the respondent knows and understands.

3.9 Data Collection Sources

The data sources for this study deals with where the information for the study will be originated. The researchers made use of primary. According to Kothari (2004), primary data deals with newly gathered information or first-hand information of original in character. The primary data collection methods that were employed in this study was face to face administration of online questionnaire by the research field assistants in Mali.

3.10 Instrumentation

The researcher employed varying instrumentation procedures to gather data for the study, but the major instrument used in the study is the online survey. The questionnaires were pre-testing among the researcher and the research field agents and other researchers to ascertain their effectiveness before they were finally sent to the field. The responses to the respective question will be done by the respondents by ticking the most appropriate answer using a seven (7) point Likert scale ranging from “Strongly disagree” (1) to “Strongly agree” (7). Also, answers or responses ranging from (1) to (3) are classified under the “Disagreement range”. The response on the exact range (4) is classified as Undefined/Indifferent/Neutral and the responses ranging from (5) to (7) are classified under the "Agreement range" for the analysis and discussion. These procedures or classifications were well explained to the respondents as well. In addition, the questionnaire was designed in both English and French to meet the language diversity in the area for easy understanding.

A structured survey questionnaire with unambiguous questions was used to ease the analysis of varying responses from the respondents. Lots of close-ended questions were used to enhance the ease with which the questionnaires can be completed. The questionnaires were structured according to the research objectives and made for easy understanding. The first section collected demographic data of respondents, and the second section covers questions on the objectives of the research.

3.10.1 Data Analysis and Presentation

Quantitative techniques were employed in the data analysis and presentation. The SPSS program will be employed in analyzing the demographic characteristics of the raw data gathered with the online questionnaire and SmartPLS software to analyze the hypothesis. The hypothesis was done using the Pearson Correlation Analysis. The results were further presented using descriptive tables. These techniques were employed due to their appropriateness in communicating clearly the results from the field in both tabular and clear manner. The results presented in a tabular manner come with frequencies showing the number of occurrences of the demographic factors. Figures and loadings of the constructs and their responses are also presented for easy understanding.

3.10.2 Ethical Consideration

In order to obtain and introduce the subject to the target population of the study. The researchers were well informed about the various ethical considerations governing the study and the gathering of data from the field. In this regard, the researchers explained the aims and objectives of the study to the various respondents to make sure they are clear that the study was for academic and references purpose. Also, various literature and works reviewed together with all sources of information used in the study were respectively acknowledged and referenced accordingly.

CHAPTER 4

4 DATA ANALYSIS AND DISCUSSION

4.1 Introduction

The data collected from the field is analyzed in this chapter in accordance with the objectives of the study and the structure of the questionnaire. In regards, the basic or demographic data of the respondents is analyzed first. This is followed by the general research objectives analysis which is categorized under respective headings and presented in tables for easy understanding and interpretation.

4.2 Basic and Demographic Data Analysis

Table 2: Demographic Characteristics of the Respondents of the Study

Variable	Frequency	Percentage
Gender		
Male	49	52.1%
Female	45	47.9%
Total	**94**	**100.0**
Experience		
Yes	39	41.5%
No	55	58.5%
Total	**94**	**100.0**
Farm Size		
Small (less than 8 hectares)	52	55.3%
Medium (between 8 to 20 hectares)	37	39.4%

Large (above 20 hectares)	5	5.3%
Total	**94**	**100.0**

Source: Field Data, March 2021

4.2.1 Gender Analysis of Respondents

Gender is a very important characteristic in every study hence the researcher made a conscious effort to pay critical attention to the gender composition of the respondents. A total of 94 respondents were used for the study and the data gathered shows that 52.1 percent of the respondents are men and 47.9 percent of the respondents are women. This shows that there is increasing participation of women in the agriculture sector in the area but now the majority of farmers engaged in the area are males.

4.2.2 Analysis of Experience of Respondents

The study seeks to access whether the respondents have prior experiences in the use of smart farm or modern agriculture technologies either before engaging in their own farms or before the study was conducted. In terms of the experience, the responses gathered showed that 58.5 percent of the farmers did not have any prior or previous knowledge on a smart farm or modern agriculture technologies but 41.5 percent of them had a past or prior knowledge of smart farm in agriculture. This shows that smart farming awareness still needs to be encouraged in the area to educate the people on smart farms or the benefits they will get in the application of new technologies to their farms. Table 1 above shows the data distribution of the respondents as discussed.

4.2.3 Analysis of Farm Sizes of Respondents

The table above also presents information on the various farm sizes on which the respective respondents use for their farming activities. The results showed that 55.3 percent of the respondents have small farm sizes which are less than eight (8) hectares of land, 39.4 percent of the respondent have medium farm sizes which range from 8 to 20 hectares of land and 5.3 percent of the respondents have large farm sizes which are above twenty (20) hectors of land. This shows that the majority of the people are small-scale farmers whose farmlands fall below eight hectares of land.

4.3 Measurement Model (Reliability and Validity)

Structural equation modeling (SEM) is a multivariate analytical method that can simultaneously "test and estimate complex causal relationships among variables, even when the relationships are hypothetical, or not directly observable" (Hair, Sarstedt, Ringle, & Mena, 2012). From the statistical point of view, SEM represents an advanced version of general linear modeling and multiple regression analysis. SmartPls program version 3 was used to determine to construct reliability and validity (i.e., convergent and discriminant validity).

The measurement model has been analyzed for convergent validity by using composite reliability (CR), factor loading, and Average Variance Extracted (AVE).

As part of the measurement model evaluation, the indicators loadings were exanimated in the threshold of .50 which is acceptable reliability for the loading items (Bagozzi, & Heatherton, 1994; Bagozzi, & Yi, 1988). Table 2 shows that the factor loadings were above the threshold of .50 but only two items (T3 and EU1) were taken out because they had low factor loadings (<.500) and therefore were not part of the analysis.

Internal consistency has been analyzed for model assessment; however, Cronbach's Alpha was the measurement instrument with a range of .70 which is acceptable (Cronbach, 1951; Nunnally, 1976). Table 2 shows again the Cronbach's alpha (α) of the research variables which was above the benchmark of .70; however, analysis of internal consistency reflects the reliability of the constructs.

The measurement model of convergent validity has also been assessing, and the Average Variance Explained (AVE) is used to access convergent validity it was above the benchmark of .50 (Fornell, & Larcker, 1981). Composite reliability (CR) of the research variables was above the benchmark of .70 (Hair et al., 2017); Thus, we concluded that convergent validity and reliability have been established.

For discriminant validity, in Table 4, the inter-correlations coefficient among the research variables was less than the square root of the variables AVE which satisfies Fornell and Larcker's (1981) criteria for discriminant validity. Altogether, the results show that discriminant validity has been established.

Table 3: measurement model and model assessment (Reliability and Convergent Validity).

Variable	Loadings	AVE	CR	Cronbach's Alpha
Compatibility		.866	.963	.948
Item1	.934			
Item2	.919			
Item3	.955			
Item4	.915			
Perceived ease of use		.602	.812	.737
Item1*	*			
Item2	.536			
Item3	.930			
Item4	.809			
Intention to use		.721	.885	.806
Item1	.740			
Item2	.919			
Item3	.878			
Observability		.636	.839	.706
Item1	.856			
Item2	.842			
Item 3	.682			
Perceived cost		.739	.919	.881
Item1	.756			
Item2	.927			
Item3	.902			
Item4	.843			
Perceived innovativeness		.807	.926	.881
Item1	.921			
Item2	.850			
Item3	.923			
Perceived usefulness		.758	.926	.883
Item1	.803			
Item2	.841			
Item3	.931			
Item4	.902			
Trialability		.905	.950	.895
Item1	.946			
Item2	.956			
Item3*	*			

Notes: (*) = deleted item during factor analysis
Table 2: measurement model and model assessment (Reliability and Convergent Validity).
(Continued)

Table 4: Correlations, descriptive statistics, and discriminant validity.

	1	2	3	4	5	6	7	8
1. Compatibility	**.931**							
2. Intention to use	.608	**.849**						
3. Observability	.672	.541	**.798**					
4. Perceived cost	.805	.701	.666	**.860**				
5. Perceived ease of use	.450	.379	.323	.426	**.776**			
6. Perceived innovativeness	.796	.733	.657	.858	.481	**.899**		
7. Perceived usefulness	.820	.672	.669	.735	.531	.808	**.871**	
8. Trialability	.850	.677	.735	.783	.434	.796	.808	**.951**
Bold values in the diagonal are square of AVE;								
Values below the diagonal are Pearson correlation coefficients generated from S.PLS								

Table 3 also shows concurrent correlations coefficients of the variables under investigation. Compatibility is correlated positively and significantly with Intention to use ($r = .608$, $\rho = .000$), Observability ($r = .672$, $\rho = .000$), Perceived cost ($r = .805$, $\rho = .000$), Perceived ease of use ($r = .450$, $\rho = .000$), Perceived innovativeness ($r = .796$, $\rho = .000$), Perceived usefulness ($r = .820$, $\rho = .000$), and with Triability ($r = .850$, $\rho = .000$). Similarly, Intention to use is correlated positively and significantly with Observability ($r = .541$, $\rho = .000$), Perceived cost ($r = .701$, $\rho = .000$), Perceived ease of use ($r = .379$, $\rho = .000$), Perceived innovativeness ($r = .733$, $\rho = .000$), Perceived usefulness ($r = .672$, $\rho = .000$) and Triability ($r = .677$, $\rho = .000$). Also, Observability is correlated positively and significantly with Perceived cost ($r = .666$, $\rho = .000$), Perceived ease of use ($r = .323$, $\rho = .000$), Perceived innovativeness ($r = .657$, $\rho = .000$), Perceived usefulness ($r = .669$, $\rho =$

.000) and Triability (r = .735, ρ = .000). Perceived cost is correlated positively and significantly with Perceived ease of use (r = .426, ρ = .000), Perceived innovativeness (r = .858, ρ = .000), Perceived usefulness (r = .735, ρ = .000) and Triability (r = .783, ρ = .000). Perceived ease of use is correlated positively and significantly with Perceived innovativeness (r = .481, ρ = .000), Perceived usefulness (r = .531, ρ = .000) and Triability (r = .434, ρ = .000). The table still reveals that Perceived innovativeness is correlated positively and significantly with Perceived usefulness (r = .808, ρ = .000) and Triability (r = .796, ρ = .000). Finally, Perceived Usefulness is correlated positively and significantly to Triability (r = .808, ρ = .000).

Although, Pearson correlations only shows the present or absence of relationships and their directions, the positive and significant correlations provide preliminary support for the research hypotheses.

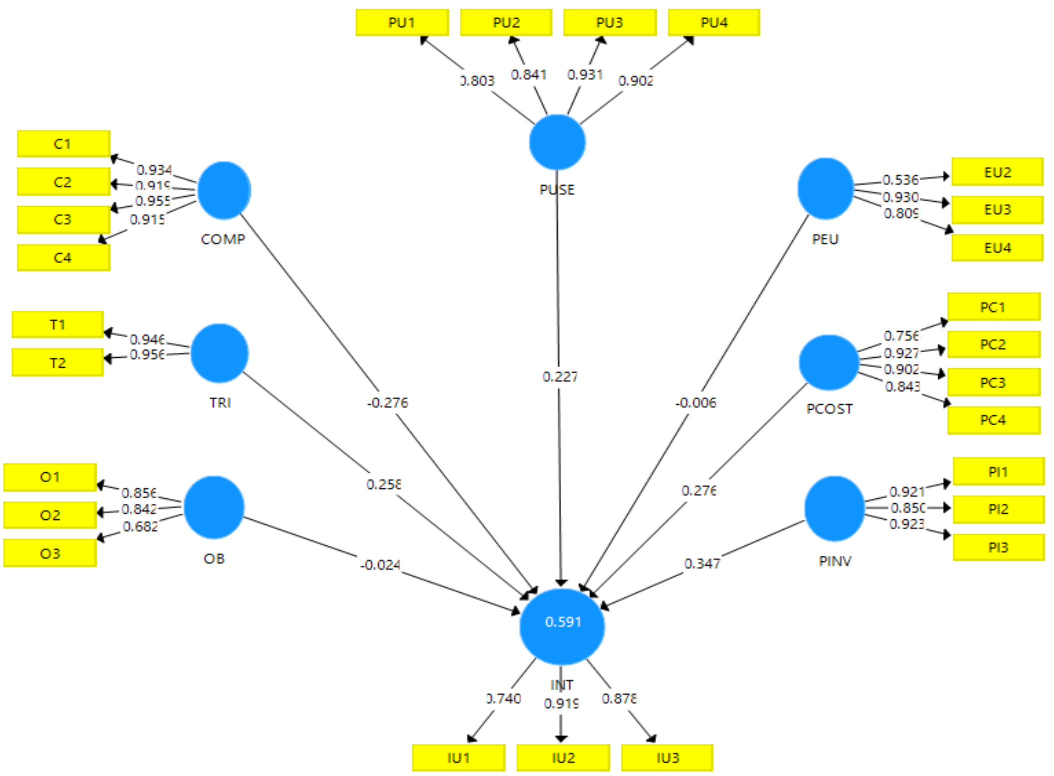

Figure 8: measurement model

4.4 Structural Model

The structural model gives a reflection of the path hypothesized in the research framework or conceptual model. A structural model is assessed based on the R^2, Q^2, and significance of paths. The goodness of the model is determined by the strength of each structural path determined by the R^2 value for the dependent variable (Williman, 2011), the value for R^2 should be equal to or over .10 (Falk & Miller, 1992). The results in Table 5 show that the R^2 value is over .10. Hence, the predictive capability is established. Further, the R^2 appears to be high enough .591, which shows that explains that 59.1% of the variance in Intention to use smart farming technologies is influenced by the exogenous variables, and 40.9% explained by other constructs.

Further, Q^2 establishes the predictive relevance of the endogenous construct. A Q^2 above zero in Table 5 shows that the model has predictive relevance.

Table 5: The values of R squared and Q squared

Variables	**R^2**	**Q^2**
Intention to use	**.591**	**.356**
Values are generated from SmartPLS		

The results show that there is significance in the prediction of the constructs (see Table 6). Furthermore, the model fit was assessed using SRMR. The value of SRMR was .078, this is below the value of .10, indicating acceptable model fit (Hair et al., 2016).

Table 6: The value of SRMR

Variables	**SRMR**
Saturated model	**.078**
Values are generated from SmartPLS	

Further assessment of the goodness of fit, hypotheses was tested to ascertain the significance of the relationships (see table 7). H1 evaluates whether Compatibility will have a positive impact on Intention to use. The results reveal that Compatibility has a negative effect and a partial significant impact on Intention to use (β = -.277, t=1.820, ρ=.069). Hence, H1 was partially supported. H2 evaluates whether Observability will have a positive impact on Intention to use. The results reveal that Observability has a negative and insignificant impact on Intention to use (β = -.022, t=.200, ρ=.841). Hence, H2 was not supported.

H3 evaluates whether the Perceived cost will have a positive impact on Intention to use. The results show that Perceived cost has a positive but insignificant impact on Intention to use (β = .271, t=1.535, ρ=.126). Hence, H3 was not supported. H4 evaluates whether Perceived ease of use will have a positive impact on Intention to use. The results reveal that Perceived ease of use has an insignificant impact on Intention to use (β = -.008, t=0.095, ρ=.924). Hence, H4 was not supported. H5 evaluates whether Perceived innovativeness will have a positive effect on Intention to use. The results reveal that Perceived innovativeness has a positive but insignificant impact on Intention to use (β = .354, t=1.622, ρ=.105). Hence, H5 was not supported.

H6 evaluates whether Perceived usefulness has a positive and significant impact on Intention to use. The results reveal that Perceived usefulness has a positive but insignificant impact on Intention to use (β = .228, t=1.010, ρ=.313). Hence, H6 was not supported.

H7 evaluates whether Trialability has a significant impact on Intention to use. The results reveal that Trialability has an insignificant impact on Intention to use (β = .255, t=1.318, ρ=.188). Hence, H7 too was not supported.

Table 7: Breakdown of the Structural Estimates and Significance

	O	**M**	**Stdev**	**T-values**	**P-values**	**2.5%**	**97.5%**
1. COMP-> INT	-.277	-.300	.152	1.820	.069	-.513	.100
2. OB-> INT	-.022	.011	.112	.200	.841	-.255	.164
3. PC -> INT	.271	.300	.177	1.535	.126	-.072	.608
4. PEU-> INT	-.008	.010	.080	.095	.924	-.171	.124
5. PINV-> INT	.354	.312	.218	1.622	.105	-.016	.809
6. PUSE-> INT	.228	.249	.225	1.010	.313	-.131	.699
7. TRI-> INT	.255	.227	.193	1.318	.188	-.093	.668

Notes: *O= Original sample; M= Sample Mean; Stdev= Standard deviation*

Values below the diagonal are Pearson correlation coefficients generated from SmartPLS

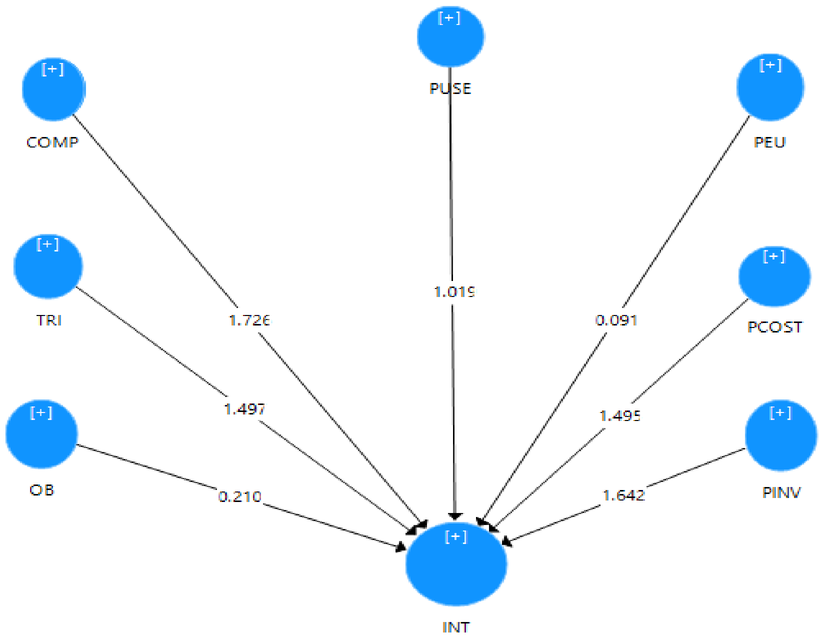

Figure 9: Structural Model

Table 8: Summary of hypotheses and decision

Hypotheses	**Decision**
H1: Compatibility-> Intention to use	partially supported
H2: Observability-> Intention to use	not supported
H3: Perceived cost -> Intention to use	not supported
H4: Perceived ease of use-> Intention to use	not supported
H5: Perceived innovativeness-> Intention to use	not supported
H6: Perceived usability-> Intention to use	not supported
H7: Trialability-> Intention to use	not supported

4.5 Analysis of Hypothesis

H1: Compatibility will have a positive effect on the intention to use smart farm technology:

According to Wigmore, (2013), compatibility deals with the ability of different systems to work together without any adjustments and issues. It also looks at the capacity of the two systems to interoperate without difficulties. Li et. al., (2019), in their study on the factor influencing technology adoption behaviors among Litchi farmers, revealed that although the experience of farmers, training, and size of farm highly influences their intention to adopt smart technology on their farms, the compactible nature of these technologies with other systems to increase yield both in terms of quality and quantity averagely and positively related to their intentions, acceptance, and decision to use smart technology. In a related study by Diallo, Aman, and Adzawla (2019) on the factors influencing the adoption of climate-smart agriculture by farmers in Mali, it was discovered that the ability of technology to work well on the farm of grain farmers to gain desire results influences their decision to use smart farm technology. This study showed that farmers are ready to adopt smart technologies on their farms if they are compatible with their farm structure and processes. Similarly, Jeetendra et. al., (2018), in accessing the factors which affect the adoption of multiple climate-smart technologies in India discovered that household characteristics, plot characteristics, market characteristics, and major climate risks are the leading factors influencing the farmer's intention to use smart technologies. This is followed by how well and interrelated the technologies will fix into their farming set-up. It was seen that the compatibility of these technologies played a positive and significant role in the final decision of the farmers as to whether to adopt the smart technology on their farms or not. It is clear from all the reviews that, compatibility of technology is positively related to the intention of the farmers to adopt a technology as the inability of the technology to work together with existing structures and systems makes their adoption wasteful (Diallo, Aman, and Adzawla, 2019).

The results from the correlation analysis carried out showed that compatibility is having a negative effect on the farmers' intention to use smart farm technology. The correlation revealed a result of -0.277 which is weak. This implies that a 1 unit increase in Compatibility will result in a .277 unit decrease in intention to use. Furthermore, the significance level between the two constructs was slightly above .05 (.069), thus partially significant. This demonstrates that the compatibility of smart farm technology is partially and slightly relevant to the purchase intentions of the farmers in Mali. It can further be explained that compatibility has a partially significant effect on the purchase intentions of the farmers in Mali.

However, this rejects the hypothesis and shows a weak correlation and adverse relationship between the two variables. This result is not in line with the findings of Li et. al., (2019), which also shows that the compactible nature of technology and the user's intentions are positively related to their acceptance and decision to use that technology. Considering the establishment's partial significance, we can say the conceptual hypothesis is partially supported.

H2: Observability will have a positive effect on the intention to use smart farm technology:

Observability is very crucial in the modern-day considering the characteristics of modern applications and the fast pace at which new technologies are been developed. The principles of observability afford users the opportunity to look at how the internal state or ability of a system and technology can be measured through inferring from gained knowledge of the system or technology's output. Hence to improve observability, a farmer must keep watch over all the applications or innovational components to be able to satisfy him or herself of its wealth and value (Waterhouse, 2018).

Clearly, observability looks at giving the opportunity to the farmers to watch or views how some of these smart farm technologies are been used as well as how they operate over time. According to Li et. al., (2019), the ability of people to observe others using various tools and processes also positively affects their intentions to use the same or similar tools and processes especially when they view these tools and processes to be very impactful.

Also, Diallo, Aman, and Adzawla (2019) in their study to access the factors influencing smart farm climate technology in the Segou region of Mali discovered that observability is very significant in determining whether a farmer would like to adopt a smart farm agriculture technology or not. It is relatively significant to observe how these technologies operate to be able to effectively operate them as well. In addition, Bradford et al, (2019) all reaffirmed the position that, observability has a positive impact on farmers intention to adopt a technology as the more the farmers observe others who employ these technologies on their farms and the benefits, they get overtime, the more they are encouraged to also implement same on their farms. Observation they suggested makes farmers more attracted to new technologies and ways of doing things hence they went further to encouraged suppliers to use more illustrations to market smart farm technologies.

Using the correlation analysis in Smart PLS, a negative correlation was established between farmers' observability and their intention to use smart farm technology. A very weak and negative correlation was identified (-0.022). This implies that a 1 unit increase in Observability will result in a .022 unit decrease in intention to use. Furthermore, the significance level between the two constructs was above .05 (.841), thus insignificant.

This means that when observability or more people observe others while they use their smart farm technology, their intentions to use some on their own farms is insignificantly affected, hence does not influence their purchase intention. This showed that the hypothesis is not supported by that of Li et. al., (2019), which indicated that people observing others using various tools and processes also positively affects their intentions to use the same or similar tools and processes.

H3: Perceived cost will have a negative effect on the intention to use smart farm technology:

According to Fong, et al., (2015), the degree to which an individual believes that the usage of a particular technology will cost money can be described as the perceived cost of such technology. It also deals with the second attribute of how consumers will consider prices of products relative to their disposable income which is important. In regards, the perceived cost looks at how the farmers view or the impression formed by farmers about how expensive or not expensive a smart technology costs or might cost them when they finally make up their mind to adapt it for their operations.

Accordingly, Konare, (2001), in a study realized a link between cost and adoption of new technologies such that the perceived cost of new technology directly influences the users' decision to use such technology. Also, Baker et al., (2002) indicated in a study that cost as perceived by users has a significant effect on their purchasing decisions especially when the user is not from a financially stable environment. According to Jahangir and Begum (2008), although the study revealed some respondents were not bothered by perceived cost as far as the technology is useful, a majority still believes the perceived cost of the product will harm their intended usage. Although the cost of a product or smart technology is a financial sacrifice it as well as some positive effects on the perceptions of value through increased product quality perceptions, regardless, the overall effect of cost on perceptions of value seems to be negative as it discourages the intention to usage among the majority (Agarwal andTeas 2001). Phonthanukitithaworn, Sellitto, and Fong (2015), in their study support the assertion that customer's perceived cost harms their intention to use technology, product, or service. This is further support by the study of Diallo, Aman, and Adzawla (2019) which suggested that farmers especially those from underserved communities critically consider the cost of a smart farm technology before they declare their intentions to adopt such technology or innovation.

The findings have revealed a positive correlation between perceived cost and intention to use smart technology. The correlation analysis in SmartPLS revealed a positive but weak correlation of 0.271. This implies that a 1 unit increase in Perceived cost will result in .271 unit increase in intention to use. On the other hand, the significance level between the two constructs was above .05 (.126), thus insignificant.

This shows that the farmers in Mali's decisions to critically consider cost or cost does not affect their intention to use smart technology. Accordingly, Konare, (2001) also realized a link between cost and adoption of new technologies in his study. This research, through its finding, identifies that cost as perceived by farmers has no significant effect (doesn't influence) on their decision or intention to use smart farm technology. We believe that most farmers were not bothered by the perceived cost so far as the technology is useful. Therefore, the conceptual hypothesis is opposed.

H4: Perceived ease of use will have a positive effect on the intention to use smart farm technology:

Al-Gahtani, (2001) indicated that the perceived ease of use represents the extent to which people acknowledge as the truth that using an exacting method and technology will come at no cost or stress to them. Also, perceived ease of use is used represents the level to which an innovation is viewed to be understood easily, learned, and operated (Saunders and Lewis 1997), (Thornhill, 2009).

Rogers (1983 cited by Saunders and Lewis (1997), Thornhill, (2009) again established that the perceived ease of use is used to show the degree to which an innovation is seen not to be difficult to understand and the degree to which consumers view new products or services to be better than other substitutes.

In regards, Chen and Barnes (2007) through their study empirically established that the technological aspects of perceived ease of use positively or significantly affect customer adaptation intentions. In a related study by Hernandez and Mazzon, (2007) it was discovered that perceived ease of use on usage intention is positively and directly related as most users will readily accept products and services which they can operate without any doubts and stress. In support Saunders and Lewis (1997), Thornhill, (2009) also discovered that people's perceived ease of use of technology motivates them to patronage such products and services. This position was reaffirmed by Diallo, Aman, and Adzawla (2019) when they indicated that farmers in the Segou region are positively influenced by perceived ease of use of technology.

The findings of the study have established that perceived easiness in using smart farm technology is positively linked to intention to use smart farm technology. The result from the correlation analysis identifies a weaker and negative correlation of -0.008. This implies that a 1 unit increase in Perceived ease of use will result in a .008 unit decrease in intention to use. Furthermore, the significance level between the two constructs was above .05 (.924), thus insignificant. Hence, the perceived ease of use of a smart farm technology does not necessarily influence farmer's decisions or intentions to use it on their farms.

With reference to the, it shows that as people's perception about how easy technology can be use increases, their intention to use such technologies won't be affected or influenced hence, the high possibility that the technology won't be used. The conceptual hypothesis is rejected and has no empirical support.

H5: Perceived innovativeness will have a positive effect on the intention to use smart farm technology:

An action that creates new ideas, processes, or products and when put into implementation results in a positive effective change can be described as innovativeness: alternatively, it deals with the creating and capturing of new ways of doing things which results in speed and quality (Chuck, 2008). Perceived innovation on the other hand looks at how individuals view the new product or idea compared to the current or old one or idea.

According to the study of Hirunyawipada and Paswan, (2006), it was discovered that there is a positive relationship between user's perceived innovativeness and their intention to use. The study added that innovations about cognitive and domain-specific enhance the actual intentions to adopt new smart technology or products and sensory innovativeness and perceived social and physical risks encourage users' desire to acquire novel information about these new products or smart technologies. Similarly, Kunz, Schmitt and Meyer (2011) also confirmed that perceived innovativeness about technology or product significantly influences the intention of users to adapt them to their activities as every user will want something new which eliminates any stress or challenges, they face. Further, Lowe and Alpert (2015) also discovered that there is some positive relationship between perceived innovativeness and the buying behavior of consumers such that when the perceived innovativeness is higher, the desire and acceptance to use such technology or product is also higher and when the perceived innovativeness is low, there is decreased attempt to use such technologies or products.

The findings of the study established that there is a positive correlation between perceived innovativeness in a technology and farmer's intention to use it on their farms in Mali. The correlation analysis in SmartPLS revealed a positive correlation of 0.354. This implies that a 1 unit increase in Perceived innovativeness will result in .354 units increase in intention to use. On the other hand, the significance level between the two constructs was above .05 (.105), thus insignificant. Hence, the perceived innovativeness of a smart farm technology does not necessarily influence farmer's decisions or intention to use it on their farms. This means that our finding has no empirical support. This shows that no matter how innovative the smart technology, the more likely farmers won't use it on their farms due to some of the challenges affecting smart farming in the country.

H6: Perceived usefulness will have a positive effect on the intention to use smart farm technology:

Mathwick, Malhotra and Rigdon (2001) explained perceived usefulness to be the degree to which a person views a particular system to improve their job performance. Tan and Teo (2000) after their study stated that the perceived usefulness of innovation is an important factor in determining adaptation of innovations as they realized that most of the respondents agreed to use new smart innovations if they see them be very helpful. As an effect, Polatoglu and Ekin, (2001) stated that the higher the perceived usefulness of using services and technologies, the higher it is likely that the services shall be adopted by users when they realized that perceived user usefulness about a service or product influences their choices or decisions. Furthermore, Pikkarainen et al. (2004) in a study in Finland discovered that perceived usefulness is a determinant of the actual behavior which encourages the use of the modern era to use more innovative and user-friendly self-service technologies that give them greater autonomy in performing their task. To support these findings, Saunders and Lewis (1997), Thornhill, (2009) indicated that, the way institutions and users view how significant an application or technology might help with their operations positively influence their intention to adopt these technologies in their study on the role of perceived usefulness and whether it significantly and positively related to users' adaptation of new technologies. They also as a result proposed that since the way users view an innovation or smart technology influences their degree of adapting the technology there must continue awareness creation about these technologies. Similarly, Chen and Barnes (2007), also acknowledge before that the perceived usefulness of a product significantly affects its choice by the user or customer. In all, the degree to which a farmer perceived a technology to influence his or her farm operations significantly will positively influence the intention of the farmer to adopt smart technology.

The finding of the study revealed that perceived usefulness has a positive relationship with the intention of the farmers in Mali to use smart farm technology. The analysis in SmartPLS revealed a positive but weak correlation of 0.228. This implies that a 1 unit increase in Perceived usefulness will result in a .228 unit increase in intention to use. On the other hand, the significant level between the two constructs was above .05 (.313), thus insignificant. Hence, the perceived usefulness of a smart farm technology does not necessarily influence farmer's decisions or intentions to use it on their farms. This shows that even though farmers believe and know of the usefulness of smart technology, they likely won't use it on their farms due to some of the challenges affecting smart farming in the country. This opposes the findings of Li et al., (2019), that the more people think technology will be very useful to their farming activities; the more likely they will want to use these technologies. This means that our finding has no empirical support.

H7: Trialability will have a positive effect on the intention to use smart farm technology:

Space (2017), indicated that Trialability deals with how easy it is for a customer to try a new product or service as it is very significant for new innovations to be experienced to see their wealth and value. This experience needs to be compared with the words or statements made about the products to be sure there is no exaggeration of facts and value. Accordingly, in this study the researcher sort to access how trialability could influence farmers' intention to use smart farm technologies on their farms. In support, Jaleh (1977), in a study on the factors influencing farmers' adoption of agricultural technologies revealed that the access to the trail by the farmers makes them more willing to adopt a technology. This is because they have personally used the technology and experienced how effective they work or do not work. Also, the study by Diallo et al., (2019) again supports the position that the trialability of new innovations and technologies affects the intentions of farmers to either use or not to use a particular technology on their farms as this affords them the opportunity to see how things work for themselves.

Bradford et. al., (2019) in their study on the factors influencing the adoption of smart farming by Brazilians into grain farming discovered that the ability of the farmers to use or experience the way technology works through training and trial over some time influences their intentions to use new smart farm technologies as part of their operations especially as they can now be sure on their ability to use the technology and the quality and usefulness of such technology to their work.

To affirm, Santisi, Lodi, Magnano, Zarbo and Zammitti (2020) in their study indicated that possessing the courage to try new innovations and practices proves to positively affect several work behavioral outcomes, personal identity, and actions hence the intention of people to always keep trying and adopting new trends, technologies and innovations.

The findings also revealed that access to trialability by the farmers has a positive relationship with their intention to use smart farm technologies. The correlation analysis in SmartPLS revealed a positive but weak correlation of 0.255. This implies that a 1 unit increase in Trialability will result in a .255 unit increase in intention to use. However, the significance level between the two constructs was above .05 (.188), thus insignificant.

Hence, the access to trialability of a smart farm technology does not necessarily influence farmer’s decision or intention to use it on their farms.

The result suggested that, even when farmers have the opportunity to try or experiment with the various smart farm technologies, there will be no significant or positives energy among them to use these technologies on their farms as well. The findings are in relation to that of Santisi, Lodi, Magnano, Zarbo, and Zammitti, (2020) who have shown that having the courage to try new innovations and practices proves to positively affect several work behavioral outcomes, personal identity, and actions hence the intention of people to always keep trying new trends and innovations, is opposed in this study. This means that our findings have no empirical support.

4.6 Discussion Summary

The findings from the analysis and discussions above revealed many interconnections and interesting factors which are driving the adoption of the smart farm in Mali. The discussions showed that most of the farmers have small-scaled farmlands per the criteria of the study. This is followed by medium-scale farmlands and few large-scale farming or farmlands. It was evident that most of the farmers are not familiar with the smart farm and modern technological appliances hence a reduction in its patronage. Also, it showed that the farmers in Mali will be very delighted or are willing to adopt and integrated smart farm and modern technological appliances and applications into their farming activities and operations. The key factors identified to be the factors affecting the adoption of smart farm and modern technological applications and appliances include fear of high cost and high cost of installing most of these smart farm and modern technological appliances and applications, current economic conditions in the country, fear of failure of these appliances, inadequate education, and demonstrations using these technologies and the fear of future economic uncertainty or recessions.

The factors identified are largely external factors that directly and indirectly influence the entire region of the study and the country. In this regard, these factors are more likely to also affect the farmers in other parts of the country. For instance, the current economic condition is likely to affect the income of these farmers hence their inability to save enough money to invest in smart farm or modern technologies which will significantly boost their production. Also, since their income or sales revenue is very low, they are likely to find it difficult to access reasonable credit from other financial institutions to invest in these new technologies aimed at expanding their outputs and increasing their incomes or profits. This situation is closely linked with uncertain future economic conditions as indicated by the respondent to also affect their decision to accept or buy smart farm and other modern technological applications.

A couple of these issues is the fear of disappointment from these appliances and applications. It appears from the responses that, most of the farmers are scared of the technologies failing to work as expected after they have invested in them. These fear factors are likely to affect the rate of their acceptance of the modern technologies and their productively which will collectively make up the national food stock and economy. The rate of response also showed that the cost of these technologies will also deter most of the farmers in the region and likely the entire country from buying them as they already anticipate bad economic conditions in the future and will not like to invest all or most of their incomes into expensive smart farm appliances and new technologies.

Regardless, the findings revealed that these farmers are open to trying the new technologies if they can be convinced that they are very effective through observation and practical illustrations. This will clear any misconceptions about the quality of these smart farm appliances and modern technologies. There seems to also be inadequate education on these new technologies which created misconceptions and doubt about the effectiveness of these new or modern technologies aimed at improving agriculture production in the country.

CHAPTER 5

5 CONCLUSION AND RECOMMENDATION

This chapter presents the conclusions drawn from the findings of the study and various recommendations proposed based on these findings.

5.1 Conclusion of Study

The purpose of this study was to investigate the factors influencing the farmers' intention to adopt SF technology in their farms. Three research objectives were formulated to guide the study. The research objective one sought to identify the key factors influencing farmers' decision to adopt SF technology in the agriculture sector in Mali; objective two sights to explain how these factors affect the entire sector in the region and in Mali in particular; while three pursued to recommend policy and strategies that may be increased SF technology adoption to boost rural incomes and enhance food security in Mali. Therefore, this section presents a summary of the research finding as grouped according to the objectives of the study.

The study targeted the Kaye region of Mali, especially fonia Moribougou cercle. A total of ninety-four (94) farmers were able to respond to the online survey administrated with the help of research field assistance and their responses were duly analyzed. The demographic data revealed that the majority 49 (52.1%) of those actively involved in farming activities were male while 45 (47.9%) were female. The higher number of males is the effect of a sociological and cultural behavior that allows males to be a principal actor in the sector. On the experience distribution, it was found out that majority 55 (58.5%) of the farmers did not have any experience of SF technology in their farm, the notable low involving in farmers experiences of using SF was attributed to the fact that most of them did not have any knowledge about it. On their farm size level, the findings show that most of the farmers 52 (55.3%) apply their farming activities on a small size land which is less than 8 hectares, which is not affordable for the community and for the country in general as there will not have enough food for all.

Identifying the key factors influencing farmers' decision to adopt SF technology in Mali has resulted in the testing of hypotheses such as the effect of compatibility on intention to use; the effect of observability (the opportunity for farmers to see either SF technology fit their farming system) on intention to use; the effect of perceived cost (the farmer’s impressions about the cost of SF technology) on intention to use; the effect of perceived ease of use (farmers intention toward the easy understanding of SF technology) on intention to use; the effect of perceived innovativeness (farmers perception about doing their daily work differently) on intention to use; the effect of perceived usefulness (farmers view about the utility of smart farm technology) on intention to use; and the effect of trialability (farmers point of view about trying the SF technology) on intention to use.

However, the investigation concluded in this research found out that farmer’s intention to use or adopt smart farm technology is partially their ability to discover that the system is compatible with their farming style. However, the other variables which are observability, perceived cost, perceived ease of use perceived innovativeness, perceived usability, and trialability do not have any significant effect on farmer’s intention to use SF technology. This clearly indicates that for the promotion of the adoption of SF technology, specific factors must be considered, such as targeting or add more variables to those already existing.

Variables such as education and access to credit can be suggested. According to Diallo, Aman, and Adzawla (2019) education plays a crucial role in improving human capital and the understanding of the field in which he is improving on. That includes however that farmer’s ability to study SF and new technologies can also play a significant role when it comes to pulling out their intention to use the SF technology. Access to credit by farmers as one of the major challenges in this study can also lead to the higher probability of SF adoption by farmers.

It has become very clear that the level of adoption of SF into the farming activities of Malian farmers is on the low although the farmers giving the opportunity and the enabling environment are willing and have intentions of adopting and using it in their farming operations. The driving forces of the adoption of SF appliances and applications in the country are cost, economic uncertainties, fear, and misconceptions about the efficiencies of these appliances and technologies. Regardless, it is evidently clear that the farmers are highly prepared to embrace these technologies with a little education and demonstration made to them so that they can see how these applications really work.

5.2 Limitations of the Study

The statistical analysis performed on the hypotheses of this paper presented results and inferences that opposed recent literature on smart farming. This could be as a result of the sample size is small and possibly does not represent the whole population per this study. This also means that the findings of the study, cannot actually be generalized.

With regards to the concern above, we would like to encourage future researchers to endeavor to use a larger sample size and a representative sampling technique to make a good assessment that won't just be statistically but practically significant.

5.3 Recommendations of Study

Considering the low level of SF adoption, and a probably positive effect of education and access to credit, there is a need to improve farmers' knowledge of SF technology. This also justifies the need for the government through the ministry of Agriculture and Rural Development to promote the adoption of smart farm technology.

The study recommends that the government and various stakeholders who wish to promote agriculture and those who wish to do agric-business in the country or region should use experimentation and illustrative approaches to show the farmers how these technologies work. Also, there must be some form of targeted and general education on the importance and benefits of adopting and using smart farms appliance to encourage these farmers. This education can be carried out by the "Farm Digital Extension Unit" which can be created and well-resourced to specifically undertake smart farm education services under the government or respective agriculture ministry. Various well-crafted educational campaigns in the respective local dialects can also be made and played or shared on all media channels across the country. The other issues of economic expectations and uncertainties are also relevant hence the government and the agriculture ministry must make sure they enhance efficiency to strengthen the economy so as the farmers can get credit and other incentives to invest in smart farming and modern technologies themselves. Regardless, the farmers are also encouraged to create various credit groups among their respective farmers' associations so that collectively they can contribute significant money which gives them the opportunity to access strategic credit facilities that they can use to invest in key smart farm appliances and modern technological applications aimed at enhancing their yields and profits. Doing and handling these issues will bring to light the full potentials of the farmers in Mali and the food shortages and poverty levels of the citizens will significantly reduce.

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7 APPENDIX 1: RESEARCH QUESTIONNAIRES

Survey - The items were answered using a 7-point Likert scale ranging from "Strongly disagree" (1) to "Strongly agree" (7).

Compatibility

COMP1 I feel that the Smart Farm and modern technological appliances fits my farming style

COMP2 I feel that the Smart Farm and modern technological appliances are compatible with my day-to-day farming needs

COMP3 I think that the Smart Farm and modern technological appliances will fit well into my farm

COMP4 I think that the Smart Farm and modern technological products and applications are useful for the tasks I do at my farm

Trialability

TRI1 Being able to try out and experiment with the Smart Farm and modern technological appliances before purchasing it is very important to me

TRI2 It is important to ask questions about Smart Farm and modern technological appliances before buying and installing them

TRI3 I do not need to see how the Smart Farm and modern technological appliances work before I buy and install them

Observability

OB1 It is important for me to see the benefits of others using Smart Farm and modern technological appliances

OB2 Observing other Smart Farm and modern technological users before installing and using Smart Farm and/or modern technological appliances is necessary

OB3 seeing others use Smart Farm and modern technologies would have an effect on me

Perceived usefulness

PUSE1 I feel that the Smart Farm and modern technologies would enable me to accomplish farming tasks more quickly

PUSE I feel that installing and using the Smart Farm and modern technologies would make things easier to do

PUSE3 I feel that I would find Smart Farm and modern technologies useful for doing various tasks at my farm

PU4 I feel that using Smart Farm and modern technologies would increase my farming productivity

Perceived ease of use

PEU1 I feel that the Smart Farm and modern technological appliances are easy to install and use

PEU2 I feel that it is easy for me to learn to use the Smart Farm and modern technological appliances

PEU3 I feel that it is easy to get the Smart Farm and modern technological appliances and devices to do what I want them to do

PEU4 I would find the Smart Farm and modern technological to be flexible to interact with

Perceived cost

PCost1 I fear that the cost of Smart Farm and modern technological appliances is going to be way over my budget

PCost2 I consider cost carefully before I install Smart Farm and modern technologies

PCost3 Economic uncertainty might affect my purchase decisions

PCost4 Given the current economic situation, I would carefully look at the cost of Smart Farm and modern technologies

Consumer perceived innovativeness

PINV1 Smart Farm and modern technological products and applications are innovative

PINV2 Smart Farm and modern technological products and applications are totally new to me

PINV3 When I first heard about Smart Farm and modern technological products and applications, my impression was “Wow!”

Intention to use

INT1 I intend to use Smart Farm and modern technology in the future

INT2 Given that there are more and more Smart Farm and modern technology products and services in the market, I predict that I would intend to use them

INT3 I plan to install Smart Farm and modern technology in my house in the near future

Demographic variables

Gender

Male

Female

Prior experience of Smart Farm Technology

Yes

No

Farm size

Small (less than 8 hectares)

Medium-sized (between 8 and 20 hectares)

Large (above 20 hectares)