UTILIZATION OF COMMUNICATION IN THE ADOPTION OF CLIMATE SMART AGRICULTURAL TECHNOLOGIES AMONG FARMERS IN WEST POKOT COUNTY, KENYA

BY

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DECLARATION

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ABSTRACT

Climate-smart agriculture is among long-term agricultural-based technologies invented and developed to spearhead sustainable agricultural development by addressing food availability and climate challenges. With this huge mandate and opportunities, the technologies have not been adequately adopted by the target farmers. This study has endeavored to explore how communication can be a potent tool to drive effective and efficient execution of agricultural programs on climate-smart and the extent to which it influences the utilization of the technologies among farmers in West Pokot, Kenya. The study is derived from the implementation of the Kenya Climate Smart Agriculture Project (KCSAP), a World Bank's five-year project (2017 – 2022) implemented in 24 counties among them West Pokot. The objectives of the study were to find out the types of communication that have been adopted by agricultural researchers to enhance the utilization of climate-smart agricultural technologies; assess the extent to which farmers in West Pokot County have adopted climate-smart agriculture based on information received from agricultural researchers; assess communication barriers and explore communication interventions that can be put in place to improve utilization of climate-smart agricultural technologies among farmers in West Pokot County. This study is grounded on the diffusion of innovation theory, technology acceptance model, and knowledge-based theory. The study employed a pragmatism mixed method approach; where both quantitative and qualitative approaches were utilized sequentially. 494 farmers were sampled for quantitative data while 29 key informants were sampled for qualitative data. Quantitative data was collected by use of questionnaires while qualitative data was collected through conducting interviews. ANOVA analysis showed significance, an implication of the linear relationship between the utilization of climate-smart agricultural technologies (UCAT) and the independent variables. An analysis of the coefficients revealed that on regression, the variables were significant ($p<0.05$) except interventions of communication ($p>0.05$). From qualitative data, it was established that language barriers, poor communication techniques, inadequate information centers, and limited numbers of extension officers in the field for face-to-face communication were some of the communication barriers in the field while some of the interventions proposed by the key informants included; improving two-way communication, use of vernacular language in radio stations and increase of face-to-face communication. The study concludes that, while there was an emerging appreciation of climate-smart agriculture and the need for its adoption by West Pokot farmers, their adoption was mainly constrained by poor means of communication such as language barrier and technical terms used by scientists to communicate to farmers. The study therefore recommends agricultural communication agents should package their messages in a local language frequently used and understood by farmers in West Pokot County. Climate Smart Technologies published in English should be translated into local vernacular language, further information can be passed through local radio stations that speak local language that can easily be understood by the farmers. Different approaches of communication and extension are proposed as flagship models that can be implemented through agricultural research institutions, private extension partners, and in some cases, through a partnership with local awareness creation organizations.

DEDICATION

This thesis is dedicated to my family members for their patience, prayers, and moral support during my study period. To all the farmers who toil day and night to feed the Nation of Kenya.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANOVA:	Analysis of variance
ASALs:	Arid and Semi-arid Lands
ASDSP:	Agricultural Sector Development Support Programme
C4A:	Communication for Agriculture
CAADP:	Comprehensive African Agricultural Development Programme
CCAFS:	Climate Change Agriculture Food Security
CGIAR:	Consultative Group on International Agricultural Research
CGIAR:	Consultative Group for International Agricultural Research
FAO:	Food Agricultural Organization
GDP:	Gross Domestic Product
GEF:	Global Environmental Facility
GEF:	Global Environmental Facility
GHG:	Greenhouse Gas
GoT:	Government of Tanzania
ICM:	Information and Communication Management
ICT:	Information Communication Technology
ICT4A:	Information and Communication Technology for Agriculture
ILRI:	International Livestock Research
ISAAA	International Service for the Acquisition of Agri-biotech Applications AfriCenter
JKUAT	Jomo Kenyatta University of Agriculture & Technology
KACCAL:	Kenya Adaptation to Climate Change in Arid and Semi-Arid Lands
KALRO:	Kenya Agriculture and Livestock Research Organization
KCSAP:	Kenya Climate Smart Agriculture Project (KCSAP)
KEFRI:	Kenya Forestry Research Institute
KEVEVAPI:	Kenya Veterinary Vaccines Production Institute
KNBS: `	Kenya National Bureau of Statistics
MDG:	Millennium Development Goals
MNTs:	Multinational Teams

MTP:	Medium-term plan
NACOSTI:	National Commission for Science, Technology and Innovation
ODK:	Open Data Kit
RAs:	Research Assistants
RML:	Reuters Market Light
SA:	Smart agriculture
SCCF:	Special Climate Change Fund
SCCF:	Special Climate Change Fund
SMS:	Short Message Service
SPSS:	Statistical Package for the Social Sciences
T&V:	Training and Visit
TAM:	Technology Acceptance Model
TAM:	Technology Acceptance Model
UNEP:	United Nations Environment Programme
UNICEF:	United Nations International Children's Emergency Fund
WB:	World Bank
WB:	World Bank
WFP:	World Food Programme

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CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter provides the background information by explaining the context in which this study was conducted. The chapter also outlines the problem that prompted this study, the study objectives, the research questions, and the scope of the study. Additionally, the chapter highlights the assumptions under which the study was conducted, the significance of the study, and the definition of key terms in this study.

1.1 Background to the study

Communication is crucial in the agricultural sector. Since the beginning, people's lives have depended on different communication ways to relay messages and get feedback. Communication has taken several steps to grow to what it is today. Communication plays an imperative role in the process of social interaction. During this stage of interaction, humans influence one another regarding what they know, their behavior, and their feelings. The power of human communication has been evident through efforts and developmental communication, particularly in developing countries (Buntse, 2021). Communication is key in different set-ups in ourselves in either creating peace or causing war among us. Television print media and radio which are categorized as traditional media has played a major role in the field of communication by informing, educating, and entertaining the public to ensure they remain updated and assist them in decision-making. The same elements of communication have also been employed to propagate war and

spread information that creates peace. Development in technology has widened communication by providing different several ways to send messages. For instance, the rise of smartphones and social networking sites has necessitated the sharing of messages and the flow of information across different media platforms. It has also facilitated immediate feedback from the audience as they can react back to different messages according to Diane and Patrick (2019).

According to the United Nations Human Development Report (2014), "Majority in different nations does well concerning the development of human beings. Different nations have recorded growth in technology, education, and earnings. This shows positive progress in a healthy nation and secured living". This achievement may be linked to the growth of communication and social changes. The UNICEF (2014) report further adds that communication for growth is perceived as a collaborative method for the distribution of thoughts and information using a variety of communication ways and methods that authorize persons and societies to take action to advance their lives.

The Communication for Development public has claimed that operative messages and communication practices are preconditions for positive progress. Promoters reason that communication and information runs are the essence of development plans; an important share of permitting and assisting a fit, lively civic people; vital for the construction of well-organized and active markets; and a precarious section of social alteration.This fundamental standard was stated by Panos in their journal, The Case for Communication (Panos, 2007)

Agricultural science is key for the growth of economies in advanced as well as developing nations. In nations that are advancing, most laborers labor in farming sectors, whereas in advanced nations, agriculture facilitates the production of food and other industrial inputs (Rajeswari, Suthendran & Rajakumar, 2017). In Kenya, the agriculture sector is key in the economy as it adds to 25% of the National Gross Domestic Product (GDP) openly and an additional 27% secondarily through connections to agro-based trades and the provision area, contributing a total of 52% support to GDP (Ministry of Agriculture, Livestock, Fisheries and Irrigation, 2018). The sector is deemed as solitary of the main concern in the economic pillar of Kenya Vision 2030 (Government of Kenya, 2007). This is for the reason that the segment is vibrant, and some economic actions are rightly connected to the area whereas other areas rest on agricultural products as their raw material for actions such as industries. The area also aids in creating income for the nation where 66% of the nation's whole exports are agricultural yields (KALRO, 2019). This assists Kenya's stability of trade and receives foreign exchange which is used for developing the nation.

Additionally, the agricultural area offers to about 45% of the nation's populace with popular are those living in the villages (FAO, 2014). And so, this offers a foundation of living for the people by being able to get what to eat and earning income. Agriculturalists are moving to agricultural business thus growing the volume of businesspersons in Kenya. Additionally, the youth, who are the leading in population Kenya's labor force (Kenya National Bureau of Statistics, 2019) are in the front line of choosing agriculture as an industry for their provisions hence increasing the rate of employment.

Due to the significance of the farming segment, the Kenyan administration amplified its financial distribution to farming in the fiscal year 2019/2018 from 46 billion to 53 billion Kenyan shillings to fund the area (Potato Council of Kenya, 2020). Likewise, it assists the government's Big Four agenda where food security is a key part. Food security has grown to a major alarm in the current and previous world due to the growing of the world populace thus contributing to a decrease in available farming space as well as strain on the environment. According to FAO (2020), the low living standards seen in Kenya are connected to the fluctuations in the nation's farming area. For the reason that foodstuffs are mainly found from farm products and their associates on the farm. The implication is that the farming sector provides food for the population. Hence, the encounters in the agricultural industry put doubt on the availability of food in the future. According to the KNBS (2022), the nation has registered a growth in population from 12 million 1n 1971 to 55 million in 2022 (KNBS, 2022). For the reason that the country has registered a population increase, the government and the public must rethink some of the challenges facing the farming industry and find a solution to them that will encourage farming and a lot of emphasis on food security through the development of agriculture.

Several countries should come up with ways to encounter problems that are facing the agricultural industry which lowers productivity which in turn reduces its contribution to the nation's economy. FAO (2015) identified the problems as; a change in climate. Some of these, are vermin and infections, underdevelopment of roads, losses after harvesting, traditional farming methods, planting wrong seeds, and lack of enough agricultural information from agricultural officers. FAO (2020) recommended the following in their documented policies to assist in the growth of agricultural development and make it

competitive; a) refining study and extension activities b) growing structures in countryside regions c) refining the value of living for the people living in the countryside by providing them with learning facilities, health services and make them reach to properties with a lot of ease, and d) encouraging workable agriculture and growth by maintaining the surroundings. To achieve the recommendations shared by FAO (2020), effective communication is required for farmers, Communication with farmers has not been fully used by most policymakers on how farmers can implement the agricultural TIMPs and policies.

In Kenya, some of the major challenges facing the agricultural sector are the vulnerability to extreme weather events, climatic shocks, climatic changes, lack of shared agricultural information, and variability among other challenges. In 2015, the Government of Kenya highlighted that extreme weather events, climatic shocks, and climatic changes create stresses on food and water supply while degrading the environment (GOK, 2015). In the same year, a study by Ogola (2015) found that extended periods of drought negatively impact livelihood opportunities and community resilience undermining long-term food security. This prompted the Government of Kenya to look into the challenge keenly and come up with an agricultural strategy to respond to extreme weather events, climatic shocks, and climatic changes in agriculture. After doing a wide variety of research on climatic shocks, and climatic changes, the government developed the Kenya Climate-Smart Agriculture Strategy (KCSAS) 2017-2026 (GoK, 2017). The policy circles out a thorough proposal on how to acclimatize to climate change and shape the flexibility of agricultural structures while lessening releases for improved food and food security and better living (Ministry of Agriculture, Livestock, Fisheries and Irrigation, 2018).

The Kenya Climate-Smart Agriculture Strategy has been adopted and implemented in various parts of Kenya, especially in Arid and Semi-Arid Lands (ASALs). However, past studies that have been conducted after the adoption and implementation of the Kenya Climate-Smart Agriculture Strategy have shown that the strategy can be effective if only there is reliable effective communication of agricultural research information (Awuor, Raburu, Onditi & Rambim, 2016; Mwambi, Oduol, Mshenga & Saidi, 2016; Obiero, Waidbacher, Nyawanda, Munguti, Manyala & Kaunda, 2019). This implies that communication between researchers and farmers is critical in ensuring the effective utilization of climate-smart agricultural technologies that have been designed and adopted to avert the challenges of climatic shocks/changes in the agriculture sector, thus, building the resilience of agricultural systems, and minimizing emissions for enhanced food and nutritional security and improved livelihoods (Nizam & Hassan, 2017).

Communication generally refers to the transferring of information from one end to another. In the utilization of agriculture-based technologies, communication refers to the sharing or dissemination of agricultural information among the agricultural value chain players and in this study between agricultural researchers and farmers, which is seen as a policy instrument to support agricultural development (Protopop & Shanoyan, 2016). Adequate sharing of agricultural information through effective communication enables farmers to learn and develop the most resilient framework to promote sustainable farming practices (Protopop & Shanoyan, 2016). According to Kenya's Department of Agriculture, Livestock and Fisheries (MoALF, 2017) farming extension services denote a sharing practice of operational with agriculturalists or societies to aid people in obtaining pertinent and valuable agricultural information or linked awareness and services for

intensification of their ability, farm production, and economic constancy. For example, the distribution of agricultural information aids farmers in generating relations with another group of actors in the area for instance customers hence generating market connections and enhancing their revenue.

Despite the advantages of sharing agricultural information through different agricultural extension structures in Kenya wherever there are numerous shareholders, there is an absence of collective strategies and principles that should be implemented when circulating information to agriculturalists, mainly over the climate-smart technologies. A previous study by Mwambi, Oduol, Mshenga, and Saidi (2016) found that poor communication has been posted as one of the critical factors that derail climate-smart agriculture. Mwambi et al only focused only Avocado farmers and not all farmers in Kandaria and only 100 respondents were used in the quantitative research. There is a need to carry out a mixed study to explore the effectiveness of communication in communicating agricultural information to farmers by increasing the number of respondents. Therefore, this study explores communication as a potent sociological tool to drive effective and efficient implementation of climate-smart technologies and the extent to which it influences the utilization of the technology among farmers in West Pokot County. This will also complement the government's effort to build guidelines for the effective dissemination of agricultural information. Indicate what the Mwambi et al study did not focus on which your study considers to be important.

1.1.1 Communication of Agricultural Research

Communication from agriculturalist to agriculturalist is in the main area which allows farmers to study from each other's knowledge. Study indicates to a certain extent that most agriculturalists implement fresh farm practices largely after they have acquired from their associates about their achievement with these performs or desirable, they have seen this achievement through their experiences (Rogers, 2015). Mostly the societal position of an agriculturalist in a society rests on to a huge magnitude on the way he practices farming. Maintainable agriculture might need a revolution in the collection standards for best farming practices. These standards might be part of them, challenging for an agriculturalist to reduce the usage of insecticides even if that would upsurge his revenue, since his harvest is low.

The study has discovered that investigators do not communicate agricultural communication effectively. Kirkland, Mouton, and Coates (2010) claim that most of the studies that have been done mostly focus on improving the living standards of people living in Africa though not much has been done by researchers in the field of communication (Kirkland, Mouton, and Coates, 2010, p.3). A study by Edge, Martin, Rudgard, and Manning (2011, p. 3) established that creating a study output liberally and willingly accessible may be with the people. These academicians realized that there are obstacles to the communication of study results for instance absence of necessary properties and recognized strategies to initiate these actions. Researchers also realized that existing habits in selecting ways of channel study output are commonly based on the traditional ways of journal publication and in books and presentations in seminars.

(Butera, Shyaka and Habimana,2012, p.61). This places away individuals like agriculturalists whose education level is low and have might not be able to get educational ways of communication.

Edge, Martin, Rudgard, and Manning (2011, p. 9) recognized that the best ways which inspire scholars to communicate their study findings efficiently are linked to 'openings for professional improvement', 'universities want to report or communicate results', and organizational abilities ('getting to enough IT infrastructure'). They also grasped other opportunities such as rewards in terms of money in connection to royalties and openings for their development. They also detected that scholars rarely share their results due to a lack of incentives whenever they communicate their findings (Edge, Martin, Rudgard, and Manning, 2011).

Though academicians agreed that they don't rely on their findings in the right way, they all agree that when agricultural study findings are communicated in the right way, then it contributes a lot to the field of science, therefore, being able to access farmers and this help in fighting poverty in our countries,' (Edge, Martin, Rudgard and Manning, 2011).

From the previous research, there is a gap as mentioned in a research that was done in Rwanda by Edge et al., therefore there is a need to conduct research in Kenya on how communication influences the utilization of climate-smart technologies among farmers in West Pokot County.

1.1.2 Agricultural Research in Kenya

Studies in agriculture include any study that aims at increasing the output and qualities of yields and animals by improving their genes, protecting plants, irrigating plants, storage methods, climate-smart agriculture, provision of markets, and improving managing of properties (Reardon, Echeverria, Berdegué, Minten & Zilberman, 2019). The major agriculture research institutions in Kenya include; the Kenya Agriculture and Livestock Research Organization (KALRO), Kenya Veterinary Vaccines Production Institute (KEVEVAPI), Kenya Institute for Public Policy Research and Analysis (KIPPRA), CGIARs, various universities, International Livestock Research Institute (ILRI), among others. The Kenya Agriculture and Livestock Research Organization (KALRO) is obligated to expedite the sharing of research knowledge, technologies, and innovation for wider adoption and stemming the volatility in agricultural production (Kibe, Kwanya & Owano, 2020). The Kenya Climate Smart Agriculture Project (KCSAP) intends to deliver simple records required to aid the founding of agro-weather structures that will set up a key feature of sending unified agro-weather and market advisories to recipients (Lee, 2017).

KCSAP aims to increase the availability of suitable and correct meteorological conditions, average temperature, market, and advisory data by smallholder agriculturalists for high yield and coming up with crops and livestock that can survive harsh climatic conditions. The facilitation of efficient communication from researchers to farmers on how to facilitate smart agriculture is expected to mitigate climate change. The change of climate is a reality that is a challenge to food security in the whole world and

has a lot of good and bad effects in the agricultural field of the world. Thus, there is a need for extensive agricultural research to facilitate sustainable agriculture.

Therefore, there is a need to examine how researchers in Kenya are communicating their research findings to farmers and whether the communication is timely and communicated in a way that farmers can easily understand and utilize the information received. Climate Smart Agriculture is a concept that most farmers do not understand even though it has been in existence for a long period in Kenya, therefore there is a need to understand how information on climate-smart agriculture is being communicated by researchers and agricultural officers in Kenya.

1.1.3. Climate Smart Agriculture Technologies

Climate change is evolving as a main challenge to farmers, food availability, and the lives of many people in different parts of the world according to IPCC (2014). Much research shows that as a result of high temperatures, agricultural out may be important (Lobell et al., 2012; Aggarwal et al., 2009), Ups and downs in precipitation forms (Prasanna, 2014; Mall et al., 2006), and differences in rate and strength of life-threatening climatic actions such as heavy downpours and lack of rain (Brida and Owiyo, 2013; Singh et al., 2013). The projected effects of both past and forthcoming climate change on crop output in several parts of the world show that the output has dropped to 36% for wheat, 20% for rice, 50% for millet, and 60% in maize subject on the region, forthcoming climate situations and predictable year (Porter et al., 2014). Variations in crop plantation best for and connected to agriculture biodiversity, reduction in input use effectiveness, and occurrence of pests and diseases are part of the main reasons climate change affects

farming (Zabel et al.,2014; Norton, 2014). Agriculture production structures need variations to these fluctuations to ensure the availability of food and improved lives for communities that depend on farming.

Different ways are available that can be used to control the adverse climate change problems related to Agriculture. These ways once adopted can lead to lasting solution on increased output, improves crops resilient to harsh climatic conditions, and lessen greenhouse gas emissions which can be termed as climate-smart agriculture technologies (FAO, 2010). Climate-smart agricultural technologies are actualized by embracing the world as a way to change and safeguard the agricultural area. It is described as a policy to talk about the problems brought about by climate change and food security by sustainably increasing productivity, bolstering resilience, reducing greenhouse gas (GHG) emissions, and improving the attainment of nationwide food security and development goals (FAO, 2010). Strategy requirements for climate-smart technologies comprise the necessity to upsurge food crops, feed an increasing population of 9 billion people by 2040, organize savings for agriculturalists, and moderate GHG release (World Bank, 2010). Agriculture is the major economic sector in most nations and is crucial to ensuring elementary necessities and living for 60% of the ecosphere's lowest communities (GCEC, 2014). Therefore, adaptation, mitigation, and food security (the three pillars of climate-smart agricultural technologies) will have important implications for the world's poorest farmers.

Broadly, climate-smart agriculture emphasizes evolving strong food production methods that result in food and profit security through advanced climate change and inconsistency

(Vermeulen et al., 2012; Lipper et al., 2014). Most agricultural methods and machinery such as least cultivation, diverse approaches of crop cultivation, provision of fertilizer or manure, crop watering, and residue combination may increase harvesting of agricultural produce, well crops are irrigated in the right way and provided with the right nutrients and lessen Greenhouse Gas (GHG) released from agricultural events (Branca et al., 2011; Jat et al., 2014; Sapkota et al., 2015). Likewise, collecting rainfall, planting recommended seeds, ICT-based agro-advisories, and crop/livestock insurance may improve agriculturalist yields to lessen the effect of climate change unpredictability (Mittal, 2012; Altieri & Nicholls, 2013). Overall, the climate-smart agricultural technologies choices incorporate old-style and advanced styles, know-how, and facilities that are appropriate for certain localities to accept climate change and unpredictability (CIAT, 2014).

The method used in communicating climate-smart agriculture affects how the messages are received, interpreted, and implemented. The various ways of communication are radio, TV, field visits, public meetings (chief meetings, mosques, and places of worship), person-to-person communications, and more lately cellular and networking social platforms (BBC World Service Trust, 2010; Gambhir & Kumar, 2013; Kalungu et al., 2013; Mamun et al., 2013). The central feature of these ways of communication and methods is the way they are used affects the adoption of climate-smart agriculture (Moser, 2010). For instance, studies established when messages concerning climate-smart agriculture are channeled in English or Kiswahili language, it's not easy for most of the communities to understand and utilize the information as most of them only understand

their local language best (Mamun et al., 2013; Roncoli et al., 2008; Simelton, et al, 2011; Muchunku et al, 2014; Singh et al., 2014; Khan et al., 2012).

Examples of messages channeled through these media include; weather patterns on rainfall which targets all agriculturalists across the world as this may affect their yield, initial cautions of possible catastrophe actions (scarcity of rain, heavy downpours, etc.) aiming on decreasing disaster consequences, improving community consciousness and prompting crisis reactions (Luseno et al., 2003; Mokotjo & Kalusopa, 2010; Hansen et al., 2007). In several circumstances, the messages come from the government media and main nationwide organizations for example KALRO and organizations managing crises (Mittal, 2012; Panos Eastern Africa, 2011).

West Pokot is a beneficiary of the Kenya Climate Smart Project funded by the World Bank and implemented by the Ministry of Agriculture, Livestock and Fisheries, and the 27 County Governments, (World Bank Report, 2022). Therefore, there is a need to conduct a study in West Pokot to find out the type of communication used in West Pokot and how communication influences the utilization of climate-smart agriculture among the farmers.

1.1.3.1 Climate Smart Techniques

The implications of climate change on agriculture, especially among small-scale farmers, have frequently been addressed through efforts to innovate and gain better access to technical methods (Howden et al., 2007). As a result, efforts have been made to develop best practices for adjusting to the effects of climate change and variability. The adoption of Climate Smart Agriculture (CSA) is one of the innovative strategies advised (FAO,

2010; WMO, 2001; WMO, 2007; WMO, 2009). The term "Climate Smart Agriculture" (CSA) was first used by the FAO and has since received widespread support from international organizations including the World Bank, United Nations Environment Programme (UNEP), World Food Programme (WFP), Consultative Group for International Agricultural Research/Climate Change Agriculture Food Security (CGIAR/CCAFS), and Comprehensive African Agricultural Development Programme (CAADP) (FAO, 2010; 19 FAO, 2013).

It seeks to strengthen the livelihoods of small-scale farmers by improving access to services, knowledge, genetic and financial resources, markets, etc. It is intended to promote sustainable intensification, sound and efficient management of natural resources, and provides an opportunity for funding climate change (ibid). S is for specific, M is for measurable, A is for achievable, R is for dependable, and T is for timely in the SMART acronym (McCarthy et al., 2012). The climate-smart strategy seeks to increase productivity and returns, enhance ecosystem and livelihood adaption, and lower greenhouse gas emissions (FAO, 2010). Agriculture is therefore deemed SMART in the context of the climate-smart concept if it achieves the aforementioned goals. The strategy incorporates tried-and-true existing technologies as well as other cutting-edge techniques like conservation agriculture, agroforestry, water harvesting, and efficient use, use of varieties and breeds that can perform better under various climatic stresses, and timely use of safety nets, risk insurance, and climate information by farmers (FAO, 2010; FAO, 2013).

These technologies have been used successfully in several nations in Africa, Asia, Latin America, and the Pacific (Branca et al., 2011; Branca et al., 2012). Its widespread acceptance, though, is still difficult. Review of several studies (Rockstrom et al., 2009; Branca et al., 2011; Branca et al., 2012), on select practices such as the use of cover crops, rotation of crops, intercropping with legumes, water harvesting, irrigation, integrated nutrient management, contour farming, terracing, agroforestry, minimum tillage and crop residue management showed stability in production and significant increase in yield of crops both in the short and long run in humid and dry areas.

The improved soil fertility, water retention capacity, controlling soil erosion, and improved soil structure are all credited with the rise in yield. As opposed to conventional techniques, these activities encourage soil carbon sequestration, which is the process by which soils absorb and store carbon from the atmosphere (Branca et al., 2012). 20 In addition to increasing livestock production and ensuring resilience to irregular weather patterns and the consequences of extreme weather events, particularly in dry areas, improved pasture and grazing management improves the quality of feed (Kohler et al., 2014; Kuria et al., 2015). The study conducted by Fanen et al. (2014) on the impact of climate-smart practices in preventing desertification, mitigating climate change, and enhancing livelihoods in Northern Nigeria showed promise. To increase their acceptance, however, there is a requirement for the right institutions, political will, and significant financial, and human resources, in addition to making information and incentives available.

1.1.3.2 Small-scale Farmers Adopting climate-smart Practices

Given their contribution to increased productivity and incomes, the adoption of scientific and technological innovations in the agricultural sector has drawn significant attention (Rockstrom et al., 2009; Branca et al., 2011; Branca et al., 2012), particularly in developing countries where agriculture plays a crucial role in eradicating poverty and hunger and supporting the livelihoods of the majority of small scale farmers (World Bank, 2008). As a result, a variety of agricultural technology as well as a great body of literature have been produced. Despite these initiatives, the adoption of new technology at the farm level is still a difficult and evolving problem. Research undertaken in African and Asian nations, including Ethiopia, Nigeria, and Nepal in India, has confirmed this (Deressa et al., 2009; Dulal et al., 2010; Fanen et al., 2014). Numerous initiatives have been made in Kenya to encourage the adoption of climate-smart activities. Although these initiatives with efficient, sustainable, and productivity-enhancing technology have been put into place, their adoption has remained low, especially among small-scale farmers. Numerous studies conducted nationwide (Ogada et al., 2014; Mugwe et al., 2009) have supported this. According to different locations and agroecological zones in Kenya, the low adoption has been proven to depend on several factors (Ogada et al., 2014). According to a survey conducted in Embu and Taita in 2011 by Mutsotso et al. in Kenya, farmers' adoption of biodiversity conservation was hindered by the lack of the necessary technologies in the area's agro-businesses. Resource endowment was identified as one of the key elements influencing the decision to adopt or reject the innovations in a different study by Mugwe et al. (2009) that looked at the uptake of soil fertility 21 management strategies among small farmers in Kenya's central highlands. Other research

conducted by Ogada et al. (2014), which mainly focused on the adoption of fertilizers and improved maize varieties in Kiambu, Embu, and Coastal lowlands, noted low adoption as a result of climatic conditions, high input and labor costs, limited access to extension services, the absence of inputs in agro shops, gender, and low financial endowments.

1.1.3 Farming in West Pokot County

West Pokot is one of the counties in Kenya with the potential to achieve the best agricultural outcomes with the implementation of climate-smart agriculture strategies. The agricultural department is a significant portion of West Pokot's economy, paying to almost 86% of domestic earnings (Gatobu, Omboto & Mining, 2020). A domestic baseline study done by ASDSP in 2015 stated that 42.9% and 24.2% of women-led households cited cultivation of crops and keeping of animals, respectively, as their main source of employment (Kemboi & Maina, 2017). Merely 3.7% of youth-headed households termed agriculture as their key source of income. Overall, women and youth contribute 5% and 6% of their acreage to agri-business, respectively, compared to 3.4% for men.

In Kenya, the government through the Office of Agriculture is effecting the Kenya Adaptation to Climate Change in Arid and Semi-Arid Lands (KACCAL) scheme, using donations they received from the Global Environmental Facility (GEF)/Special Climate Change Fund (SCCF) through the World Bank (WB). West Pokot is one of the regions that is benefiting from the KACCAL project. Extension programs focus on soil and water conservation practices as part of wider farmer training on Climate-Smart Agriculture and are expected to help the residents in the region to have smart farming (Lee, 2017).

The construction of terraces and storm water harvesting structures is expected to spread head-smart agriculture. Access to reliable and timely agricultural information will help end the perpetual food insecurity and promote tremendous livelihood. Based on the 2019 census, the urban population accounted for only 10% of the total population in the county, making West Pokot one of the least urbanized counties in the country (KNBS, 2022) Update with the figure from the census. The Infotrak Countytrack Performance Index report (2022) ranks West Pokot at number 39 among the 47 counties in terms of development. Being one of the least developed countries could imply a lack of proper infrastructure to fuel communication and implement climate-smart projects. This formed the rationale to conduct the study in the county since it will be convenient in generalizing other counties.

West Pokot is among the Sub–Counties in Kenya, The County has five major types of media channels just like other counties in Kenya, including; TV, radio, print media, mobile phones, and Web. Due to inadequate knowledge and scarce resources, reading newspapers is not common among Kenyans, which is around 38% of Kenyans studied indicated that they haven't read for close to more than a year according to Brown (2010). More people in the town read the newspaper as compared to those in the village areas. A study conducted by the Media Council of Kenya in 2019 established that out of 35,000 respondents, (86%) of them indicated that they listen to the radio, 84% watch television, 63 read the newspaper and those who use smartphones and the Web were 41% in that order. This research indicates that most people listen to the radio and this was followed closely by those who watch Television, Comparing this to a study that was done by Synovate (2019) every year, newspaper readers drop by 4%, most of their readers are

now moving to broadcast media or using their smartphones to receive similar content they were receiving from the newspaper.

In West Pokot, a qualitative study that was conducted by (UNFPA 2016, UNICEF/WHO, 2017) established that there is a need of face to face-to-face communication to channel information in West Pokot. This is a result of differences between the people living in West Pokot in terms of their living standards and what they do for a living. The majority of them rarely reach media like radio or TV, they rely mostly on face-to-face communication. In West Pokot, the Northern part of the county experiences harsh climate conditions making harsh living conditions therefore majority living in these areas are not able to access media in comparison to those living in the southern parts and western areas. For those who can listen to radio, they mostly tune to a community radio station that is Kalya FM that speaks their vernacular language (UNFPA2016, UNICEF/WHO, 2017). Mechanisms should be employed on how to get men and village elders who are vital in the community since they are heads of families and community leaders. Village elders were important in communicating messages to the communities that they headed where the old were tasked with bringing together the society to get the information through gatherings. Chief meetings were also used and also using community leaders passed messages to the community members. The study also establishes that marketplaces are the main areas to get members of the community. When farming messages are to be communicated, they should be designed in a way that they can be communicated in marketplaces and to be communicated on market days, this will assist in getting the majority who come to the market (UNFPA2016, UNICEF/WHO, 2017).

Most scholars, correspondents, and organizations have taken their time, energy, and cash on climate-smart agriculture communication in the past decades. Communicating climate-smart agriculture, though, its impact has not been felt by most people in many countries as most people do not accept the concept. Furthermore, the opinions of advocates and rivals have become even more rooted despite the energies to converse the scientific information. This looks paradoxical as the main function of communication is to create a mutual understanding of interests, principles, and favorites, taking keen consideration of the desires of those who are involved. Therefore, science communication is an important factor for any country for successful adoption and utilization of any science such as climate-smart agriculture among farmers in Kenya and its counties such as West Pokot County.

1.1.4 Science Communication Concept in Agriculture

Agriculture has been recognized globally as one of the key sectors that can be utilized in the reduction of carbon dioxide, methane, and other greenhouse gas emissions, which are very instrumental in the mitigation of climate change (Robinson et al., 2018). However, several changes in agricultural practices have been difficult to implement because the new farming practices often bring unknown risks to the agricultural industry, which already deals with many uncertainties, including pest pressures, weather variability, and the influence of local and international markets. This implies that farmers must trust and adopt the new agricultural practices and technologies, which are being developed by agricultural researchers/scientists. Creating this belief with agriculturalists needs individual rapport and empathy for the problems that are faced by individual farmers

(Bernacchi & Wulfhorst, 2017; Coquil et al., 2018). This can be attained using operative science communication in the dissemination of scientific information between agricultural scientists and farmers/citizens/stakeholders in the agricultural sector.

Science Communication (SciCom) is a rising communication practice in agricultural research. It comprises the application of required knowledge, mass media, actions, and discussion to come up with an individual or individuals in some of these areas to respond to agricultural science (the AEIOU vowel analogy): Awareness, Enjoyment, Interest, Opinion-forming, and Understanding (Burns, O'Connor, & Stocklmayer, 2003). The operative communication of agricultural science theories increases the importance of science to societies that practice agriculture and inspires its incorporation into strategy and policymaking, thus leading to improved agricultural production. For example, science concepts like those applied in controlling armyworms that affects maize plantation, locust invading farms, and controlling aflatoxin in foodstuff in African countries should be communicated appropriately to different media channels to reach all farmers and stakeholders.

In agricultural science communication, agricultural scholars frequently struggle to use media podiums to transfer their agricultural study findings in a way that most end-users (policy makers, traders, fellow researchers in other fields, farmers/stakeholders) will be able to interpret. However, most agricultural study outcomes contain relevant agricultural messages that may assist in countering some of the problems faced in the agricultural sector. Thus, need for agricultural studies to come up with ways to solve challenges that farmers are facing. The intervention should be practical and cheap to farmers and in the

end, lead to a rise in farmers' output. In the middle of the requirements are legislators and agriculturalists who are important to the use, ascending, and carrying out of inventions in the agricultural sector. Science communication summarizes any action that includes one section communicating produced science-associated messages to a single, collection, or media channels (Briese, 2019).

Chandra Mohan (2010) suggests that the majority of publications in print media linked to science actions frequently show information too detailed or complex terms not highly researched or lack accuracy. The publisher additional spots that a main assessment measure for the outcome of scientists by their bosses is their abilities to print their outcomes in peer-reviewed journals as contrasting to publishing as grey literature and other means of communication. Though peer-reviewed journals are assumed as the key typical information sources by many, the style, content representation, and occasionally limits enforced by editors hinder their right to use by most of those who are supposed to get the information. The valuable models established by scientists for people are occasionally hence not seeming to possible consumers. Furthermore, not several scientists capitalize on improving their communication abilities nor traverse a collection of channeling choices accessible and appropriate for getting diverse target clusters for the reason that they do not sum much in their performance assessment.

Currently, the improvement of choices for agriculture messages channeling and improved desire for information by the people, as agricultural scientific results are being broadcasted and printed in various media houses. They are also aired through the internet by use of social media networking platforms like YouTube Channels and blogs.

Agricultural researchers are thus cheered to advance their expertise in science communication and apply the current range of communication podiums to communicate their findings. Moreover, drive in science communication abilities and submission as one of the main performance assessment standards for agricultural researchers by agriculturalists must be fortified. Through the mechanisms, the gaps that exist in science communication will be narrowed down which is not strong at the moment. Consequently, the work of agricultural study results in refining agriculturalists' livelihood will be important. Additionally, operational science communication can upsurge the probability of agricultural researchers acquiring finance for progressing their farm activities (Briese, 2019).

The researcher is required to increase their energy in connection to simplifying their findings in a way that farmers and other value chain actors can easily understand and interpret their results. When research findings are communicated in the right way, it bridges the gap between the researcher and the users of the findings such as farmers (Briese, 2019). Therefore conducting research exploring communication as a potent tool in the utilization of climate-smart agricultural technologies. Through this, the researcher will be able to identify the method employed by the scientist to ensure their research findings are communicated and understood by farmers and can give their feedback.

1.1.5 Communication of Agricultural Research Information in Kenya

Communication of agricultural research messages may be explained as can be described as the sharing of agricultural research findings to the intended respondents who may include; farmers, value chain actors, and stakeholders through either face-to-face,

television, radio, print media, or seminars and meetings like conferences. Rabin, Brownson, Haire-Joshu, Kreuter, and Weaver (2008) explained communication of agriculture as sharing information with a specific group of people through media by the use of developed structures for a target group. Communication is important as it increases the chance of uptake and use of new technologies once the target group can get the information.

Numerous approaches have been employed to channel agricultural messages in Kenya. They include; extension officers/agents, farmer-to-farmer information sharing, agriculturalist learning institutions, media, farm shows, agricultural information desks, agricultural shows and exhibitions, field days, e-agriculture, agricultural technology shops, and exchange visits (MoALF, 2017). The usage of agricultural extension officers is among the common ways in Kenya. However, the inadequate personnel of the officers compared high number of practicing farmers they are to deliver services to is too low than the suggested number (Nation Correspondent, 2014).

Agricultural communication is critical and includes exchanging information between farmers to farmers or even with experts or researchers (Maina, 2015). Sustainable development in the agricultural sector depends on the generation of appropriate technologies and the creation of an effective communication strategy for disseminating recommended techniques to end-users. In Kenya, there are numerous communication approaches to farmers, including individual visits to the farmers and cooperative extension. The change in information dissemination is an intervention to ensure knowledge and information on technologies, methods, and practices are put to the proper

use by farmers (Maina, 2015). However, there still exists a communication gap between scientists/researchers and end-user stakeholders, thereby slowing the adoption of valuable technologies, innovations, and futuristic agricultural practices (Lee, 2017). This is mainly due to the changing dynamics of agricultural research and the ever-increasing societal demands for understanding the research implications, which has ignited a strong need for enhanced communication for engaging a wide spectrum of stakeholders (Gatobu, Omboto & Mining, 2020). The main proposal made by the Kenyan government through the Ministry of Agriculture (2017) to maximize the delivery of information was that the message should be created in a simple way that can be easily interpreted by your target audience and the right choice of media to air the content. It explains that the message to be communicated should meet all the requirements and should consider the targeted groups such as the farmers and other value chain actors in the field of agriculture. Furthermore, the approach adopted should be cheap and economically justifiable.

1.1.6 Communication of Agricultural Knowledge in West Pokot

The agricultural knowledge among the farmers in West Pokot has been low as reported by Akuto, (2020). Inadequate sources of trustworthy and recent information attached to extensive communication gaps between scholars and agriculturalists are currently a significant weakness to the embracing of smart farming by agriculturalists in West Pokot County (Kemboi & Maina, 2017). The agricultural department is facing a lot of problems with climate change effects, inadequate finances, and poor living conditions (Gatobu & Omboto, 2020). The importance of agricultural knowledge is that it helps farmers

develop an understanding of how food is grown and how to take care of the animals and land.

Low agricultural knowledge among the West Pokot farmers has led to low agricultural production. Accessing information through television and radio is increasing and this can be a turnaround strategy among the farmers to enhance their farming activities. Farmers in West Pokot cannot effectively utilize climate-smart agricultural technologies to advance their farming strategies since they have not received sufficient and effective agricultural research information about climate-smart agriculture. The agricultural researchers and extension officers are supposed to effectively and adequately disseminate knowledge to farmers about climate-smart agricultural technologies, however, this is not the case (Kibe, Kwanya & Owano, 2020).

Even though several researches have been done by other scholars in West Pokot County on the role of extension officers in communicating agricultural information in West Pokot, most of the scholars did not focus on how communication impacts the utilization of climate-smart agriculture in West Pokot. Therefore, the overall aim of conducting this research was to explore how communication has influenced the utilization of climate-smart technologies among farmers in West Pokot County, Kenya, thus, enhancing agricultural productivity. The study explored communication as a potent tool in the utilization of climate-smart agriculture by investigating; principles of communication that have been adopted by agricultural researchers/officers to enhance the utilization of climate-smart agriculture, analyzing types of communication used by agricultural researchers/officers in the dissemination of information to farmers about climate smart

agriculture, assessed the extent to which farmers in West Pokot County have adopted and applied climate smart agriculture based on information received from agricultural researchers/officers, assessed the communication barriers in dissemination of information to farmers about climate smart agriculture and explored communication interventions that can be put in place to improve utilization of climate smart agriculture among farmers in West Pokot County.

1.2 Statement of the Problem

Agricultural experts have been creating technology-based systems to assist farmers with various parts of farming over the past 20 years, such as; crop selection, weather forecast, climatic changes/shocks, pest mitigation, and market conditions, among others (Harris & Achora, 2018). However, information about these agricultural research technologies has not been effectively disseminated to farmers, thus, low utilization of agricultural technologies among farmers. This poses a question as to why farmers are not fully benefitting from the agricultural research technologies that have been designed and developed by agricultural researchers to improve agricultural production in Kenya.

The lack of effective communication between agricultural researchers/officers, policymakers, value chain actors, and farmers regarding the availability, applicability, and usage of agricultural technologies is one of the main factors heavily influencing the low utilization of agricultural technologies among farmers in Kenya. According to Jan, Sultan, and Ali (2011), modern agriculture changes and advances as a result of communication. In the wake of this, GSMA (2015) observed that one of the issues impeding Kenya's agricultural sector's potential growth is a lack of information provided

to farmers about current technology and how to use it to increase agricultural output. This suggests that farmers still don't have access to essential services like the timely, relevant, and practical agricultural information they need to increase output in the twenty-first century.

Climate-smart agriculture is among the long-term agricultural-based technologies that have been in existence for over a decade. They are designed and developed to enhance sustainable agricultural development; in particular, promoting climate-smart agriculture, especially in arid and semi-arid lands (ASALs). Further, climate-smart technologies seek to spearhead sustainable agricultural development by addressing food security and climate challenges (Ministry of Agriculture, Livestock and Fisheries, 2017). However, there has been very low utilization of climate-smart agriculture in areas that have been designated for adoption and implementation, such as West Pokot County, Kenya.

Effective implementation of climate-smart agriculture requires effective communication between agricultural researchers/officers, policymakers, and farmers. This is because communication is a potent sociological tool for the utilization of climate-smart technologies especially in rural areas (Age, Obinne, Demenongu, 2012), such as West Pokot County. Age et al. (2012) concluded in their study that the possibility of seeing improved utilization of climate-smart agriculture among farmers, especially in rural areas, will remain problematic and in limbo as long as there is a continued imbalance in the dissemination of information about climate-smart agriculture among farmers and improper targeting of information.

Studies have shown that researchers have not been properly disseminating the results of their agricultural studies. The usefulness of science communication for farmers has not received much examination because it is a relatively new idea. According to a survey of the literature, academics have demonstrated the value of agricultural research for development, particularly in underdeveloped nations. Researchers should concentrate not only on producing research discoveries, publishing papers, and giving presentations at scientific seminars and conferences but also on effective communication with various target audiences, according to scholars. While little to no research has been conducted in the field of communicating agricultural research findings for use by farmers, research has largely concentrated on the development of agricultural research outcomes. Extension has been conceptualized and discussed in Kenya's agricultural sector as a notion that encompasses the dissemination of agricultural research findings, even though "extension" and "communication" are two distinct concepts. The structure remained mainly "top-down" notwithstanding the changes that occurred in Kenya's agriculture sector. Farmers have always been the target of discrimination. There has been an excessive dependence on seminars, conferences, publication of papers, and mediated communication by agricultural researchers to communicate their findings, these channels of communication are more suitable to researchers and academicians as compared to farmers and this might affect the utilization of their findings such as information on climate-smart agriculture. Climate smart agricultural technologies have the potential of bridging the information gap in the agricultural sector through effectively disseminating agricultural research information to farmers, thus, boosting their agricultural productivity. Therefore, conducting the current study is justified in analyzing how communication influences the

utilization of climate-smart agricultural technologies among farmers in Kenya, with a particular focus on West Pokot County.

1.3 Research Objectives

1.3.1 General Objective

The general objective of the study was to explore how communication can be a potent tool to drive effective and efficient execution of agricultural programs on climate-smart and communication interventions that can be put in place to improve the utilization of climate-smart agricultural technologies among farmers in West Pokot, Kenya.

1.3.2 Specific Objectives

i. To find out the types of communication that have been adopted by agricultural researchers to enhance the utilization of climate-smart agricultural technologies in West Pokot County
ii. To assess the extent to which farmers in West Pokot County have adopted climate-smart agriculture based on information received from agricultural researchers
iii. To assess the communication barriers in the dissemination of information to farmers about climate-smart agricultural technologies in West Pokot County
iv. To explore communication interventions that can be put in place to improve the utilization of climate-smart agricultural technologies among farmers in West Pokot County.

1.4 Research Hypotheses

This study was guided by the following research hypotheses:

H01. The types of communication used by agricultural researchers/officers in the dissemination of information to farmers about climate-smart agriculture do not influence the utilization of climate-smart technologies in West Pokot County.

H01. The types of communication used by agricultural researchers/officers in the dissemination of information to farmers about climate-smart agricultural technologies influence the utilization of climate-smart technologies in West Pokot County.

H02. The extent to which farmers have adopted and applied climate-smart technologies based on information received from agricultural researchers/officers has significantly influenced the utilization of climate-smart agricultural technologies in West Pokot County.

H02. The extent to which farmers have adopted and applied climate-smart technologies based on information received from agricultural researchers/officers does not influence the utilization of climate-smart agricultural technologies in West Pokot County.

H03. The barriers to communication in the dissemination of information to farmers about climate-smart technologies significantly influence the utilization of climate-smart agricultural technologies in West Pokot County.

H03. The barriers to communication in the dissemination of information to farmers about climate-smart technologies have no significant influence on the utilization of climate-smart agricultural technologies in West Pokot County.

H04. The interventions of communication put in place significantly influenced the utilization of climate-smart agricultural technologies among farmers in West Pokot County.

H04. The intervention of communication put in place does not influence the utilization of climate-smart agricultural technologies among farmers in West Pokot County.

1.5 Justification for the Study

The agriculture area performs a major part in enhancing economic growth in Kenya and adds about a quarter of the GDP (KALRO, 2019). Agriculture has also employed a larger population in Kenya hence providing them with income to boost their incomes mostly in the villages (GoK, 2017). There are readily available materials that provide information on agricultural production and the processes involved, although some farmers are not able to get this information mainly those living in rural areas. These farmers are facing challenges that involve: a language barrier, high cost of acquiring information, poor infrastructure, inadequate communication tools, and many other challenges that make their situation worse.

The absence of suitable and effective communication policies and mechanisms leads to deprived documentation of farmers' requirements and importance and eventually inadequate messages to agriculturalists and information distribution which hampers the division's development. The only way to bridge the gap is through implementing the chances available from agricultural technologies and communication development. The adoption and implementation of climate-smart agricultural technologies can be improved through possible inventive means of distributing agricultural information. There is a change from the common method of communicating agricultural research findings from extension workers, scientific publications, seminars, and conferences to newer methodologies such as the use of science communication, and digital platforms among others. Based on this background, this study seeks to analyze how effective

communication of agricultural information influences utilization of climate-smart technologies among farmers, thus, driving agricultural development.

Through this study on the extent of the utilization of climate-smart agricultural technologies, it will be easy to identify and capitalize on the best ways of communicating agricultural information to farmers for utilization. The study will work as a guide to those who are planning to disseminate information to farmers within different regions or help them in determining the most effective strategy to be used towards the success of passing information to farmers, e.g., non-governmental organizations, private institutions, and government agencies. This will help in addressing the information gap in Kenya's agricultural sector hence creating an accelerated plan for agricultural economic development.

1.6 Scope of the Study

The study was carried out in the Kenyan county of West Pokot, which is located in the North Rift Valley along Kenya's western border with Uganda. Elgeyo Marakwet County to the Southern East, Trans Nzoia County to the South, Turkana County to the North and North East, and Baringo County to the East are its neighbors. West Pokot, North Pokot, Central Pokot, and Pokot South are the four sub-counties that makeup West Pokot County. It has a population of 621 241 people and a land area of roughly 9,169.4 square kilometers (KNBS, 2019)

This study focused on the principles and types of communication that have been adopted in West Pokot County to effectively disseminate information on climate-smart agriculture. Further, the study assessed the extent of the adoption and application of

climate-smart agriculture by farmers based on the information they received. The study also assessed communication barriers in the dissemination of information and communication interventions to improve the utilization of climate-smart agriculture among farmers in West Pokot County. The target population comprised; lead farmers within West Pokot County and key informants from the County Meteorological Department, County Agricultural Extension Office, County communication personnel, chosen researchers from KALRO, CGIARs, chosen universities (public and private), private research organization, and national and county policy makers' representatives.

1.7 Assumptions of the study

First, the study assumes that the use of climate-smart agricultural technologies is satisfactory in determining the enhancement of the communication of agricultural research information in West Pokot County. Second, the study assumes that West Pokot County is a good representation of other ASAL counties in Kenya where climate-smart agricultural technologies have been adopted and implemented. Third, the study assumes that the respondents will have knowledge about climate-smart agricultural technologies and they will provide honest and valid information on utilization of climate-smart agricultural technologies based on the knowledge received from agricultural researchers. Lastly, the study assumes that the study area will be easily accessible that the respondents will cooperate with the researcher and the research assistants will be available during the field exercise.

1.8 Significance of the Study

The current study provides insight that is beneficial both to national and county policymakers, farmers, researchers, and development partners. The County Government of West Pokot is expected to benefit by receiving repackaged accurate agricultural research findings from climate-smart agriculture to improve their farming activities. Moreover, other countries will gain from the findings of the study on how the improvement in communication between researchers/experts and farmers can improve farm production and increase food security.

The research findings will provide a new perspective to the Ministry of Agriculture in formulating ideologies in policy-making structures that would promote appropriate and effective communication between the National and County Agriculture and farmers. Besides, acquired information will be a critical enabler in formulating effective, policies, regulations, and frameworks directly associated with appropriate and effective communication. The results will also be beneficial to farmers in identifying the most appropriate and effective communication tool that can enhance the exchange of ideas between themselves and also with the agricultural experts. Additionally, the study findings will support the government in the attainment of the Millennium Development Goals (MDG) goal "eradicate extreme poverty and hunger" and also the attainment of Vision 2030 goals through improving agricultural extension services that drive economic growth and improve the livelihoods in Kenya.

The study's conclusions will offer suggestions and guidelines for creating communication plans that encourage the use of climate-smart agricultural technologies and thereby boost

agricultural growth. To secure the efficient flow of agricultural information on climate-smart agriculture and hence promote agricultural development, developers of climate-smart agriculture in the agricultural sector can also utilize these guidelines as a benchmark.

The study will be significant in the role of communication in communicating agricultural information such as climate-smart agriculture among farmers. It will provide the best communication practices that scholars can utilize to ensure their findings can reach farmers which will increase the adoption.

Vision 2030 identified the agriculture sector as one of the key drivers of the economy to sustainably achieve an average economic growth rate of 10 percent, reduce poverty levels to 25%, and boost food security to 30% by the year 2030. Therefore, the study will be significant to ensure this is achieved through the utilization of effective communication practices that ensure farmers can get information and adopt climate-smart agriculture.

The study add knowledge on the existing literature and also provide reference point for scholars who are doing research to explore how communication can be potent tool to drive effective and efficient execution of agricultural programs on climate smart agriculture and communication interventions that can be put in place to improve utilization of climate smart agricultural technologies among farmers.

1.9 Operationalization of Terms

Climate-smart agriculture: Form of agricultural methods that aims at production growth, improves resilience, decreases/eliminates greenhouse gas discharges, and improves the realization of nationwide food safety and expansion objectives (FAO, 2010).

Climate-smart technologies: Refers to the electronic devices that are adapted to sustainably improve agricultural output, improve resilience to climatic pressures, and moderate greenhouse gas releases (FAO, 2010). They are ways of seizing, handling, keeping, and communicating messages about climate-smart agriculture.

Agricultural research: Agricultural studies entail some study actions to improve the output and value of yields and livestock.

Agricultural information: It includes all materials that are in print form or yet to be printed that have data concerning agricultural practices and policies which include scientific information, marketable material, social-cultural information, and policy information. According to this research, the words are employed to mean information concerning climate smart agriculture.

Agricultural extension services: Agricultural extension is a practice in which extension officers offer agricultural services to people living in the villages to advance their living standards by distribution of information (FAO, 2018). In this research framework, the words used to mean aiding agriculturalists to

increase the yields of their cultivations through using the knowledge shared to increase their productivity and decision-making.

Communication: Communication is the sending and receiving of agricultural messages between the researchers and the agriculturalist.

Information dissemination: According to this research, the words are used to mean the distribution of knowledge concerning agriculture from the researchers to the agriculturalist through the use of various communication channels.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter examines the notion of communication, the concept of Climate Smart Agriculture and the technologies employed the theoretical framework, the empirical review, and finally the conceptual framework. Each section will be critically evaluated, as detailed in the subsections below.

According to Bloomberg and Volpe (2008: 26), a literature review establishes the broad context of the study by explicitly indicating what should or should not be included within the scope of the study and justifying those judgments. It strives to raise awareness and provide more information about what has been examined, by whom, where, why, how, and what the study's findings were. According to De Los Reyes and Kazdin (2008), a literature review situates the current study in its historical context by describing the study's background and demonstrating the relationship of the current study with previous studies in the same area, thereby identifying trends and debates in the existing literature. Furthermore, the literature assists the researcher in obtaining additional knowledge by learning what was accomplished in prior studies and provides the researcher with a new perspective on what to cover, particularly in studies that were not sufficiently covered by past researchers.

Cooper (2011) Demonstrates the importance of conducting a literature review since it can: construct a bridge across related topics by integrating what has been done or said, criticize past studies, and highlight the significant concerns in the field.

According to Pautasso (2013), a literature review is important because it allows the researcher to get ideas that support and defend his/her point of view, as well as advance the arguments that enable the researcher to answer the research questions and solve the problem. As a result, the literature evaluation in this study is critical since it will support and defend the researchers' views, claims, and efforts (Mathipa, 2015).

The goal of this study is to investigate how communication has influenced farmers' use of climate-smart agriculture in West Pokot County, Kenya, hence increasing agricultural productivity. By demystifying the ideas of communication and knowledge distribution by agricultural researchers and extension officers/agents, the project will investigate communication as a powerful instrument in the usage of climate-wise agriculture.

2.2 Communication as a Concept

The concept of communication is a method that researchers have used and identified in many ways. Scholars have researched the public-organization interaction. The word communication is derived from the Latin region. It derives from the term "communicare," which means "common care." It is a solution to the common problem of establishing mutual knowledge between individuals or organizations.

Okumbe (1998) defines communication as the sending of a meaningful message from the sender to the recipient, as well as the interpretation of the message to information and the

provision of feedback. Durbin (1998) defined communication as the transmission of messages from one person to another or from one organization to another. He further highlighted that only communication between people or groups allows for exchange. According to Herbert and Goller (1998), when people exchange information through conversations, there is no permanent sender and receiver. The roles of the persons involved in the process of giving information and receiving feedback change depending on the sender and recipient. It ensures that everyone has the opportunity to listen and speak at the same time.

The use of communication services is on the rise for organizations to be successful since this depends on their efficient use of strategic communication. Communication may also be defined as the process of giving, receiving, and exchanging true thoughts, knowledge, films, audio, and textual materials for the message delivered to be simply interpreted by the receiver.

The essential factor in ensuring good communication is ensuring that your receiver can comprehend the message so that the receiver may provide feedback based on the message interpreted. Communication is also useful in our interpersonal talents to help us manage our emotions, motivation, and way of life. According to Marilyn (2003), communication should be used as a model to boost the company's production and performance.

When communication is employed as a technique for public relations, it results in favorable relationships. This can be defined as people motivating and assisting one another to complete their activities so that they can complete what is assigned to them by the organization and so contribute to the organization's growth. However, if

communication is not done properly, it can lead to a decrease in output since employees will not be setting the right goals for themselves, will lack confidence in their jobs, and may fail to deliver no matter how hard they try.

2.2.1 Communication for Sustainable Development

The word "development communication" came from Asia. Its definition differs from one academic to the next. According to Nora (2015), development communication is the art and science of human communication applied to the rapid transformation of a country from poverty to systematic economic growth that results in better social and economic equality and aims to meet human needs.

Development Communication, also known as Communication for Development (C4D), has been identified as a channel of empowering voice, promoting meaningful communication, and bringing about significant social change through the process of continuous empowerment. Its fundamental goal is to create an atmosphere for change as well as to provide innovations through which society can change.

According to the World Bank (2004), development communication entails creating more accessible channels for the public to obtain information on reforms, listening to clients and strengthening their ability to negotiate with stakeholders, encouraging developing organizations to achieve a more participatory communication process, and finding solutions to grounded activities that require research.

Techniques for development communication include information dissemination, social mobilization, media advocacy, and seminars and conferences. Other tactics employed by

the C4D include social-media-based web forums, television and radio broadcasts, community-based campaigns, public hearings, group discussions, interviews, debates, deliberations, and stakeholder consultations. The strategies and approaches allow for the dissemination of information in a broader manner that reaches a large number of people through campaigns, while also promoting and empowering local community ownership through equitable involvement. According to the current study, the media, particularly radio, is expanding and servicing Africa's young, rural, and uneducated populations. (BBC, 2006).

According to Adebayo (2017), communication strategy is a process of spreading information in which ideas are communicated from a source to a recipient to change his/her skills, knowledge, and attitude.

According to Van Dusseldorp (2012), farmers continue to face difficulties in accessing the communication tools established by scientists. The data reported by researchers were in technical jargon that was inaccessible to farmers in rural areas (Hatibu et al., 2012).

Policy documents can be used and comprehended in a variety of ways, especially if the information sources and conveyors employed are funneled in such a manner that the message contained is transmitted in a familiar phrase that only certain individuals understand (Williamson, 2006). Famers can gain trust and confidence in researchers and stakeholders as technology partners and transfer partners only through ongoing involvement, which increases the likelihood of successful communication.

The Agricultural Sector Development Strategy (URT, 2001), the Agricultural Sector Development Program, and the medium-term plan (MTP) for research and development

in Tanzania have recognized one of the main issues with the utilization and utilization of research results. (MAFS, 2003) is poor communication when conducting research in Tanzania. According to Norrish (2001), research knowledge can only point a target group in the proper direction by providing the appropriate products and pathways if the communication strategy is planned at the start of the project.

2.3 The Concept of Big Data

Big Data is a concept that can be examined for insights that help with strategic choices and better decisions (Kamilaris, Kartakoullis & Prenafeta-Bold, 2017). Weblogs, web pages, photos, audio files, social media feeds, and other types of data are all presently available (Ribarics, 2016). Growing a constant stream of unstructured data in a sector like agriculture indicates that every facet of the industry is now reflected in the growth (Ogola, 2015). Unstructured and structured data may be needed in Kenya's agricultural sector to comprehend the farmers' familiarity with new farming techniques, their financial capacity to adopt the innovations, and the level of assistance they require to meet the needs of each industrial component. Trustworthiness along the entire value chain is required for a valid deployment of the big data idea (Nizam & Hassan, 2017).

Value and velocity must also be present for Big Data to have an impact on any aspect of communication (Wolfert, Verdouw, & Bogaardt, 2017; Boyd & Crawford, 2012). The communication tools at our disposal are developing more quickly than ever. Real-time information is also attracting more people's attention. The Big Data idea has been impacted by these changes in the communication sector (Ogola, 2015). The speed at which participants in the Big Data concept receive and process data must be increased.

According to Marjani, Nasaruddin, Gani, Karim, Hashem, Siddiqa & and Yaqoob (2017), a Big Data hub with a low velocity index is likely to mislead stakeholders into becoming inexperienced explorers.

Better value for their information is a major focus of big data analytics (Nizam & Hassan, 2017). In other words, the information should provide value as it moves from the hub to end users. As a result, incorporating big data into the way agriculture communicates adds value by facilitating the adoption of cutting-edge agricultural techniques. The Big Data concept's key attributes—value, velocity, veracity, diversity, and volume—can command growth in a range of businesses if it is anchored on the right communication platforms (Protopop & Shanoyan, 2016).

Numerous industry stakeholders are becoming more interested in the possibilities of Big Data communication applications in agriculture. The Big Data concept in agriculture serves as a platform for high-volume, high-velocity assets that need creativity and insight into decision-making (Sonka, 2014). The ability of global agri-food systems to meet the task of doubling the food supply by 2050 could be considerably improved by the potential advances in agricultural productivity and supply chain efficiency from Big Data-based solutions. Infrastructure and capacity continue to be important requirements for effective Big Data applications. Multiple industries are changing communication as a result of the Big Data concept. Therefore, it is up to Kenya's agricultural players to find ways to leverage the power of their communication sector to advance the country's ambition for climate-smart farming.

The platforms powered by big data are reviving communication and access to information about agricultural research in many regions (Ogola, 2015). Through its AgriLife program, Uganda, for instance, has demonstrated how effectively Big Data analytics and stakeholders in agricultural research can use the notion to improve communication (Anaba, Banadda, Kiggundu, Wanyama, Engel & Moriasi, 2016). Personalized communication is primarily simple to execute with the Big Data concept. Historically, agricultural sector communication emphasized group outputs (Ribarics, 2016). At the moment, the focus is on each person's strengths and limitations. The shifting climatic trends present various difficulties for different farms. The Big Data concept allows for the segmentation of stakeholders and the targeting of farms according to their unique needs. The Big Data idea also accelerates the growth of communication infrastructure, making it more efficient.

2.3.1 The Big Data Analytics Frameworks

Numerous different forms of data are generated by agriculture, including data from economic models, agricultural productivity, and crop diseases (Shah, Hiremath, & Chaudhary, 2016). Real-time data on the air, weather, soil, crop maturity, labor costs, and even equipment can be used to make wiser decisions (Acharjya & Ahmed, 2016). The use of big data in agriculture lessens farmers' failures since it suggests the kinds of soil and water levels that support a given production. Numerous tools and strategies are used in the big data analytics framework to handle data and make choices. The effectiveness of these methods is crucial since they facilitate decision-making. The effectiveness of these methods is crucial since they facilitate decision-making. Big data analytics generally

employs clustering, classification, and association approaches (Majumdar, Naraseeyappa & Ankalaki, 2017; Rani, Priyanka & Monica, 2019; Wolfert, Verdouw & Bogaardt, 2017).

According to Xu, Collier, and O'Hare (2017), data classification includes the process of classifying data into appropriate groups so that it can be used and safeguarded more effectively. One of the data mining approaches, classification divides unstructured data into organized classes and groups and aids in information finding and planning for the user (Zinyoni, 2017). Data classification mimics the process of making intelligent decisions. Particularly important to risk management, compliance, and data security is data classification.

The data association includes looking at any connections between the provided data. To discover correlations and co-occurrences between data sets, the association of the data is used (Majumdar, Naraseeyappa, & Ankalaki, 2017). Best used to explain patterns in data from databases like relational databases and transactional databases that appear to be separate sources of information. Data association is significant because it helps researchers and farmers choose the information that can be trusted the most (Arjun, Joshi, Das & Amutha, 2018). High information association indicates that the data are highly connected and that they can be utilized to draw general conclusions about agricultural-related topics.

In most cases, clustering is used to organize data into forms that are simpler to comprehend and manage (Delgado, Short, Roberts & Vandenberg, 2019). Farmers may be able to access several pieces of information through the segmentation of the

information and make a thorough judgment as a result. A method for exploratory data analysis is clustering. Clustering enables farmers to visually assess vast amounts of data, facilitating speedy decision-making (Kumar & Sekhar, 2018). Large datasets are grouped using the unsupervised approach of clustering.

Majumdar, Naraseeyappa, and Ankalaki's (2017) study demonstrated the importance of clustering in data processing and decision-making. According to the study, clustering places related information in the same group or cluster for quick retrieval and analysis. Users may easily access and gain a thorough knowledge of the variety of information by grouping similar data, facilitating accurate decision-making. The study also found that clustering facilitates visual analysis of huge amounts of data, facilitating decision-making.

Xu, Collier, and O'Hare (2017) conducted a second study to examine big data clustering algorithms. The study's findings showed that clustering is one of the key methods for data mining, which is carried out by identifying clusters with a comparable set of data. Data mining is a method used to uncover hidden patterns in data and usable information. Big data analysis is challenging, therefore typical data mining techniques cannot be readily applied to it. The study also pointed out that clustering methods are used and a suitable clustering methodology is offered, which improves information accessibility.

In Enugu State, Nigeria, Obidike (2011) investigated the difficulties farmers encounter while attempting to get agricultural information. The cross-sectional research design was used in the study. Farmers from Enugu State were among the demographic that was targeted. Data collection involved the use of questionnaires. Descriptive and inferential

analysis were both used in the analysis. According to the study, there is a shortage of food production among rural farmers in the Nsukka local government area of Enugu State. This is likely because of obstacles that prevent them from having access to timely and current information, which would have allowed them to maximize the yield from their farms. The study concluded that in this era of information technology, telecenters give rural farmers timely and trustworthy information regarding developments in areas such as enhanced seedlings, better-cultivating techniques, and fertilizer application that must be embraced. The governments of developing nations bear a significant responsibility for ensuring adequate rural development in their various communities and local administrations, which would result in effective and efficient agricultural systems that would not only provide food and animal protein but also encourage the sustainable exploitation of natural resources.

A study on the big data analytics framework for agriculture was undertaken by Zinyoni (2017). The study's findings demonstrated that big data consists of extraordinarily huge data sets that may be computationally examined to identify patterns, trends, and relationships. According to the study, the creation of a comprehensive data analytics framework for agriculture helps farmers evaluate and forecast the results of the crops before they are grown by using past data. The application makes it possible to log information more effectively, and the amount of data that farmers can access through sophisticated agricultural management systems gives them access to working with datasets that go well beyond their farms. The study suggested creating a comprehensive data analytics framework for agriculture that would allow farmers to evaluate and forecast crop results using historical data before planting.

Furthermore, a study on dynamic data classification methods and tools for large data was carried out by Rani, Priyanka, and Monica (2019). The study's findings demonstrated that categorization algorithms are used on large transactional databases to offer consumers data services from a vast amount of data sets. One of the facets of machine learning is classification, and there are essentially two types: supervised classification and unsupervised classification. The study's findings also demonstrated that clustering is the process of grouping data sets into a predetermined number of clusters so that each cluster's data points share a set of traits. The clustering of data points into clusters ensures that there is a minimum distance between the data points within the clusters. According to the study, clusters are areas with a high density of data points with comparable characteristics. The study concluded that clustering the data makes it easier to analyze the data set, enables the discovery of insightful data among large data sets, and enables the drawing of conclusions from it.

In a 2017 study, Wolfert, Verdouw, and Bogaardt explored the use of big data in smart farming. It was descriptive research. The main tools for doing research were questionnaires. The study's findings showed that big data may rethink business processes for game-changing business models, drive real-time operational choices, and provide predictive insights into farming operations. The study also showed how important the Big Data idea is for improving smart farming. The growth of Big Data ideas has sped up the expansion of communication infrastructure. The goal of big data analytics is to improve the value of the information shared between senders and recipients. By engineering the adoption of cutting-edge agricultural techniques, the promotion of Big Data in structuring

agricultural communication adds value. The study found that to improve communication, farmers must embrace the idea of big data.

Wanjohi (2015) aimed to ascertain how mobile phone technologies have improved communication among smallholder dairy producers in Kenya. The study employed the descriptive research design, gathering data on a group of dairy farmers' traits, viewpoints, attitudes, and prior as well as present experiences. Utilizing well-structured questionnaires, the data was gathered. The study found that the use of mobile phone technology in farming had boosted information access. The advancement of cell phone technology has facilitated communication among farmers across the nation. According to the study, farmers are aware of various mobile phone technologies and have favorable opinions on their benefits. According to the study, using mobile phone technologies for animal health, payment, and supplemental dairy services enhances communication between farmers and specialists or customers. Information, relevance, and dependability are all important for technology adoption. It was advised that individuals creating these technologies collaborate closely with farmers to learn about the difficulties they are now facing. Kenyan dairy farmers and other types of farmers might use and adapt lessons from nations that widely adopted mobile phone technologies in their dairy production.

To ascertain how agricultural technology used in agricultural extension services affected household food security in Nandi County, Sigei (2014) undertook a study. The study used a survey research approach with 14,489 houses in Tinderet District as the target population. The study narrowed down the 15 places in Tinderet to 2 using purposive sampling. Four sub-locations were selected from each of the sampled locations once

again using a purposeful sampling method. The sample size was increased to 120 households by selecting eight villages at random from the sub-locations that had been studied. To gather comprehensive data on the impact of extension services on food security in Nandi County, the researcher sampled 12 important informants. Utilizing questionnaires and interview schedules, data was gathered. Utilizing descriptive statistics, data was examined. The survey found that households had access to information via field demonstrations and radio broadcasts. Extension efforts must go beyond simply transferring technology to include training farm households in knowledge and skills necessary for sustainable farming and rural development. There needs to be a paradigm change away from the Training and Visit (T&V), which stresses individual contact and involves the transfer of technology.

According to Bell (2015), the issue of information access has drawn more attention recently, particularly in light of the potential contribution of information and communication technology (ICT) to providing farmers with the information they require. ICT has already demonstrated its ability to significantly increase access to information and communication (as well as ease money transfers). However, a more recent concern has been how to effectively use ICT's potential to assist the world's rural poor. Since the internet's inception in 1994 and the rapid adoption of cell phones starting in the mid-1980s, many people have embraced "ICT for Agriculture. Despite all of these apparent failures, there is a growing body of knowledge about what makes ICT applications for agricultural extension successful as well as how ICT might influence the behavior of impoverished farmers for the better. While many ICT efforts still have sustainability

concerns, people are learning how to use these technologies to better serve their audiences and encourage behavior change in agricultural extension.

In 2016, Sousa, Gian, and Home did research on the use of information technology for farmer-to-farmer exchange and agricultural extension. The objective was to assess the potential of mobile phone video as a tool for farmer-to-farmer communication and agricultural extension in the rural context of Western Africa. To complete this study, 460 farmers from Mali and Burkina Faso were interviewed. According to the participating farmers, 3G phones are widely available, even to people who had previously had restricted access to information sources, such as young women.

Video-based information can change the conventional top-down pattern of information transfer from extension agents to farmers and is helpful to illiterate farmers. The results demonstrated the enormous potential of mobile video as a tool for agricultural extension and farmer-to-farmer communication in underdeveloped nations. An innovative kind of farmer-to-farmer communication is the use of video on mobile devices. This method has the potential to transform and scale up extension operations, enabling the essential intensification of land use as well as more resilient, inclusive, and democratic farming systems. The study found a favorable correlation between the growth of information technologies and increased communication.

2.4 Concept of Science Communication

Science communication is a practice comprising structures and receivers who are driven and self-conscious in their communicative methods (Holliman, 2006). Thus, scientific knowledge is very visible in a widespread array of target groups, who are progressively

working in exchange of ideas with specialists and strategy creators, adding information, skills, outlooks, and opinions to these discussion processes (Holliman, 2005). Time and again, these discussions rise, either indirectly or openly, to deliberations of know-how. As per the outcome, scientific technological information can flow inside institutions an area in which the information was generated for instance by scholars in seminars, and it's able to move to the entire community. For instance, print media, broadcast media, and through internet and information carry science-related topics.

Science communication is a practice comprised of structures and receivers who are driven and self-conscious in their communicative approaches (Holliman, 2006). Thus, scientific knowledge is extremely evident in a wide range of target groups, who are increasingly working in the exchange of ideas with specialists and strategy developers, giving information, skills, perspectives, and opinions to these conversation processes (Holliman, 2005). These discussions frequently lead to deliberations about know-how, either implicitly or explicitly. As a result, scientific-technical information can circulate within institutions where it was developed, such as by scholars in seminars, and then spread to the entire community. Print media, television media, and the internet and information, for example, cover science-related themes.

Consuming scientific information is a fluid and unclassified process. There is no assumption that the audience can understand the complicated terminology used in science communication. Above all, the criteria utilized do not specify how the scientific knowledge will be sent to receivers and processed by end users. Furthermore, unless a person is a student of the science being communicated, their comprehension, abilities,

and expertise in that study will influence their outcome in the subject of discussion. As a result, the connection between science and the general public as consumers is becoming increasingly complex and contentious (Holliman, 2005). The public perceives this as a result of a perceived lack of openness in the relationship between science, industry, public policy, and society as end-users of science. According to a study by the House of Lords Select Committee on Science and Technology (2000), good science communication could be a crucial component in lowering conflicts between science and consumers (public/society) by boosting democratic levels through better interaction and consultation.

Science is today more visible and easily accessible to the public than it was in the previous two decades, thanks to modern information and communication technologies. This follows several demands for upstream collaboration among the general public, industries/organizations/institutions, policymakers, and scientists (e.g., Wilsdon and Willis 2004). However, it remains to be seen whether increased calls for discourse and consultation will have an impact on scientific research advancement in the coming years. Indeed, Holliman (2005) observed that working scientists in any discipline must communicate research within a climate of conversation between the scientific public and the general public. This is supported by the majority of funding organizations, which currently require professionals to communicate research to the community as a mandatory circumstance, assuming that at least a portion of the total payment would be consumed on such measures. About this, one can only use taxpayer money to disseminate scientific knowledge and do research on science communication. For example, in

agricultural scientific research; taxpayers have the right to know how their money is used by the government.

There are additional pragmatic and even philanthropic motives for disseminating research, such as climate-aware farming technologies. First, you will have learned science from persons who have prior expertise and experience with scientific information and methods; in this case, agricultural researchers in the agricultural sector. Without these individuals to inspire and drive agricultural development, consumers of their agricultural research would have struggled to understand, accept, and execute science in a way that is appropriate for long-term agricultural development. As a result, effective science communication by agricultural researchers/scientists provides an opportunity to inspire farmers, policymakers, and agricultural institutions/organizations to be interested in modern agricultural research, such as climate-smart technologies, resulting in easier adoption and implementation. In this sense, agricultural researchers/scientists have the opportunity to communicate science as both scientists and citizens, by listening to the views of the larger society (all agricultural stakeholders) and producing agricultural scientific information to inform agricultural debates such as climate-smart agriculture.

The broader picture of science communication necessitates agricultural researchers being communicators, both in terms of producing and receiving agricultural scientific information via a variety of communication platforms such as media. This is because to effectively pass on agricultural technology information, the sender must have prior knowledge and thoughtful notions about the receiver. To put it another way, while people may not have the same understanding of the science concept, for farmers and value chain

actors in agriculture to use agricultural communication, farmers and value chain actors in agriculture must be able to interpret the agricultural information being communicated. Therefore, for one to be in a position to research agriculture, one should be able to have knowledge and understanding of science communication. In West Pokot, the farmers are being communicated to by extension officers and the researchers. Science communication is important when communicating with farmers and therefore, the study will explore the science communication used in West Pokot by extension and researchers to communicate with farmers. To communicate effectively with policymakers, agricultural extension agents, and farmers, agricultural researchers must be aware of the various practices and conventions influencing those individuals, as well as be aware of and respect for any different attitudes and beliefs. To do this effectively, audience mapping is required, which will assist researchers in understanding communication strategies for suitable and effective information consumption.

2.5 Concept of Communication in Agriculture

Communication of agricultural research messages can be defined as the dissemination of agricultural research findings to intended respondents such as farmers, value chain actors, and stakeholders via face-to-face, television, radio, print media, or seminars and meetings such as conferences. Rabin, Brownson, Haire-Joshu, Kreuter, and Weaver (2008) defined agricultural communication as the dissemination of information to a specific set of individuals via media using developed frameworks for a target group. Communication is crucial because it raises the likelihood of new technology adoption and utilization once the target group has access to the information.

According to research, investigators do not transmit agricultural information as effectively as they should. According to Kirkland, Mouton, and Coates (2010), most studies have focused on improving the living standards of Africans, but little has been done by researchers in the field of communication (Kirkland, Mouton, and Coates, 2010, p.3). Edge, Martin, Rudgard, and Manning (2011, p. 3) discovered that making research output freely and willingly accessible may be helpful to people. These academics recognized that there are barriers to communicating study results, such as a lack of necessary properties, and devised techniques to commence this process. Researchers also discovered that existing practices in channel study output selection are often based on traditional methods of journal publication, books, and seminar presentations. Butera, Shyaka, and Habimana (2012). This excludes persons such as agriculturalists who have a poor education level and may not be able to obtain instructional communication methods.

Agricultural scholars frequently struggle to use media podiums to convey their agricultural study findings in a way that the majority of end-users (farmers/stakeholders) will be able to interpret. However, the majority of agricultural study outputs contain applicable agricultural messages that may aid in the resolution of some of the challenges encountered in the agricultural sector. As a result, agricultural studies are required to develop solutions to the problems that farmers face. The intervention should be practicable and inexpensive for farmers, resulting in increased productivity. In the middle of the requirements are legislators and agriculturalists who are critical to the use, advancement, and implementation of agricultural inventions. Briese (2019) defines scientific communication as any action that comprises one component distributing produced science-related communications to a single, collection, or media outlets.

The way of conveying climate-smart agriculture has an impact on how messages are received, processed, and applied. Radio, TV, field visits, public meetings (chief meetings, mosques, and places of worship), person-to-person communications, and, more recently, cellular and networking social platforms are among the various modes of communication (BBC World Service Trust, 2010; Gambhir & Kumar, 2013; Kalungu et al., 2013; Mamun et al., 2013). The important feature of these modes of communication and procedures is that their use influences the adoption of climate-smart agriculture (Moser, 2010). According to studies, when climate-smart agriculture messages are delivered in English or Kiswahili, most communities struggle to understand and apply the information because they only speak their native language (Mamun et al., 2013; Roncoli et al., 2008; Simelton et al., 2011; Muchunku et al, 2014; Singh et al, 2014; Khan et al., 2012).

The Kenya Climate Smart Agriculture Project (KCSAP) intends to supply simple records needed to aid in the establishment of agro-weather structures, which will establish a vital feature of sending unified agro-weather and market advisories to receivers (Lee, 2017).

The goal of KCSAP is to provide smallholder agriculturalists access to appropriate and correct meteorological conditions, average temperature, market, and advisory data to increase production and develop crops and livestock that can withstand difficult climatic circumstances. Climate change is projected to be mitigated by facilitating effective communication from researchers to farmers on how to support smart agriculture. Climate change is a phenomenon that poses a threat to global food security and has both positive and negative consequences in the agricultural area. As a result, substantial agricultural research is required to promote sustainable agriculture.

Agricultural communication is defined as the sharing of information about farming and natural resource industries via effective and efficient media such as newspapers, magazines, television, radio, telephones, and the Internet to reach appropriate audiences (Nizam& Hassan, 2017). Farmers' conduct is influenced by agricultural communication (Cole, Giné, Tobacman, Topalova, Townsend, & Vickery, 2013). Sustainable agricultural growth is dependent on the development of relevant technology as well as the development of an efficient communication strategy for communicating suggested approaches to end-users (Protopop and Shanoyan, 2016).

The implementation of effective communication depends on the channel of communication. There are numerous channels of communication, such as; social media, print media, television, and radio. Organizations employ platforms, such as; YouTube, Twitter, Facebook, and Instagram, among other social media platforms, to ascertain multiple pieces of data, including educational levels, interests, social classes, and geographical locations, among others (Marjani, Nasaruddin, Gani, Karim, Hashem, Siddiqa &Yaqoob, 2017). Organizations are currently employing target marketing and personalized communication due to their intensive research on social media inputs.

The advancements in data sources infrastructure such as social media platforms have fueled developments in the communication infrastructure. Even though satellite and sensor technologies are not used broadly in developing countries, the available platform should be appropriate in delivering the necessary outcomes. The other node that links communication and the applications of the Big Data concept is cloud computing and

storage (Marjani et al., 2017). Every effort towards effective communication demands the capacity to utilize the available resources appropriately.

In Kenya, there are numerous methods for communicating with farmers, including individual visits and cooperative extension. By connecting print media to Big Data sources such as agricultural research organizations, farmers can receive real-time information (Nizam and Hassan, 2017). Kenya has seen a growth in the number of television channels, which are great for disseminating pertinent information to farmers (Ogola, 2015). There is also a rise in the number of radio stations that broadcast in vernacular languages. Access to information via television and radio is rising, and this could be a turnaround tactic to broaden data access. Radio stations boost their agricultural research content as more information becomes available in analytic databases (Wanga, 2012).

Low agricultural knowledge among the West Pokot farmers has led to low agricultural production. Accessing information through television and radio is increasing and this can be a turnaround strategy among the farmers to enhance their farming activities. Farmers in West Pokot cannot effectively utilize climate-smart agricultural technologies to advance their farming strategies since they have not received sufficient and effective agricultural research information about climate-smart agriculture. The agricultural researchers and extension officers are supposed to effectively and adequately disseminate knowledge to farmers about climate-smart agricultural technologies, however, this is not the case (Kibe, Kwanya and Owano, 2020). Agricultural communication is important to farmers, especially in arid and semi-arid areas. The study explored the communication

strategies used in West Pokot and their effectiveness in communicating agricultural technologies to farmers.

2.5.1 The Communication Science and Study of Mass Communication

The study of mass communication is simply one aspect of a larger field of research into human communication and one of many topics covered by the social sciences. A science that "seeks to understand the production, processing, and effects of symbol and signal systems by developing testable theories, containing lawful generalizations, that explain phenomena associated with production, processing, and effects" is what Berger and Chaffee (1987:17) refer to as "communication science." Although this definition was intended to be 'mainstream' and apply to the majority of communication research, it is heavily skewed in favor of one type of inquiry: the quantitative analysis of communicative behavior and its causes and effects.

It falls short in particular when addressing the nature of "symbol systems" and signification, the exchange of meaning in a variety of social and cultural situations. The conclusion of this chapter provides an overview of the primary different approaches to the study of mass communication. Technology advancements that have muddled the distinctions between mass and interpersonal communication as well as between public and private communication have also made it difficult to define the discipline. There has never been a universally accepted definition of the key idea of "communication," which makes it impossible to find a single, universally accepted definition of a "science of communication" today.

The expression can be used to describe a wide range of concepts, including the act or process of information transmission, the giving or taking of meaning, the sharing of information, ideas, thoughts, or emotions, the process of receipt, perception, and response, the exertion of influence, and any type of interaction. Communication can be consensual or forced, and there are an infinite number of channels and content options, which further complicates problems. Furthermore, no "science of communication" can be self-sufficient and independent given the diverse fields from which it has emerged and the complexity of the problems it raises, including those about culture, politics, economics, and legal difficulties.

Interdisciplinary and multifaceted techniques and methodologies are required for the study of communication (McQuail, 2003b). The various levels of social organization at which communication occurs provide a less troublesome manner to situate the topic of mass communication within a larger area of communication investigation. This criterion suggests that mass communication can be viewed as one of several societal communication processes, at the top of a pyramidal distribution of other communication networks. Any group of connected nodes (people or locations) that allow for the interchange and transmission of information between them is referred to as a communication network. Mass communication often consists of a network that links a large number of receivers to a single source, whereas new media technologies typically offer interactive connections of various kinds.

There are more cases to be identified at each decreasing level of the pyramid than there are at the top, and each level poses a unique set of research and theoretical challenges.

Even though the media system is frequently divided based on regional and other social or demographic factors, there will frequently be one large public communication network, typically reliant on the mass media that can reach and involve all citizens to varying degrees. There are several possible foundations for a strong communication network that spans a society besides the mass media. Alternative (non-mass-media) technologies for sustaining society-wide networks do exist today (particularly the network of physical transportation, the telecommunications infrastructure, and the postal service), but they typically lack the societal-level social elements and public roles that mass communication has.

Historically (and in certain locations, even now), the state, the church, or political parties established society-wide public networks based on shared ideas and typically a hierarchical line of interaction. From the "top" to the "bottom," this involved various channels of communication, from official publications to one-on-one interactions.

In rare situations, such as a natural disaster, significant accident, the onset of war, or other emergency, alternative communication networks can be activated to take the place of mass media. Direct word-of-mouth was the sole option in the past, but today cell phones and the Internet may be successfully used to link a huge population. In reality, the United States' original goal in developing the Internet in the 1970s was to offer a backup communication system in the case of a nuclear assault. Numerous distinct types of communication networks operate at a level below that of the entire society.

One kind replicates social interaction within a broader civilization at the level of a region, city, or town and may include a corresponding media system (local newspaper, radio,

etc.). Another is exemplified by the company, workplace, or profession, which may not have a single location but is typically very integrated inside its organizational boundaries, where there is a great deal of communication flow. The 'institution', which might be associated with the government, the legal system, the educational system, the religious system, or social security, is a third category. A social institution's actions are always varied, necessitate coordination and extensive communication, and have prescribed forms and routes.

The networks at play in this situation are not accessible to all people and are restricted to fulfilling specific limited goals (such as promoting education, upholding law and order, disseminating economic information, etc.). Below this level, there is a wide range of communication network types that are based on aspects of daily life that people share, such as an environment (such as a neighborhood), an interest (such as music), a necessity (such as child care), or an activity (such as sport). The main concerns at this stage are attachment and identity, cooperation, and norm building. Attention has typically been paid to conversational styles and patterns, patterns of interaction, influence, affiliation (degrees of attachment), and normative control at the intragroup (for example, family) and interpersonal levels. The processing of information (such as attention, perception, attitude development, understanding, memory, and learning), the attribution of meaning, and potential impacts (such as knowledge, opinion, self-identity, and attitude) are the main foci of communication research at the intrapersonal level. The expanding 'globalization' of social life—in which mass communication has played some role—has complicated this pattern that at first glance appears to be well-defined.

There is one more 'level' of communication and exchange to take into account, and that is the level of communication and exchange that transcends and even disregards national boundaries concerning an expanding spectrum of activities (economic, political, scientific, public relations, sport, entertainment, etc.). Organizations and institutions are less restricted by national borders, and people can fulfill their communication needs in social contexts other than their own. Our cultural and informational options have grown significantly, and there is no longer the same degree of correlation that there once was between patterns of personal social contact in shared space and time and communication technologies. The notion of a developing "network society" has been advocated in part because of this (see Castells, 1996; van Dijk, 1999; as well as Chapter 6 in this book). As a result of such advancements, networks are also no longer, as previously suggested, bound to anyone's 'level' of society.

Without the customary "cement" of shared space or personal familiarity, communication networks can now form more quickly through hybrid (both public and private) forms of contact. In the past, it was possible to roughly match a particular communication technology with a given 'level' of social organization, with television at the highest level, the press and radio at the regional or city level, internal systems, telephone, and mail at the institutional level, and so on. This is no longer feasible due to advancements in communication technology and its broad use. For instance, practically all levels of communication are now supported by the Internet. In addition, it supports chains or networks that are not just horizontal but also vertical (in both directions) or diagonal and links the social "top" with the "base." For instance, a political website can give citizens at

various levels of society access to political leaders and elites, enabling a variety of patterns of flow.

Although their near monopoly of public communication is increasingly being questioned, for the time being, the 'traditional' core mass media of newspapers, television, and radio continue to serve the same purpose of society-wide communication.

2.6 Agricultural Climate Smart Technologies

According to Vermeulen et al. (2012) and Lipper et al. (2014), the goal of climate-smart agriculture is to create robust food production systems that produce secure supplies of food and a profit while reducing the effects of advanced climate change and climate variability. Most agricultural methods and machinery, such as minimum cultivation, diverse crop cultivation approaches, fertilizer or manure provision, crop watering, and residue combination, can increase agricultural produce harvesting, ensure crops are irrigated properly, and reduce Greenhouse Gas (GHG) emissions from agricultural events (Branca et al., 2011; Jat et al., 2014; Sapkota et al., 2015). Similarly, collecting rainfall, planting recommended seeds, ICT-based agro-advisers, and crop/livestock insurance may increase agriculturalist yields and reduce the impact of climate change uncertainty (Mittal, 2012; Altieri & Nicholls, 2013). Overall, climate-smart agricultural technology options include traditional and cutting-edge methods, know-how, and facilities that are acceptable for certain localities to accept climate change and unpredictability (CIAT, 2014).

The way of conveying climate-smart agriculture has an impact on how messages are received, processed, and applied. Radio, TV, field visits, public meetings (chief meetings,

mosques, and places of worship), person-to-person communications, and, more recently, cellular and networking social platforms are among the various modes of communication (BBC World Service Trust, 2010; Gambhir & Kumar, 2013; Kalungu et al., 2013; Mamun et al., 2013). The key element of these modes of communication and procedures is that how they are used influences the adoption of climate-smart agriculture (Moser, 2010). For example, studies show that when messages about climate-smart agriculture are delivered in English or Kiswahili, most communities struggle to understand and apply the information because they only speak their native language (Mamun et al., 2013; Roncoli et al., 2008; Simelton et al, 2011; Muchunku et al, 2014; Singh et al, 2014; Khan et al., 2012).

Messages channeled through these media include weather patterns on rainfall that target all agriculturalists worldwide as this may affect their yield, early warnings of potential disaster actions (scarcity of rain, heavy downpour, etc.) aimed at reducing disaster consequences, improving community consciousness, and prompting crisis reactions (Luseno et al., 2003; Mokotjo & Kalusopa, 2010; Hansen et al., 2007). Messages from the government media and major national organizations such as KALRO and crisis management groups are delivered in a variety of situations (Mittal, 2012; Panos Eastern Africa, 2011).

2.7 Theoretical Structure

This study is based on the theoretical concept that climate-smart agricultural technologies can bridge the agricultural information gap by successfully conveying agricultural research information to farmers, hence increasing agricultural production. The

phenomena have two variables: farmers' use of climate-smart agricultural technologies and the efficacy of communication processes that distribute knowledge about climate-smart agriculture. In this study, three theories were employed to develop a roadmap to help answer the research objectives: diffusion of innovation theory, technological adoption model, and knowledge-based theory. The theories are utilized to describe the impact of communication in the circumstance, answering research concerns about communication and the application of climate-smart agricultural technologies. This is detailed in further detail in the sections that follow.

2.7.1 Theory of Diffusion of Innovation

Everett Rogers proposed the spread of the innovation hypothesis in 1962. According to the theory, innovation diffusion is founded on the assumption that innovation adoption entails the continual and purposeful propagation of new ideas. Rogers defines innovation as a perceived new idea, activity, or item. When an idea appears new to a potential adopter, the perception of change is critical (Dearing, 2009). The features of innovative adoption are ascribed to groups to demonstrate that all inventions go through a predictable process before getting broadly adopted (MustonenOllila & Lyytinen, 2003). Technological innovation contains information and, as a result, reduces uncertainty. The relative benefit, compatibility, complexity, trialability, and observability of an innovation theory are all factors that influence its diffusion (Dingfelder & Mandell, 2011). There are several paths/channels by which new ideas, discoveries, and practices are transmitted to targeted audiences.

The innovation diffusion theory can be used to explain process innovation that includes technology. According to the principle, a new thought should be distinguished by providing genuine solutions to people's problems (Cheng, Kao, & Lin, 2004). The more accurate a concept is, the more likely it will spread. The theory proves that with little communication input, even the best ideas are rendered useless (Lien & Jiang, 2017). Every idea is valid if applied at the appropriate moment (Al-Jabri &Sohail, 2012). People consider ideas to be useful if they can be translated into solutions to real-world issues. Finally, the theory considers social system traits to be critical in the application of new ideas (Dearing, 2009).

The theory, however, had several flaws. The idea neglected to focus on complicated concerns like as cultural and political aspects, and societies are thought to be rational in deciding whether or not to accept a new technology (Bradford & Florin, 2003). The diffusion hypothesis focused on the innovation rather than the social-cultural variables associated with the technology and the repercussions of introducing the innovation into the sector (Minishi-Majanja & Kiplang'at, 2005). Technological innovations become effective when customers and stakeholders value and benefit from them. In some cases, the community may opt not to accept the introduced technology since the innovation is not a priority.

Despite its limitations, the theory can be applied to the current investigation. According to the principle, a new thought should be distinguished by providing genuine solutions to people's problems. From planting to watering to harvesting, climate-smart agriculture has received a lot of technological attention. To implement climate-smart programs, the

social system must be built to allow for efficient information collection and transmission. Climate-smart agricultural technology must prioritize variables such as information exchange via platforms such as social media and private portals, as well as radio and television.

Farmers who have seen the wrath of climate change on agriculture should adopt an idea that can bring climate-aware agriculture to fruition. Climate-wise agriculture is an important component of modern agricultural innovation (Wolfert, Verdouw, & Bogaardt, 2017; Boyd & Crawford, 2012). Climate-smart agriculture can help to spread numerous concepts, techniques, and discoveries related to climate-smart agricultural practices. Linking climate-smart agricultural technologies to aspects of the diffusion of innovations theory leads to a better understanding of the specific elements that must be targeted by climate-smart agricultural technologies to improve agricultural research communication findings in this era of climate-smart farming.

The hypothesis helped to explain how academics' innovations in climate-smart agricultural technology are conveyed to West Pokot farmers and how the invention is distributed to farmers in West Pokot. This clarified if agricultural research is successfully shared and utilized by farmers in West Pokot.

2.7.2 Model of Technology Acceptance

In 1989, Fred Davis put up the Technology Acceptance Model (TAM). The technology acceptance model is an information systems theory that explains how users of technology accept and use it. TAM stresses psychological inclination and social factors, such as beliefs, attitudes, and intentions, as crucial variables in technology adoption, in contrast

to diffusion theory (Bates, Manuel, and Oppenheim, 2007). Technology's acceptance is influenced by how beneficial and simple it is regarded to be to use (Lee, Kozar, & Larsen, 2003). Perceived usefulness is the extent to which a person thinks that using a system will enhance his or her performance. A person's perception of how easy they think it will be to utilize a system is known as perceived ease of use. (Lederer, Maupin, Sena, & Zhuang, 2000). According to the approach, the technology introduced aims to simplify labor and increase the interchange of ideas (Chuttur, 2009). The recipients of the technology must be educated on the significance of adopting new technology and the influence it will have on overall efficiency (Dalcher & Shine, 2003).

According to the Technology Acceptance Model, technology influences how people communicate, learn, and think. It contributes to societal efficiency and influences how people connect daily (Surendran, 2012). Adapting to new ways of doing things improves the flow of information from one location to another. According to Davis, an individual's attitude is not the only component that influences the use of a system, but also the impact that it may have on performance. Even if someone does not like the new technology, the chances are that he or she will utilize it or gain indirectly as a result of its overall impact (Simon, 2007).

Beneficiaries of newly introduced technology must be permitted to communicate their opinions and even criticize any acts they believe are harmful to them or the organization (Shang & Liu, 2009). Nonetheless, the model has some flaws. For example, the model ignored other elements that influence acceptability and desire to use technology, such as education and age (Dishaw & Strong, 1999). Another disadvantage of TAM is that it was

intended to be employed in an organizational context rather than in daily life. The concept did not provide a vital solution for people who may be resistive to the adoption of new technology.

The study makes use of the technology acceptance model. Climate-smart agriculture seeks to maximize the value of the information provided (Nizam& Hassan, 2017). The concept demonstrates that technology receipts must be a part of the process of introducing new technology. Thus, farmers must be engaged and educated on the need to accept the changes brought about by climate-wise agriculture. Technology is transforming all parts of life, including how people communicate and do activities (Park, Nam, and Cha, 2012). The potential benefits in agricultural productivity and supply chain efficiency from climate-smart agriculture could greatly improve the ability of global agri-food systems to meet the task of doubling the food supply. Climate-smart agriculture is transforming how farmers and agricultural specialists communicate. As a result, agricultural stakeholders can educate farmers on how to use the strength of their communication through climate-smart agriculture to progress the nation's climate-smart farming strategy.

The idea aided in explaining the numerous research technologies established by agricultural research organizations addressing climate-smart agriculture in West Pokot, as well as the farmers' reactions to their use.

2.7.3 The Theory of Knowledge-based

Through innovation systems, knowledge within the systems can be improved (Nickerson & Zenger, 2004). The theory, however, has several flaws. For example, According to

Fromlet (2001), the theory does not develop mechanisms to deal with information asymmetry, which occurs when some information is only available within the company and management is unable to share it with the rest of the workforce due to its sensitivity. Furthermore, Pompian and Longo (2004) identified another flaw in the theory: it was only concerned with how to improve knowledge management and did not dwell on the remedies connected with people who leak information to competitors. Knowledge exchange, learning, and innovative approaches improve productivity. Knowledge-based resources are difficult to reproduce and are socially problematic, as they are dependent on varied knowledge and capacities across individuals or businesses (Nickerson & Zenger, 2004). A knowledge-based perspective implies that someone can be distinguished from others based on their knowledge-management practices. Because each information asset is complex and difficult to mimic, someone can gain a competitive advantage through knowledge management systems.

The hypothesis was proposed by Penrose (1959), and then Wernerfelt (1984) and Barney (1991) built on it. Grant (1996) advances the theory of knowledge improvement to foster innovation and the cultural changes required to evolve and meet changing environmental needs. Knowledge is vital because it promotes awareness of the best practices that can be used to improve the production system and increase productivity (Foss, 2006). Knowledge exchange, learning, and new techniques all boost productivity. Knowledge-based resources are difficult to replicate and socially problematic since they rely on disparities in knowledge and capacity among individuals or businesses (Nickerson & Zenger, 2004). A knowledge-based approach indicates that one can separate themselves from others based on their knowledge-management techniques. Because each information

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The theory applies to the research. The primary goal of knowledge is to raise farmers' understanding of the need to use knowledge and best practices to improve the production system and generate more food. Farmers can locate optimal farm practices in the form of activities that instruct them chronologically what to accomplish during a growing season using existing tools. The use of climate-smart agriculture can have a substantial impact on the entire production of farm products. Agriculture's approaches to knowledge exchange, learning, and innovation are continuously expanding. New and improved methods of sharing knowledge and skills are now required to keep agricultural and food production competitive and rural communities flourishing in the twenty-first century. The agricultural knowledge and innovation system describes the interactions of people and organizations within a country or region. Agricultural knowledge and innovation systems

can include farming practices, enterprises, government agencies, research, and so on, and they can vary greatly depending on the country or industry.

The hypothesis helped describe how farmers might use knowledge from researchers and agricultural extension to practice climate-wise agriculture. The knowledge-based paradigm was also important in explaining communication hurdles to climate-smart agriculture. This was used to describe how farmers' lack of expertise in climate-smart agriculture is causing barriers to accessing climate-smart agriculture information, limiting their adoption and practice of climate-smart agriculture.

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2.8 Empirical Review

2.8.1 Principles of Communication

In many nations, agriculture has played a significant role in economic development. Shepande (2010) asserts that a robust agricultural sector increases GDP, generates employment, and broadens the tax base of a nation. Hans (2015) also noted that the majority of people on the continent are employed in agriculture, particularly in rural areas, which drives the continent's economy. Given that the vast majority of Kenyans are

employed in agricultural-related activities, a well-developed industry should have a significant positive impact on the welfare and development of the nation. (Shepande, 2010). The majority of persons engaging in agricultural operations in the country are rural poor, and as a result, they operate on a small scale, owing to a lack of finance.

Information transmission channels are essential for its dissemination, especially to farmers. In Kenya and other African countries, it has been challenging to assess the efficacy of communication channels for the distribution of information in the agricultural sector (Mburu, 2013). Governments and other agriculture sector stakeholders have used a variety of communication channels quickly to disseminate agricultural information to farmers on various agricultural activities (Achebe and Lucky, 2013). This has greatly increased farmers' access to information that will help them increase production. Many farmers, particularly those in rural regions, use radio as a key communication and dissemination tool. Television, mobile phones, mobile applications, short messaging services (SMS), and the Internet are examples of other information transmission platforms (Adam, 2002).

When individuals at higher management levels speak with people at lower levels of the organization, this is known as downward communication. Downward communication flows have dominated traditional ideas of business communication practices. These flows transmit information from higher levels of the organization to lower levels. Through speeches, announcements in business bulletins, company board policy manuals, and company procedure handbooks, managers communicate downward to group members (Canary, 2011).

Executive members have a conduit for instructions, directions, and information thanks to the downward flow of communication. But as information is transferred from one person to another, a lot of it is lost. A transmission can also become damaged if it travels a great distance before reaching its intended recipient (Tourish, 2010).

A company's higher success requires both good upward and efficient communication at the bottom. The growth of upward communication flows has received particular attention from the academic community. This relates to communication within a company that occurs between bosses and subordinates. This is crucial to meeting the personality requirements of employees and determining whether they have understood the information that has been given to them. The five ways that information is sent upward in a firm are as follows (Canary, 2011:22).

The firm structure must perfectly allow for both upper and downward communication flows. Communication must go both ways through the formal organizational chain of command. Unfortunately, communication at the lower level is more difficult than communication at the higher level. The following are some barriers to effective upward communication in the workplace (Cheney, 2011).

Within a company or organization, communication flows upward and downward often following the formal chain of command. The necessity for communication laterally or diagonally across the lines of the formal chain of command, however, increases as the firm and the challenge grow larger. The term "horizontal communication" refers to this. The informational nature of these communications is similar to that of downhill and upward communication, although not exactly. Here, information is mostly used to

motivate actions within or across departments of a particular company or within divisions in an organizational structure for the entire business. The following categories can be used to categorize horizontal communication (Canary, 2011:26).

An important thread running through all of the guiding principles is the need to increase the public's trust in the communication organization. The literature frequently refers to the idea of building trust, and many notions include it implicitly, either as a component or an effect. Trust in the communicative organization will rise as a result of, among other things, timely, honest, and empathic conversations; clear and transparent communication; and managing and disclosing uncertainty. Building trust through these messages only enhances the organization's reputation and credibility, increasing its capacity to provide effective messaging and support in future crises (Babacan & Babacan, 2013; Coombs & Holladay, 1996; Covello, 2003; Fischhoff, 2013; Fischhoff & Scheufele, 2013; Dahlstrom, 2018; Kappel & Holmen, 2019; Manski, 2018; Palttala et al., 2012; Scrimshaw, 2019).

The public can deal with uncertainty, self-efficacy, and reassurance by receiving a consistent message (Reynolds & Seeger, 2005). This guarantees effective public engagement and strong communication throughout (Bruine de Bruin & Bostrom, 2013; Reynolds & Seeger, 2005). Consistent and consistent messages are better believed than inconsistent ones (Clampitt, 1991 in Coombs, 2019).

What is said constitutes the content of communication (Coombs, 2019). Instead of communicating what the communication organization assumes should be conveyed, the messages must be based on knowing the audience and figuring out what the audience

needs to know to make decisions and lessen harm. The communicator can choose the most appropriate and effective material for the current scenario by first understanding the audience (Desai & Potter, 2006 in Babacan & Babacan, 2013). This helps them to tailor the messages to the target audience.

The public's capacity for information interpretation can be reduced by as much as 80% during emotionally charged situations, such as a public health emergency (Gilman 2004). Therefore, messages must be succinct and clear, appealing to both reason and emotion and providing solutions to problems (Friemuth et al., 2000 in Reynolds & Seeger, 2005). To build trust and credibility in the communication organization, the messages should also be presented with compassion, concern, and empathy (Heath, 2006). The public should receive messages of empathy that are upbeat, nonjudgmental, and "possibility-centric" rather than issue-focused (Boyd & Bright, 2007 in Babacan & Babacan, 2013; Bruine de Bruin & Bostrom, 2013). According to the research, personification in storytelling structures promotes more identification and empathy than other forms of communication like rational and analytical messaging (Dahlstrom, 2014).

Based on what other scholars have looked at in terms of communication principles, this study investigated similar aspects of communication principles such as conveying messages that are accurate, sincere, and compassionate; being upfront and straightforward in communication; and managing and communicating uncertainty. The study investigated how the factors influenced farmers in West Pokot's use of climate-smart agricultural technologies.

2.8.2 Types of Communication

More communication channels are required to facilitate information dissemination as the demand for knowledge on agricultural practices and challenges grows. As a result, governments, non-governmental organizations, extension workers, and other agricultural technocrats have focused on the effectiveness of communication channels in information distribution. FAW has recently caused widespread damage to maize and other cereal crops. To choose the best communication channel to use, it is crucial to evaluate how well communication channels spread FAW information among maize farmers. The majority of agricultural information has been disseminated by media channels including television and radio, according to Abubakar et al. (2009). To demonstrate food insecurity in the event of a pest invasion of maize, smallholder farmers cultivating maize must disseminate knowledge on the fall armyworm, according to Crandall (2012).

Communication strategies for sharing agricultural research information are critical in ensuring farmers have access to reliable and accurate information. Notably, the information infrastructure, operating expenses, farmers' capabilities, farmers' information-consuming habits, and, most significantly, the local context should all be considered when determining the best model to use (Mubofu & Malekani, 2020). Web portals, voice-based services, text (SMS)-based services, self-support online communities, interactive video conferencing services, and mobile internet-based services are effective in ensuring the effective dissemination of agricultural research information (Odinga, 2018; Anyango, 2016; Thuo, Njoroge, & Wamalwa, 2019).

According to the research of Rogers (2003) and Das (2012), mass media and interpersonal communication are significant routes for spreading the findings of agricultural researchers, extension officers, knowledgeable farmers, and research organizations. Mass media and interpersonal communication play a significant role in disseminating information to farmers in rural areas, as they aid in raising awareness among farmers and stakeholders. This study analyzed the types of communication utilized in West Pokot to see if they are consistent with what Rogers (2003) and Das (2012) discovered in their investigations.

According to Ndungu et al. (2000), neighbors, family, market, and community-based groups are the primary sources of agricultural information for farmers. Malekani (2018) conducted a study to determine the sources of indigenous knowledge (IK) used for agrobiodiversity management. The study discovered that the primary sources of indigenous agrobiodiversity knowledge were predominantly tacit and local, with personal experience accounting for 205 (89.1%), parents or guardians or family accounting for 202 (87.8%), and neighbors, friends, and relatives accounting for 131 (57.0%). Different local sources were also heavily utilized, including 55 (23.9.5%) social group gatherings, 31 (13.5%) village meetings, 30 (13.0%) village leaders, and 19 (8.3%) farmer organizations Books, periodicals, seminars, and agricultural fairs were rarely used as formal sources of knowledge by farmers. Annune, Ezeani, and Okafor (2014) conducted a study and discovered that farmers preferred to obtain knowledge from their colleagues and market locations. According to Ndungu et al. (2000), between 40% and 70% of farmers regarded government extension as one of the most essential sources of knowledge. Non-governmental organizations, churches, community meetings, libraries, and agricultural

businesses were also highlighted as major sources accepted by farmers due to their important responsibilities in information distribution.

Farmers can find agricultural information from a variety of sources and information providers, according to Tantisantisom (2011). The main informational resource for Tanzanian farmers is the Tanzania Metrological Agency. Additionally, agricultural experts, instructors, extension agents, and research organizations can provide farmers with information.

A study by Kaaya (1999), established that in Tanzania, agricultural research information was disseminated through a variety of channels, including reports, handbooks, conferences, meetings, farmers' days, on-farm trials, and scientific journals. This ensured that the end users would be able to use the technologies developed during research to increase agricultural production. Dissemination strategies try to reach a wide range of end users, like farmers, inside or across geographic boundaries, practice contexts, social networks, and other networks. According to Bulaji and Craufurd (2011), farmers in India obtain information by working with public libraries that have extension staff for efficient information dissemination and by creating agricultural advisory boards made up of librarians and extension staff to make extensive use of non-print media as a way to get around the difficulties farmers face in getting information. Anyango (2016) did another study to assess the present communication and dissemination techniques for chickpea information, as well as the factors influencing them. A semi-structured questionnaire was distributed to 120 farmers from the Karaba, Gategi, Riakanau, and Wachoro sub-locations in Embu County's Mwea ward. Farmers were chosen at random from among the

available chickpea farmers and non-growers. The survey discovered that fellow farmers and ICRISAT employees were the most frequently used communication routes. Gender and farmer social networks were important in the diffusion of chickpea information. The study advised increasing field days, demonstrations, and farmer group meetings to raise chickpea awareness. Apart from interpersonal communication methods, it was also suggested that numerous communication means, such as ICTs, be used to distribute chickpea information.

This study looked into how these methods functioned based on research from Odinga, 2018, Anyango, 2016, Thuo, Njoroge, and Wamalwa, (2019), who found that the majority of communication methods used to communicate with farmers include web portals, voice-based services, text (SMS)-based services, self-support online communities, interactive video conferencing services, and mobile internet-based services.

Radio is a great medium for distributing information on agricultural subjects, such as new developments and best practices that can help farmers increase production. This can be done through a variety of efforts, like locally focused radio forums. Dodds (1999) discussed the value of radio information and cited the 50% of farmers in Zambia who confirmed that listening to radio programs about agricultural extension education increased crop yields.

Having access to and using radio for agricultural information transmission helps farmers produce higher-quality food and increase their profits. Independent radio broadcasting services are good regarding rural development outcomes, such as programming that focuses on enhancing rural living through farming and operating markets, claim Djankov

et al. (2001). Vegetable producers in Indonesia started their negotiations with dealers the following day using the prices broadcast on their local radios (Shepherd, 2000). To avoid being overrepresented by middlemen, this forces farmers to sell their produce at the right price. According to research conducted in Pakistan, farmers' negotiating power with dealers is strengthened when they have access to information on the current market price for seed cotton (Mwakaje, 2010).

The mobile phone allows consumers to easily access information. Farmers and extension workers frequently utilize mobile phones for information sharing, which benefits both sides by boosting agricultural activities. Various studies have been undertaken to determine the extent to which mobile phones are useful in agricultural growth. The Nutrient Manager for Rice Mobile initiative, according to Kwadwo and Ayalew (2011), provides rice farmers in the Philippines with information about the best times for planting and harvesting as well as how much and what kind of fertilizer to use at each stage of growth. Rice growth tracking can help farmers increase crop productivity while lowering losses. By calling a toll-free number, farmers, and extension personnel can hear instructions in their preferred local language before being asked to use their keypad to respond to 12 to 15 questions on their rice crop.

In Kerala, India, Jensen (2007) discovered that fishermen who used mobile phones were better able to stick to single pricing, decrease waste, and reduce price dispersion. According to Kwadwo and Ayalew (2011), a local company called Esoko in Ghana started a trial program called Cocoa Connect that provides crucial information to cocoa farmers on enhancing farming practices, farm safety, crop disease control, postharvest,

and productivity. Through voice and SMS messaging, farmers participating in this program receive free information and succinct answers to questions in either their native tongue or English. Farmers who subscribe to the system receive information about the weather, crops, and the current and anticipated commodity prices at various markets from Reuters Market Light (RML), which also sends four SMS messages each day to its users in India (Kwadwo and Ayalew, 2011).

Another example of how mobile phones might benefit farmers is the way grain traders in Niger utilize them to get pricing information from other markets and the way production techniques are synchronized with export market requirements in Colombo (De Silva, 2008).

2.8.3 Adoption and Use of climate-smart Agriculture Based on Agricultural Researchers' Findings

Agriculture generates a plethora of data kinds, including economic models, agricultural yield, and crop diseases (Shah, Hiremath, & Chaudhary, 2016). Real-time data on air, weather, soil, crop maturity, labor cost, and even equipment can help farmers make better decisions (Acharjya & Ahmed, 2016). The use of big data in agriculture reduces farmer failures by recommending the sort of soil and water levels that support a specific production. Several tools and strategies are used in the big data analytics framework to handle data and make choices. The effectiveness of these strategies is critical since they facilitate decision-making. Clustering, classification, and association are the primary approaches employed in big data analytics (Majumdar, Naraseeyappa, and Ankalaki, 2017; Rani, Priyanka, and Monica, 2019; Wolfert, Verdouw, and Bogaardt, 2017).

Data categorization is the process of arranging data into useful categories so that it can be used and safeguarded more effectively (Xu, Collier, & O'Hare, 2017). Classification is a data mining approach that helps users with knowledge discovery and planning by categorizing unstructured data into structured classes and groups (Zinyoni, 2017). Data classification simulates intelligent decision-making. Data classification is especially important in risk management, compliance, and data security.

The data association entails investigating any relationship between various data accessible. Data associations are used to discover correlations and co-occurrences among data sets (Majumdar, Naraseeyappa, & Ankalaki, 2017). They are most suited for explaining patterns in data from seemingly unrelated information sources, such as relational and transactional databases. The significance of data association is that it allows researchers and farmers to identify which information is most reliable (Arjun, Joshi, Das, & Amutha, 2018). High information association suggests that the data are highly connected and can be utilized to draw broad conclusions about agricultural issues.

Clustering is commonly used to organize data into more understandable and manipulable structures (Delgado, Short, Roberts, & Vandenberg, 2019). The segmentation of information can provide farmers with access to multiple sources of information, allowing them to make more informed decisions. Clustering is a data analysis technique used for exploratory purposes. Clustering enables farmers to visually examine enormous amounts of data, allowing them to make quick decisions (Kumar & Sekhar, 2018). Clustering is an unsupervised strategy for categorizing huge datasets into related groups.

Majumdar, Naraseeyappa, and Ankalaki (2017) discovered that clustering is critical in data analysis and decision-making. Clustering includes similar grouping of information in the same group or cluster for easier retrieval and analysis, as demonstrated by the study. By grouping similar information, consumers gain simple access to and a thorough knowledge of a wide range of information, allowing for more reliable decision-making. The study also found that clustering helps to visually assess vast amounts of data, which aids in making quick decisions.

Xu, Collier, and O'Hare (2017) conducted another study to survey clustering approaches applicable to huge data. The results of the investigation revealed that clustering is one of the key strategies used for data mining, in which mining is accomplished by locating clusters with a comparable set of data. Data mining is a technique for extracting relevant information and hidden relationships among data. Because huge data is difficult to examine, typical data mining methodologies cannot be directly applied to it. The study also observed that clustering techniques are used and a suitable clustering methodology is offered, which improves information accessibility.

The usage of big data is a critical strategic issue that hurts CSA implementation. According to the Ministry of Agriculture Strategic Plan (2017-2027), big data is the 'provision of accurate, timely, and reliable climate/weather information to advice agricultural, livestock, and fisheries value chain participants. To address the plan, big data suggests improving, modernizing, and maintaining meteorological infrastructure; integrating scientific and indigenous technical knowledge; and improving technical skills in weather data analysis, packaging, dissemination, and usage.

Communication of these technologies would increase farmers' adaptive capacity and resilience to the negative effects of climate change. However, the strategy does not define how to incorporate these tools to improve communication and acceptance of technologies, innovations, and information that promote improved productivity, resilience, and GHS reduction by stakeholders, particularly farmers, who are the primary victims of climate change and key implementers of climate-smart agriculture solutions.

Obidike (2011) looked into the obstacles farmers in Enugu State, Nigeria, face while trying to get agricultural information. This study employed a cross-sectional research approach. Among those targeted were farmers from the state of Enugu. Questionnaires were used to collect the information. The analysis used both descriptive and inferential methods. The study found that rural farmers in Enugu state's Nsukka local government area aren't producing enough food, perhaps as a result of obstacles such as not having timely and current information available to them, which would have allowed them to get the most out of their farmlands. According to the study, telecentres provide rural farmers with fast and trustworthy information about what is happening in the fields, including improved seedlings, better-cultivating techniques, and fertilizer application, and they should be utilized. To create effective and efficient agricultural systems that not only provide food and animal protein but also encourage the sustainable use of natural resources, the governments of developing countries have a major responsibility to ensure adequate rural development in their various communities and local governments.

Wanjohi (2015) looked into how mobile phone technology has facilitated better communication among Kenya's smallholder dairy farmers. The study used a descriptive

research design, which entails learning about a group of dairy farmers' characteristics, viewpoints, attitudes, and past and present experiences. Data collection involved the use of structured questionnaires. The usage of mobile phone technology in farming has expanded access to information, claims the research. The advancement of mobile phone technologies has facilitated communication among farmers around the country. According to the survey, farmers are aware of various mobile phone technologies and have favorable sentiments toward their benefits. According to the research, using mobile phone technologies for payment, animal health, and other dairy services improves communication between farmers and specialists or consumers. Technology adoption is predicated on dependability, relevance, and information. It was suggested that people developing these technologies collaborate closely with farmers to learn about the current issues. Kenyan dairy producers and other farming types might utilize and adapt lessons learned from countries that have widely implemented cell phone technologies in their dairy farming.

In today's world, science and technology are developing constantly and quickly. Progress is now mostly measured in hours, minutes, or seconds rather than in years, months, or days, thanks in large part to information and communication technology that is supported by electronic technology. Wijaya, Suryatiningsih, and Fahrudin (2011) and Kamaruzaman (2009) both suggest conducting a study on information transmission related to mobile phone use. The findings indicated that information dissemination via mobile phones, particularly SMS, may be used to accelerate the release of information. This is related to the extensively publicized use of mobile phones. The effectiveness of digital information services is determined by the amount of user demand and supply of

trustworthy information, as well as the speed and accuracy of the service, which is primarily determined by access to the facilities, Maksum, Buldansyah D.L., and Prawati B. (200b) showed. Additionally, it was found that students visiting the library in groups were more interested in the content of the article as a whole than the bibliographical details. According to Mr. Benunur M.N. (2006), different video instructional messages had an impact on farmer knowledge advancement just as effectively as farmer behavior that involved watching a consultant demonstrate.

According to D. Scanfeld, V. Scanfeld, and E. L. Larson's (2010) study on the dissemination of health information through social networks: Twitter, and antibiotics, social media sites offer a vehicle for distributing health information. More research is required to determine how these networks can be used to spot antibiotic misuse or overuse, promote healthy behavior changes, disseminate reliable information, and search for mengumpukan health data. Research conclusions Information transmission: Sankarto B.S., Mansjur S., and Rusmini (2006) Even though some users disagree, feedback on the outcomes of agricultural research and technology shows that consumers generally have positive sentiments about the library's website. Information, according to McFadden et al. in Kadir (2002), is defined as "data that has been processed in such a way as to enhance the knowledge of someone who uses that data." For vegetable farmers to be successful in their farming business endeavors, knowledge of breeding programs, processing farms, and marketing is essential. Wilson (1981) asserts that the necessity for information users to meet their needs and place demands on resources or formal or informal information services led to the emergence of information behavior models, which had an impact on users' success or failure in finding pertinent information. In general, the level of

utilization of cyber extension is still relatively low, but this is due to farmers' lack of awareness of the existence and benefits of cyber extension, as well as the lack of proper functioning of the group as a medium to share information and knowledge, as well as extension officers as an escort of unpreparedness in the field, according to Mulyandari's (2011) previous research on Cyber Extension as a Communication Medium in Vegetable Farmer Empowerment.

To better understand how agricultural technology used in agricultural extension services affects family food security, Sigei (2014) conducted a study in Nandi County. With 14,489 dwellings in the Tinderet District as the study's target population, survey research was performed to collect the data. From the 15 locations in Tinderet that were accessible, two were chosen for the study using a purposeful sampling technique. Four sub-locations from each sampled location were identified using another round of purposeful sampling. By choosing eight villages at random from the studied sub-locations and an additional 15 households, the sample size was raised to 120 households. To fully assess the effect of extension services on food security in Nandi County, the researcher spoke with 12 important informants. To gather data, questionnaires, and interview schedules were employed. To analyze the data, descriptive statistics were employed. The survey found that field demonstrations and radio broadcasts were the main sources of information for homes. To improve farm households' abilities and knowledge for sustainable agriculture and rural development, extension must go beyond the transfer of technology. The Training and Visit (T&V) plan, which promotes individual contact and integrates technology transfer, needs to be replaced with a more participative model.

Bell (2015) asserts that the issue of information access is gaining ground, particularly in light of the potential contribution of information and communication technology (ICT) to farmers' access to the data they need. ICT has already shown that it can considerably improve access to information and communication while also facilitating money transactions. A more modern issue has come up, though: How can the promise of ICT be effectively used to help the world's rural poor? Since the introduction of the internet in 1994 and the rapid growth of mobile phones starting in the middle of the 1980s, many have turned to "ICT for Agriculture." Despite these numerous apparent failures, there is a growing body of knowledge that offers lessons on the conditions needed for ICT applications to be successful in agricultural extension.

In 2016, Sousa, Gian, and Home did research on the use of information technology for farmer-to-farmer exchange and agricultural extension. The objective was to assess the potential of mobile phone video as a tool for farmer-to-farmer communication and agricultural extension in the rural context of Western Africa. To complete this study, 460 farmers from Mali and Burkina Faso were interviewed. According to the participating farmers, 3G phones are widely available, even to people who had previously had restricted access to information sources, such as young women. Video-based information can change the conventional top-down pattern of information transfer from extension agents to farmers and is helpful to illiterate farmers. The results demonstrated the enormous potential of mobile video as a tool for agricultural extension and farmer-to-farmer communication in underdeveloped nations. An innovative kind of farmer-to-farmer communication is the use of video on mobile devices. This method has the potential to transform and scale up extension operations, enabling the essential

intensification of land use as well as more resilient, inclusive, and democratic farming systems. The study found a favorable correlation between the growth of information technologies and increased communication.

Delgado, Short, Roberts, and Vandenberg (2019) used a descriptive survey design to investigate how Big Data analysis improves sustainable agriculture. The study's findings revealed that Big Data is critical in promoting sustainable agriculture. The precision agriculture revolution, which is being spearheaded by SPAE, which can take advantage of previous technologies paired with Big Data analysis, has been sparked by the growing effects of climate change.

Chuang, Wang, and Liou (2020) conducted a study on farmers' knowledge, attitude, and adoption of smart agriculture technology in Taiwan. The study adopted a mixed method. Both questionnaires and interview guides were employed in the study. A total of 321 farmers participated in a survey in 2017 and 2018, and the data were used to construct an ordinary least squares regression model of SA adoption. The results of the study indicated that Smart Climate Agriculture is highly influenced by Big Data. The Big Data-driven platforms animate communication and access to agricultural research information critical in promoting smart agriculture. The study concluded that smart agriculture (SA) was acknowledged as a significant trend promoting agricultural progress. International interest has been generated by the Food and Agriculture Organization of the United Nations' Climate-Smart Agriculture initiative. To enhance smart agriculture, farmers should be encouraged to embrace digital technologies and mobile devices in their farming

methods. Additionally, the report recommended that decision-makers focus on enhancing established market access and vital climate-savvy agriculture technology.

Omer and Hassen (2020) used both quantitative and qualitative research methods to perform a study on the variables impacting the adoption of Climate Smart Agricultural Practices among Small Scale Farmers of the Kurfa Chele District in Ethiopia. Questionnaires, key informant interviews, observations, and a desk review were used to collect the data.

2.8.3.1 Factors Influencing Adoption of Climate Smart Practices

It has been demonstrated that a wide range of variables, such as household and farm characteristics, influence the adoption of technology. Age, gender, education level, wealth endowment, farm size, and agricultural experience are some of these factors. The perception of the issue, the features of the technologies, the effect of institutions, and the market's influence are additional considerations when making an adoption decision (Jones et al., 2010; Rogers, 2003; Frank & Penrose, 2012). Assets and wealth endowments, including income, savings, loan availability, and insurance, are thought to have a substantial impact on small-scale farmers' adoption of technologies. This is so that farmers can innovate and take risks that enable long-term sustainable adaptation by serving as a "safety net" in times of crisis (Jones et al., 2010).

Similar to this, often adopting new technology necessitates significant capital outlays, which are typically outside the means of the vast majority of rural farmers. This suggests that compared to farmers who have less access to resources, farmers with larger resource endowments are more likely to implement climate-smart activities (Deressa et al., 2009).

Similarly, farmers' ability to embrace technology practices is seen to be significantly influenced by their effective market participation. According to Jones et al. (2010), small-scale farmers' livelihood strategies are improved by the existence and participation of markets. Market flaws have also been proven to have an impact on the adoption of innovative practices (Deressa et al., 2009; Ogada et al., 2014; Jones et al., 2010).

Surveys have also indicated that the adoption of technologies is facilitated when the necessary tools are easily accessible and available in the local market (Ogada et al., 2014; Agrawal, 2008). The adoption of agricultural practices is critically dependent on institutions as well (Djurfeldt et al., 2011). According to Jones et al. (2010), institutions at all levels must be involved in the effective implementation of climate-wise practices. For instance, local collective and civil society institutions play a vital role in asset building, information access, resource mobilization, capacity and skills development, and developing the links required for the adoption of adaptive policies (Agrawal, 2008). Adoption of new practices is significantly influenced by the policy environment that supports payments for environmental services, funds research, and fosters information and advice distribution (Jones et al., 2010).

2.8.4 Communication Barriers in Dissemination of Information

Ifukor, (2013) found in a study done in Nigeria that several factors, including the use of inefficient communication channels, illiteracy, the use of foreign languages, and excessive dependence on oral rather than written modes of communication, may hinder the transmission of knowledge. Oladele (1999) established that the poor dissemination of agricultural research knowledge was a result of insufficient communication between

farmers, extension agents, and researchers. Poor connections make it difficult for farmers to participate in earlier planning, which calls for information. Ferris (2005) said that one of the major obstacles to improving the agricultural sector in emerging nations is the lack of trustworthy and up-to-date agricultural knowledge among small-scale farmers in many African nations.

Studies have empirically established that insufficient communication or information infrastructure might result in physical barriers to information accessibility, (Ellen, 2003, Masuki et al. 2010). In the age of globalization and technology, Cogburn and Adeya (2000) posits that infrastructure for information and communication is considered a prerequisite for universal socioeconomic development.

Majority of African nations, however, lack appropriate information and communication infrastructure. Internet usage has therefore been minimal. Africa has low telephone penetration, insufficient television infrastructure, insufficient computing infrastructure, and other consumer usage, claim Cogburn and Adeya (2000). On the other hand, psychological barriers are brought on by people's failure to recognize their information demands or their inability to obtain crucial knowledge from reliable sources. Williamson (1997; 1998) lists the cost of information and the community's apprehension about receiving it as additional factors. In addition, ignorance remains the biggest obstacle to satisfying the information needs of the working poor in developing countries (Dutta, 2009). A two-man commission that studied the Southern African Development Community's member nations found that the absence of adequate tools like computers, photocopiers, current books, adequate budgetary allocations, and a dearth of scholarly

journals were the main obstacles to agricultural information (Norman and Ntokotha, 1990). Illiteracy has been cited as a significant barrier to using written information items (Carter, 1999; Mbozi, 2002). Furthermore, written materials cannot be used to transmit agricultural information in Africa due to the majority of farmers there being illiterate, according to Aina (2006). For addressing illiterate farmers, the use of print media as message carriers, such as pamphlets and newsletters, is limited. Due to a lack of financial resources, relevant agricultural information publications are scarce in Africa. Furthermore, the amount and quality of publications continue to be a concern since users cannot get relevant information promptly (Ozawa, 1995). Dutta (2009) uses the example of Nigerian fishermen to demonstrate how, because they are illiterate, they frequently receive outdated, incorrect, and wrong information through informal networks, putting them at a professional and financial disadvantage. Small-scale farmers are likely to be affected similarly.

Radio and television both provide information. However, they are pricey, batteries are expensive, certain programs have difficult timing, the messages are of poor quality, and the language is inaccurate (Kalusopa, 2005; Dutta, 2009). Additionally, rural areas lack electrification. The availability of information may also be restricted by a scarcity of funding and excessive costs. As noted by (Nicholas, 1996), using information systems online and connecting to the internet, for instance, might be expensive.

The manner and language used to provide the information are additional barriers to access for small-scale sugar cane growers. Small-Scale Sugar Cane Growers are unable to access electronic information because they lack access to and are unable to use

computers. As noted by (Ozawa, 1995; Momodu, 2002; Aina, 2007), a vast majority of African farmers are illiterate and hence unable to read or write in any language. Additionally, the majority of agricultural literature is written in English, which small-scale farmers in Africa cannot grasp. English-language material is not useful to small-scale farmers. The same idea is supported by Omekwu (1998), who claims that small-scale farmers in underdeveloped countries are unable to access current information due to language barriers. According to Rwazo (2007), the information presented must be straightforward and in a language that many farmers can understand. As a result, people use what is easiest to obtain and near at hand rather than what is best or most appropriate (Nicholas, 1996).

Another impediment to information availability is the scarcity of Agricultural Extension Officers. Farmers, for example, rarely get new knowledge due to the limited number of Agricultural Extension Workers, Ozawa (1995), Isinika and Mdoe (2001), and Aina (2006) all support this. This is brought on by the low proportion of farmers to Agricultural Extension Workers. Only a limited portion of farmers receive agricultural extension services, according to Bilonkwamanagara (2008), who claims that Agricultural Extension Workers do not reach all farmers. As a result, information on the most recent agricultural technologies is scarce, and in areas without extension agents, both men and women are denied equal access to extension services (Mntambo, 2007). Another barrier to information availability is gender-related attitudes and behaviors (Materu-Behtsa, 2004). The Food and Agricultural Organization (1998) asserts that women's greater workload prevents them from attending meetings. Ozawa (1995) concurs that the combined household and production duties take up all of a rural woman's day, making

her too exhausted to listen to the radio or take part in extension activities. Women rely on word-of-mouth or local radio for information because they have few opportunities to go to school, and they have little control over what it is about (Walker, 2002).

The majority of women's interactions with the communities in which they live and the social circles they frequently connect with determine their access to agricultural information (Achia, 2002). Despite growing recognition of the necessity of including female farmers, Durutan (1999) claims that agricultural extension programs are mostly directed at male farmers. Even when extension agents visit farmers, according to Aina (2006), they frequently concentrate their efforts on male farmers rather than women, who make up a sizable portion of African farmers.

Mbwana (1994), also notes that although Tanzanian farmers have access to a variety of information channels, the information flow that is crucial for agricultural development is impeded by several factors, such as inadequate mass media production and distribution, information content, and low educational levels. Ochieng, (1999) asserts that timely and proper knowledge is the missing component in women's effective involvement in the agricultural sector. Additionally, according to Ikoja-Odongo, (2008), Nath (2001), and the World Conference for Women (1995), millions of small-scale female farmers in Africa are essential to the continent's agriculture. Despite this, these women face obstacles that make it difficult for them to access the information they need for increased production and marketing, including illiteracy, distance from information centers, cultural restrictions, and domestic responsibilities. Furthermore, according to Naidoo et al. (2008), South African women are fundamentally uninformed about the pesticides they

encounter. As has been seen in other rural populations, this ignorance may be caused by a lack of formal pesticide application instruction.

Similar to this, the small-scale sugar cane farmers in Kilombero lack specialized knowledge in the use of inputs like pesticides. Users must view the channel through which information is conveyed as acceptable and affordable because information is only helpful if it is relevant, timely, and appropriate (Ochieng, 1999). The lack of agricultural libraries in communities with farmers is another obstacle to learning about agriculture (Aina and Dulle, 1999). Farmers are discouraged from using agricultural libraries as a source of information due to the distance between the source and the information user. This means that even if someone is aware that information exists, getting their hands on it could be challenging. This is brought on by the separation of information sources, which is particularly true for rural African farmers. Informational barriers may also be related to low meeting attendance, an inability to ask for help, and a failure to listen to the radio.

Cultural and religious taboos are another barrier to getting agricultural information in rural Africa. Depending on the type of community, men and women may have different information needs and different capacities for acquiring and using it, according to Matovelo (2008). Women often lag as a disadvantaged group in societies where cultural and religious taboos are prevalent due to possible barriers preventing them from accessing information (Ozawa, 1995).

Language barriers and information misinterpretation may also have an impact on how farmers utilize the knowledge they have received. In their study on the issues faced in agriculture regarding information transmission, Mokotjo and Kalusopa (2010) discovered

that farmers were given printed material in vernacular languages. The farmers were able to properly utilize the information because they used local languages. According to Lwoga, Stilwell, and Ngulube (2011), farmers' illiteracy hindered the dissemination and use of agricultural research knowledge in Tanzania. Isaya (2015) performed research in Tanzania on the methods used by women farmers in the Hai and Kilosa districts to spread knowledge. A lack of credit to buy farm inputs, such as improved seeds and chemical fertilizers, as well as a lack of knowledge on how to apply the information obtained from extension officers and researchers, were challenges that farmers had to deal with, according to the study. They also had trouble getting access to credit.

Ogola (2015) did a study to identify the barriers to information access that watermelon producers in Yimbo East Ward face. Structured individual interviews were used to collect data, and observations were made during farm visits. According to the survey, the biggest problems that farmers face when receiving information are the price of acquiring data and a lack of feedback. According to the survey, most watermelon growers obtain agricultural information about watermelon production through radios, fellow farmers, and phone conversations. Because of the multiple benefits of radio, the study advised establishing a community FM radio station to increase the distribution of information about watermelon production and knowledge to farmers in the region. Farmers must be engaged, persuaded, and shown the benefits of numerous communication channels in the cultivation of watermelons.

Nzonzo and Mogambi (2016) looked into the barriers to the use of information and communication technology (ICTS) in Kenya's Mwea Irrigation Scheme's irrigated rice

production. The mixed method, which included qualitative and quantitative techniques, was used. A cross-sectional survey design was selected. 6,500 homes were the intended target population for the Mwea Irrigation Scheme. 362 persons made up the sample size. Questionnaires and interviews were used to collect the data. The study discovered that the major barriers to ICT adoption among irrigated rice farmers in Kenya's Mwea Irrigation Scheme are a lack of training, a lack of ICT skills, and an inability to use and pay for ICTS and/or funds and that the most influential factor of ICT adoption among rice farmers was an increase in rice production output, followed by an increase in farmers' skills/knowledge in rice production and access to agricultural market information. The study concluded that ICTs are utilized to obtain information on available paddy seed varieties, paddy seed prices, and packaged rice prices. Lack of training, lack of ICT skills and incapacity to use, and cost of ICTS and/or funding are the key hurdles to ICT adoption among irrigated rice farmers in Mwea Irrigation Scheme, whereas the most significant factor in ICT adoption among rice farmers was an increase in rice crop output. Rice farmers should be provided with adequate workshops, training, and awareness, which should be pushed by county and central governments, as well as other private groups. These authorities should set up ICT centers in rice irrigation schemes to give rice farmers access to ICT tools and services that may not be available to all farmers based on their needs.

The study by Nzonzo and Mogambi (2016) is a mixed study that examines the hurdles faced by farmers; this influenced my investigation to identify some of the potential barriers that might emerge in my study because it was a mixed study. Even though it was ICT-related, the hurdles encountered may have been similar because both studies dealt

with farmers. As a result, the study helped indicate topics that may emerge as hurdles to communication with farmers in West Pokot regarding climate-smart agricultural adoption.

Moahid and Maharjan (2020) investigated factors influencing farmers' access to formal and informal information in rural Afghanistan. The descriptive research design was used in this study. Farmers from Jalalabad were among those attacked. Data from relevant respondents was gathered using questionnaires. In Jalalabad, Afghanistan, 292 farming households were included in the study. The study's findings revealed poor infrastructure, illiteracy, conflicts, and a lack of knowledge, indicating that agencies are impeding farmers' access to information. Famers are unable to obtain credit because of financial ignorance as well as cultural and religious beliefs. The study showed that access to information is important for farmers and supports improved farm productivity. The study advised that the government and other stakeholders assist farmers for them to gain access to proper information, which is predicted to increase farming production.

Mubofu and Elia (2017) explored how widely agricultural research information is spread among farmers. The research was carried out in the villages of Mlolo, Lupalama, and Wenda in the Iringa district in 2015. The study found that farmers were not getting enough agricultural research information. The most common sorts of agricultural research information given to farmers included information on better seed varieties, fertilizer use, crop management, and insect management. Farmers' access to agricultural research information, on the other hand, was hampered by a lack of extension officers, insufficient financing, insufficient sources of information, a lack of energy, political

interference, and the absence of information centers. The study proposed that agricultural research information be repackaged to fit the demands of farmers. In addition, the report suggested that the government hire more extension officers and post them in rural regions.

Barakabitze, Kitindi, Sanga, Shabani, Philipo, and Kibirige (2015) investigated how a wide range of information and communication technologies (ICTs) accessible in Agricultural Research Institutes (ARIs) might boost agriculture productivity in Tanzania if used successfully by agriculture researchers. A structured questionnaire and telephone interviews were utilized to collect data from a randomly selected sample of 64 respondents from the selected institutes, who were agricultural researchers, agricultural managers, and other agricultural stakeholders. Statistical tools were used to analyze the data. According to the study's findings, among the challenges impeding the use of ICTs in ARIs are insufficient computers and supporting technological infrastructure, a lack of electricity required to run computers, unreliable Internet connectivity, and a lack of systematic ICTs investment; and a lack of coordination among agriculture stakeholders due to institutional diversity and department fragmentation. This study advised that the Government of Tanzania (GoT) develop and implement ICT4A projects in Tanzania based on a researched conceptual framework connected to ICT4A use and Information and Communication Management (ICM) in ARIs.

The study took several of the hurdles that most scholars discovered in their studies to be affecting contact with farmers from the preceding literature. Hurdles such as poor infrastructure, illiteracy, conflicts and lack of knowledge, information access to farmers,

and others from many countries established themes on the communication hurdles experienced in West Pokot. The barriers described were useful in developing a questionnaire and interview guide to confirm whether the barriers mentioned by other researchers are the same as those faced by farmers in West Pokot in adopting climate-smart agriculture information.

According to Rehman, Muhammad, Ashraf, Mahmood, Ruby, and Bibi (2013), farmers have access to a variety of agricultural information sources, and this access is correlated with socioeconomic variables. A random sample of 361 responses representing a proportionate sample was chosen from the readers of three different agricultural periodicals. The data were gathered using a pre-validated questionnaire, and a statistical package for social sciences (SPSS) was used to evaluate the results. Simple frequency, percentage, mean, and standard deviation were utilized as descriptive statistics. The rank order was established using the weighted score. Additionally, the degree of connection between the chosen variables was examined using bivariate analysis. The findings indicated that farmers' primary information sources were the print media and their fellow farmers. The findings also showed that access to agricultural information was positively correlated with education and size of land holdings, but not with age or prior farming experience. The study's findings thus showed that to increase agricultural production, policies on appropriate and convenient access to agricultural information for farmers are urgently needed.

In Kenyan South Rift region, smallholder farmers use agricultural information systems to manage their cereal crops after harvest. Nge'no (2013), studied 140 smallholder farmers

utilizing descriptive survey to examine these systems mainly to document knowledge sources, needs, and accessibility about post-harvest management of cereal crops among smallholder farmers were the study's primary goals. Additionally, the researcher needed to identify the function of service providers in agriculture in facilitating smallholder farmers' access to useful agricultural information on cereal crop post-harvest management and lastly to discover the socio-demographic traits of smallholder farmers that affect agricultural data on cereal crop post-harvest management.

The findings showed that 61% of smallholder farmers cited extension agents as their primary source of agricultural knowledge, followed by 48% from the media and 1% from public research organizations and universities, demonstrating a lack of institutional support for agricultural production in terms of information. The data also revealed that 61% of smallholder farmers only accessed agricultural information once per year, which is insufficient for effective agricultural information transmission given that there are two cropping seasons per year. Additionally, 15.4% of smallholder farmers had no access to agricultural information on post-harvest management. Low farming revenues and a lack of experience were the main issues raised. The study suggested that extension agents be retrained on new post-harvest management technologies in the rapidly evolving ICT environment and that different actors work more closely together on shared post-harvest tasks.

In their 2013 study, Tenzer, Pudelko, and Harzing looked at how language obstacles affect the development of trust in multinational teams (MNTs). The study showed how MNT members' cognitive and emotional reactions to language barriers influence their

perceived trustworthiness and intention to trust, which in turn affects trust formation. The study was based on 90 interviews with team members, team leaders, and senior managers in 15 MNTs in three German automotive corporations. Oladele (2006) looked at how the multilingual farm broadcast affected Nigerians' ability to receive agricultural information. The language of presentation for each of the radio and television farm broadcast programs was collected and studied. Due to the variety of languages spoken in Nigeria, it is necessary to adapt the language of presentation so that farmers may receive agricultural information on radio and television. The study suggested that to ensure farmers' access to agricultural information, information sources for farmers should look at multilingual sources.

In the year 2011, a study was carried out in the state of Karnataka by Raghuprasad, Devaraja, and Gopala (2012). The purpose of the study was to evaluate farmers' attitudes toward adopting ICT technologies for farm communication and to ascertain how these traits related to their socioeconomic status. Due to their proximity to Bangalore, the IT hub, the districts of Bangalore Rural, Chikkaballapura, and Kolar in the state of Karnataka were specifically chosen. The majority of the farmers in these areas had access to various ICT tools and used both new and ancient ones. More than two-fifths (40.83%) of the 120 farmers chosen for the study had a favorable attitude toward ICT instruments, followed by 31.67% who had the least favorable view, and 27.50% who had the most favorable attitude. The attitude of farmers toward ICT technologies was positively and significantly correlated with factors like education, land ownership, annual income, economic motivation, risk orientation, scientific orientation, and participation in

extension programs. In light of this, the study suggested that farmers be educated on how to use these ICT tools for their well-being through appropriate educational activities.

By analyzing the impact of tospoviruses on farmers' livelihoods and the management strategies used to control tospoviruses in tomatoes in Sironko area, Nabuzale (2014) attempted to understand the knowledge, attitudes, and perceptions of farmers about tospovirus infection. By using questionnaires, focus group discussions, key informant interviews, and field visit observations, a cross-sectional study strategy was used to gather both qualitative and quantitative data.

Twenty respondents who were specifically chosen utilizing a key informant interview guide were interviewed after the researcher administered 360 questionnaires to them. Additionally, the research team observed surrounding farmers' gardens and held three focus group conversations in each of the three sub-counties. The results of the study showed that tomato growers in the Sironko district are ignorant about tospoviruses in tomatoes. Tospoviruses have an impact on the natural, physical, human, financial, and social capital stocks that support farmers' livelihoods. The farmers said that tospoviruses had an impact on all capital stocks, either directly or indirectly, due to the decline in financial stock and the disease's spread to other crops. In terms of money, market prices were severely impacted by product quality and yields. Regardless of the disease's nature, farmers always employ pesticides like dithane to control infections by management practices. Contrary to other illnesses, controlling tospovirus transmission vectors is more crucial than containing the illness itself. The knowledge, attitude, and perception of farmers must be improved through training, such as on-farm training. The organization of

farmers into marketing organizations will give them a stronger voice and enable them to negotiate better prices for their produce, reducing the impact of tospoviruses on assets supporting the farmers' livelihoods. By educating and instructing farmers in disease recognition and the use of suggested tospovirus sprays, management practices can be improved. Weeds serve as hosts for the thrips that disperse the tospoviruses, thus tomato farmers need to understand the value of weeding.

Apata and Ogunrewo (2010) used the "town crier" as a case study to analyze the development and information needs of the resource-poor and the approach used to address these demands. Based on the literature and previous investigations, the study found 2 states in southwest Nigeria where this approach has been used. For data gathering, a focused group discussion technique and interview schedule were used. With the aid of key informants, the study located 141 "town criers" throughout the study locations. The findings revealed that all Town Criers were male, had post-secondary education, and were an average of 55.54 years old. The traditional head is the main information source for the Town Crier. The Town Crier primarily disseminates information on community development and projects as well as town security. The study found that just 20% of the information provided through this channel satisfies the information demands of the general public, leading to the conclusion that it rarely does so. Previous research has shown that there are no longer any functional information/communication routes in Nigeria as a result of the collapse of extension institutions. The few extension officers that are currently in existence exclusively gather in urban regions, leaving those in rural areas behind.

2.8.5 Communication interventions that can be put in place to improve the utilization of climate-smart agricultural technologies

Wamalwa (2017) investigated the factors influencing the adoption of climate-smart practices among farmers in Kisii County's Kitutu and Nyaribari Chache. The study used a hybrid methodology. Focus Group Discussions, questionnaires, key informant interviews, observations, and desk reviews were used to collect data. Simple random and purposive sampling were employed to sample 420 small-scale farmers and agricultural technical officers, respectively. According to the study, the key variables impacting smart climate practices are a lack of awareness of applicable policy provisions, a lack of knowledge, financial constraints, limited access to weather and climate information, insufficient extension services, dysfunctional farmer groups, and a weak regulatory framework. The report advocated increasing the scale of climate and weather information sharing, promoting skill and knowledge of smart climate practices, developing good policy and legal frameworks, and mobilizing finances.

Chete and Fayosiro (2014) investigated the influence of an ICT-based initiative (mobile phone) on market access by Nigerian women farmers. Questionnaires were among the study instruments employed. Descriptive statistics were used to analyze the study. According to the study findings, limitations and challenges to creating rural ICTS facilities for farmers include a lack of content for rural society, human resource capability, coordination deficit, strategic coordination, poor infrastructures, investment risk, and poor rural infrastructure. The report proposed that the government and other stakeholders join in the process of assisting farmers in gaining access to ICTs.

Mubofu and Malekani (2020) investigated agricultural information sources as well as techniques for distributing agricultural research findings to farmers in Tanzania's Iringa District. A self-administered questionnaire was used to survey 90 farmers. To evaluate the findings, the Statistical Package for Service Solutions (SPSS) software and Spreadsheet were utilized. According to the findings of this study, extension officers' primary channels of information for disseminating agricultural information to farmers are radios, church leaders, village leaders, and seminars. The study indicated that radio, religious leaders, seminars, newspapers, pamphlets, and fliers should be used extensively to convey agricultural information among farmers to increase farm output. The study concluded that various disseminators, such as powerful persons, religious leaders, political leaders, primary school teachers, and students, should be used to spread such knowledge, in addition to repackaging agricultural research findings to match them to the needs of farmers.

Mbagwu, Benson, and Onuoha (2017) investigated the issues of satisfying the information demands of rural farmers through internet-based services in African developing countries. A literature review was done to acquire relevant data for the investigation. The survey findings revealed that the challenges to meeting the information needs of rural farmers through internet-based services include a lack of ICT infrastructures through which internet-based services can be provided and accessed, a low level of interest in utilizing agricultural information among rural farmers, insufficient knowledge among rural farmers, a low level of ICT literacy, and the lack of information providing agency in rural areas. The findings also revealed that as solutions to the identified problems, the creation of an online farmers discussion forum, organizing ICT

and agricultural information literacy, conducting research to ascertain rural farmers' agricultural information needs, and repackaging information using social media platforms were recommended.

Odinga (2018) assessed the County government mechanisms for communicating agricultural information to farmers in Siaya County's Alego-Usonga ward. This study investigated the channels through which agricultural information was disseminated, the competencies and skills of staff involved in agricultural information dissemination, the contribution of extension officers in disseminating agricultural information in the Alego-Usonga ward of Siaya County, and the challenges encountered in agricultural information dissemination. This study employed both qualitative and quantitative research methods. The population was sampled via purposeful sampling. Data was gathered through interviews and questionnaires. The study discovered that audiovisuals were commonly used for delivering agricultural information and that the people who offered agricultural information were fairly skilled. The study recommended that current channels of dissemination such as social media, peers, site visits, and agricultural shows be improved for disseminating agricultural information and that staff competencies and skills be improved to ensure effectiveness in the performance of their duties.

Thuo, Njoroge, and Wamalwa (2019) conducted a study to investigate how young farmers in Murang'a County use ICT tools to acquire and utilize agricultural dairy information. The study aims to analyze farmers' awareness of the technology available for use in accessing agricultural information, as well as farmers' methods for accessing and utilizing agricultural dairy information to promote dairy farming production.

According to the findings of the study, farmers were aware of the use of technology in acquiring agricultural information. According to the survey, farmers obtain agricultural information via radio, television, and mobile phones. According to the report, dairy farmers have restricted access to new technologies such as mobile phones for accessing and using agricultural information. According to the report, Kenya National Library Services, in partnership with the Department of Livestock Production, could organize exhibitions and information literacy initiatives for dairy producers. Infrastructure in rural regions should be strengthened by establishing Cybercafés within sub-counties and educating dairy farmers on the use of ICT technology to obtain and utilize agricultural information.

According to Dlamini and Ndwandwe's (2014) study on perceived factors influencing agricultural information dissemination to farmers by agriculture teachers and extension officers in Swaziland, the best method for farmers and students to foster the dissemination of agricultural research information to stakeholders was adequate collaboration between them and the agricultural teachers and extension officers.

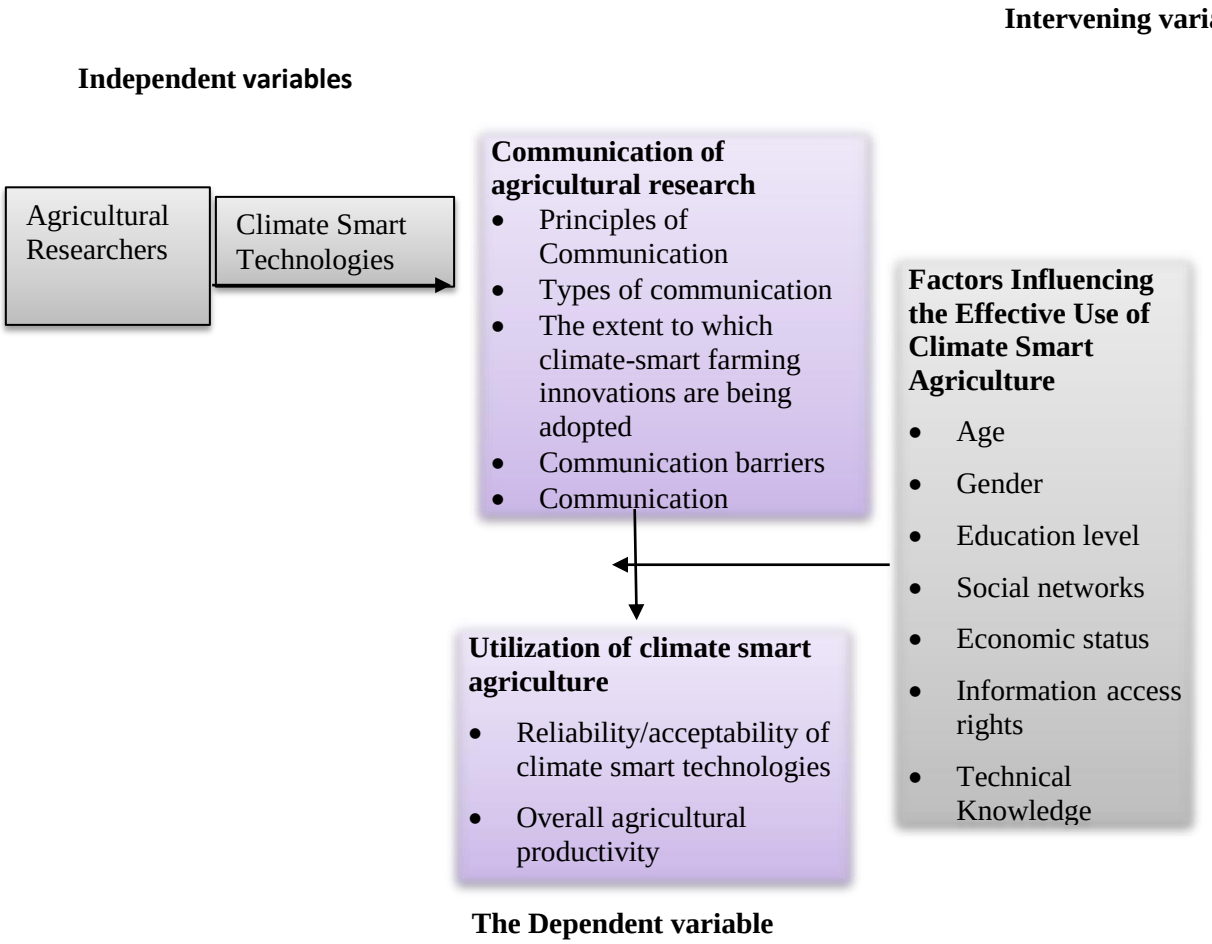
Lwoga (2010), focusing on bridging the agricultural knowledge and information divide, observed that timely access to relevant knowledge and information in Tanzania is a strategy that has the potential to help smallholder farmers make informed decisions about their agricultural production activities, marketing their agricultural produce for higher profits, and health benefits, disease prevention, and advice. Similarly, Siyao's (2012) study on barriers to accessing agricultural information in Tanzania from a gender perspective discovered that other strategies, such as the establishment of rural libraries in

farming communities and disseminating information in a form that every farmer can understand, improve agricultural information dissemination by stakeholders.

According to the literature reviewed above, most scholars discovered that there exist difficulties in contact with farmers, necessitating intervention to bridge the gap. Some of the topics that emerged included government initiatives, policymakers, stakeholders, and the enhancement of communication channels to help farmers better utilize technologies. The study borrowed several of the interventions described by different scholars and investigated further to see if they are also applicable to farmers in West Pokot in communicating climate-smart agriculture knowledge and whether the intervention may boost technology use.

2.9 The Conceptual Framework

The conceptual framework is a visual representation of the relationship between dependent and independent variables. Figure 2.1 depicts the conceptual framework institution.



Source: Author (2023)

Figure 2.1 Conceptual Framework

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter addressed the research plan or framework that was employed to address the research objectives during the investigation. It went over the research philosophy, approach, design, study area, target population, sampling technique and sample size, research instruments, data collection procedure, pilot test, data processing and analysis, and ethical considerations. Each section is thoroughly explained.

3.2 Research Philosophy

Research philosophy is concerned with the nature of knowledge and the creation of knowledge, and it incorporates substantial assumptions about how researchers perceive the world (Saunders, Lewis, & Thornhill, 2007). There are two extreme philosophical schools of thought on reality and knowing. The first research philosophy is positivism, which asserts that whatever exists can be validated via investigation, whether through observation, experiments, or mathematical/logical evidence. The second philosophy is realism research philosophy, which is based on the premise that reality is independent of the human intellect. This philosophy is built on the idea of a scientific approach to knowledge growth.

The philosophical paradigm used is determined by the research approach used. Researchers proposed many paradigms to serve as the philosophical foundation for qualitative,

quantitative, and hybrid research methodologies (Barnes, 2019; Ghiara, 2019). Because it is the one that has been selected, this study focuses on the paradigms that would serve as the conceptual foundation for mixed research methodologies.

The mixed research strategy's conceptual underpinnings have been proposed by several scholars in a variety of paradigms (Barnes, 2019; Fetters & Molina-Azorin, 2017; Ghiara, 2019). Pragmatism, critical realism, the transformative paradigm, dialectical pluralism (Barnes, 2019; Fetters and Molina-Azorin, 2017b; Shannon-Baker, 2016), postmodernism (Fetters & Molina-Azorin, 2017b), feminism, and realism (Barnes, 2019; Ghiara, 2019) are a few of the ideas mentioned. The mixed research approach is supported by pragmatism, according to researchers (Biddle & Schafft, 2015; Dieronitou, 2014; Hall, 2013; Hathcoat & Meixner, 2017; Yvonne Feilzer, 2010). Because many academics believe the pragmatic research philosophy to be the most suitable for a mixed research approach, such as the one used in the current study, this study was regulated by it.

Pragmatism has been referred to as "the philosophical partner" of the mixed research methodology since its guiding principles serve as the foundation for combining research methodologies, claim Denscombe (2008) and Mitchell (2018). Johnson *et al*. (2007) concur that pragmatism is a cutting-edge philosophy that offers the logic and epistemology for combining quantitative and qualitative approaches and methodologies. The philosophy of pragmatism, according to Creswell (2014), allows for the blending of paradigms, premises, approaches, and methodologies for gathering and analyzing evidence. The idea of "what works" is central to pragmatic thinking. The pragmatic theory of truth is mostly being discussed here. Instead of being based on presumptions about the nature of knowledge,

pragmatic thinking is simply focused on finding solutions to real-world issues (Creswell, 2014; Hall, 2013; Shannon-Baker, 2016). This indicates that pragmatism promotes "action-oriented" research methodologies, making it ideal for this study (Cameron, 2011).

3.3 Research Approach

The study used a pragmatic methodology, and in particular, a sequential QUAN-QUAL mixed method design where both quantitative and qualitative methodologies were used simultaneously.

A mixed-methods methodology mixes post-positivism and interpretivism, interweaving qualitative and quantitative data in such a way that research concerns are meaningfully explained (Fetters, 2016), offering several advantages to tackling complex research issues. Additionally, it provides a logical foundation, methodological adaptability, and a thorough understanding of smaller cases (Maxwell, 2016). To put it another way, the use of mixed-methods enables researchers to respond to study questions in a suitable depth and breadth and aids in generalizing findings and implications of the studied topics to the entire population (Enosh, Tzafrir, & Stolovy, 2014). For instance, the quantitative technique enables a researcher to gather data from a large number of participants, increasing the likelihood that the results can be generalized to a larger population.

The qualitative approach, on the other hand, honors the voices of its participants and offers a better understanding of the problem under investigation. To put it another way, while quantitative data broaden the scope of the study, qualitative data give it depth. Additionally, qualitative and quantitative data can be cross-validated. By combining data from numerous sources, triangulation is a qualitative research technique that can be used to

generate a thorough grasp of a study problem or to test its validity (Carter *et al*., 2014). Therefore, by integrating two sets of strengths and at the same time making up for the flaws of each method, a mixed-methods design offers the best opportunity to provide answers to research questions (Johnson & Onwuegbuzie, 2004). In light of this, "mixed-method research designs are becoming increasingly pertinent to addressing impact research questions" (Saville, 2012, p. 7).

As detailed by Ivankova (2014), the researcher created and carried out a sequential QUANQUAL mixed-method design whereby there was an initial quantitative approach contrasted to a subsequent qualitative approach to ensure that the convergent parallel mixed-method process is methodical and rigorous.

In this sequential QUAN-QUAL mixed method design, the meta-inferences were developed based on an initial, more quantitative examination of the research problem and a subsequent, in-depth examination of the quantitative results using qualitative methods (Creswell & Plano Clark, 2011 as cited in Ivankova, 2014). When selecting individuals for qualitative follow-up interviews and/or observations to better understand the results from the initial statistical tests, the study strands were frequently connected (Ivankova *et al*., 2006 as quoted in Ivankova, 2014).

For its applicability and strengths in compiling, assessing, and integrating quantitative and qualitative research concurrently in a single study, the sequential QUAN-QUAL mixed method technique was chosen above the other mixed method approaches. Additionally, the sequential QUAN-QUAL mixed technique strategy allows for a deeper understanding of a study problem than each research approach can provide when used alone (Rahi, 2017).

Additionally, a cross-sectional survey approach was employed in the sequential QUAN-QUAL mixed method design to gather both qualitative and quantitative data that characterize, examine, and aid the researcher in understanding the problem at hand. To gather information from participants all at once in a short amount of time, a cross-sectional survey is preferred.

The design is a type of research design that provides a thorough explanation of every part of the investigation so that conclusions can be drawn. The goal of the study was to determine whether good communication increases the usage of climate-smart technologies and, as a result, improves agricultural productivity in West Pokot County.

3.4 Research Design

According to Creswell and Plano Clark (2007, p. 58), a research design is the "procedure for collecting, analyzing, interpreting and reporting data in research studies." It is the general strategy for linking the relevant (and doable) empirical research to the conceptual research concerns. In other words, the study design determines how the data will be collected, how it will be analyzed, and how it will be used to answer the research question (Grey, 2014). Three different types of study designs can be used, according to Robson (2002): exploratory, descriptive, and explanatory. His classification system is based on the study area's goals because each design has a distinct ultimate goal. For instance, a descriptive study's goal is to paint a picture of a scenario, person, or event or to demonstrate how various elements are connected and how they manifest organically (Blumberg, Cooper, and Schindler, 2005). Descriptive studies, on the other hand, are considerably more suited for an emerging or uncharted field of study because they do not

attempt to explain why an event occurred (Punch, 2005). As a result, explanatory or exploratory research strategies are advised when there is a surplus of descriptive information.

When there is not enough information available or a problem has not been properly identified, exploratory research is undertaken (Saunders *et al*., 2007). Instead of attempting to address the research issues definitively, it merely delves into the subject at various levels of complexity. As a result, its focus is on solving brand-new issues for which little to no prior study has been conducted (Brown, 2006). Even in the worst-case scenario, exploratory research establishes the first research design, sampling strategy, and data collection method while also serving as the foundation for more conclusive research (Singh, 2007).

This study focused on how communication can be a potent tool to drive effective and efficient execution of agricultural programs on climate-smart and communication interventions that can be put in place to improve the utilization of climate-smart agricultural technologies among farmers in West Pokot, Kenya. Not much information is available on this yet climate-smart agricultural technologies have the potential to bridge the information gap in the agricultural sector by effectively disseminating agricultural research information to farmers, thus, boosting their agricultural productivity. Since there is not enough information available on this study, an exploratory research design guided the study.

3.5 Study Area

The study was carried out in West Pokot County. 621,241 people are living in the County as per the most recent census in 2019. The Pokot community and the Sengwer minority community make up the majority of the population of West Pokot County, which has its administrative center in Kapenguria (West Pokot County, 2018). With more than 80% of the people engaged in agricultural and animal (livestock) keeping activities, these two sectors make up the County's core economy. The County has a total size of roughly 9,169.4 km2 and is located between the longitudes 34° 47' and 35° 49' East and the latitudes 1° and 2° North (West Pokot County, 2018). West, Central, North, and South are the four sub-counties that make up the county (West Pokot County, 2018).

The principal food crops produced include maize, beans, sorghum, finger millet, green grams, Irish potatoes, sweet potatoes, and bananas (West Pokot County, 2018). The farmers also cultivate horticultural crops, which include fruits (mangoes, pawpaw, oranges, tree tomato, and passion fruit) and vegetables both exotic and local (onions, cabbages, kales, pumpkins, sucha, cowpeas, saga, peas, and carrots, among others) (West Pokot County, 2018). Fruits and vegetables contribute immensely to food security as farmers use them for sustenance and generate income for households (Akuto, 2020).

Based on the 2019 census, the urban population accounts for only 8% of the total population in the County, making West Pokot one of the least urbanized counties in Kenya (KNBS, 2019). Being one of the least urbanized counties implies a lack of appropriate infrastructure to fuel communication and implement smart-climate projects in the County. West Pokot is also a beneficiary under the Kenya Climate Smart Project financed by the

World Bank and implemented by the Ministry of Agriculture, Livestock and Fisheries, and the 27 County Governments. This formed the rationale to conduct the study in the County since it will be convenient in generalizing other counties that are not urbanized.

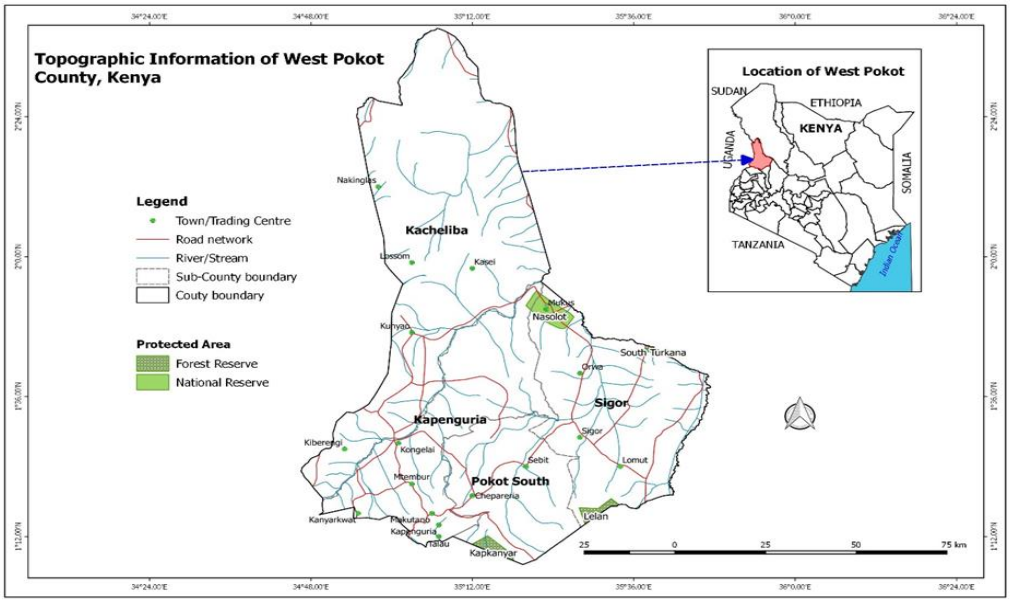


Figure 2.2 A map of West Pokot County, Kenya

Source: National Agriculture Research Survey

3.5 Target population

Population refers to a complete group of objects having common observable characteristics (Cooper & Schindler, 2014). The population often tends to have a wide geographical spread and, in most cases, the researcher is not necessarily interested in the entire or universal population (Kothari, 2004).

The target population for the quantitate data involved all farmers in West Pokot. According to the (2019) census, the county has a population of 621,241 with four constituencies, 20 wards, 16 divisions, 65 locations, and 224 sub-locations. The study targeted all the Sub-Counties in West Pokot including West Pokot, North Pokot, Central Pokot, and Pokot South.

The target population for the qualitative data included; County and National officers, County communication officers, representatives from KALRO, CGIARs, chosen universities, private research organizations, policymakers, NACOSTI, Communication experts, and Media representatives. The researcher targeted agriculture-based universities in Kenya. These include Egerton, Jomo Kenyatta University of Agriculture & Technology (JKUAT), and Moi University. The observation unit included county meteorological staff, county agricultural extension officers, County ICT personnel, representatives from KALRO, CGIARs, private research organizations, lecturers from chosen institutions, and policymakers from both national and county governments.

3.6 Sample Size and Sampling Technique

3.6.1 Sample Size

The sample size is a subset of the population (Creswell, 2014). It is an element selected to represent the complete population. It is a limited section that represents the entire population (Mugenda, 2008; Saunders *et al*., 2009). Several factors, such as; the type of target population, variability about time, costs, accuracy, and estimate required should be taken into consideration when determining a sample size for a study (Ramenyi, Williams, Money & Swartz, 2003). Sample sizes larger than 30 and less than 500 are appropriate for

most social research (Sekaran & Bougie, 2010). To address research questions/hypotheses, a decision was made on which target population was best to provide the information that is required in the study (Creswell & Clark, 2007).

3.6.1.1 Quantitate Sampling for Farmers

In practice, the sample size used in a study is based on the expense of data acquisition and the need to have sufficient statistical power. There is a need to specify the following sample size criteria to determine the suitable size of the sample: the precision level, the level of confidence of risk, and the variability degree in the attributes being measured (Fisher, 1992; Israel, 1992; Kothari, 2009; Mugenda & Mugenda, 2003). A formula for sample size determination may be derived to specify how much error is suitable as well as how much confidence is necessary (Alreck & Settle 1995; Fisher, 1992; Roscoe, 1975; Kothari, 2009; Mugenda & Mugenda, 2003; Weisberg & Bowen, 1977). A significance (or probability) level of 0.05 has been established as a commonly acceptable confidence level in the majority of the behavioral sciences. Roscoe (1975), Mugenda and Mugenda (2003), Kothari (2009), and Fisher (1992) recommended 10% as a "rule of thumb" acceptable level. Weisberg and Bowen (1977) cited 3% to 4% as the acceptable level in survey research for forecasting the results of the election.

According to the KNBS (2019) census, the county had a population of 621,241 with four constituencies, 20 wards, 16 divisions, 65 locations, and 224 sub-locations. In collecting quantitative data, the probability sampling approach was used. The farmers were grouped into clusters informed by sub-counties. From each Sub-County, farmers were randomly picked based on the total population of those living in the Su-County. Fisher's (1992)

formulae was then used to obtain the sample size of farmers who participated in the study, Mugenda (2003) and Kothari (2009):

$$\mathbf{n} = Z2\ (pq)\ d2$$

Whereby, n = the intended sample size if the targeted population is greater than 10000

Z= the standard normal derived at the required confidence level (The value for Z is found in statistical tables which contain the area under the normal curve).

d = the desired level of precision (an acceptable level of sampling error), p = the estimated proportion of an attribute that is present in the population, q = 1-p.

Using this formula, the researcher used 30% as the estimated proportion of the farmers in West Pokot to have the characteristics of interest and calculated the sample size (n) for the study using the desired confidence level of precision (d) of 5% (0.05) and the Z- statistics of 1.96 (at a generally acceptable level of 95% confidence level) as illustrated by the formula;

$$\mathbf{n} = 1.962 \text{ x } 0.3 \text{ x } 0.7\ 0.052 = \mathbf{494}$$

Therefore, the calculated sample size for this research is 494 farmers in West Pokot County. Therefore, the total sample size of the respondents (farmers) that will be targeted is 494 farmers in West Pokot County, Kenya.

3.6.1.2 Sampling for Key Informant Interview

Respondents from key informant interviews were sampled using purposive sampling. The respondents were chosen based on their awareness of the function of communication in the use of climate-smart agriculture among West Pokot inhabitants. County agricultural officers, FAO, KALRO, KCSAP, a lecturer from the University of Nairobi, MoALF&C, Ministry of Agriculture, Irrigation, and Pastoral Economy Pokot South, International Service for the Acquisition of Agri-biotech Applications (ISAAA) AfriCenter, IITA, FAO, and AATF were purposively sampled for this study.

The sample size was distributed proportionally among the four Sub-Counties, as shown in Table 3.1.

Table 3.1 Distribution of Sample Size in West Pokot County

Sub-County	Population	Sample Size
West Pokot	155,310	148
North Pokot	150,500	148
Central Pokot	200,100	105
Pokot South	115,350	93
Total	**621,260**	**494**

Source: Author 2023

In addition to the farmers, 29 key informants were sampled from the following organizations; County Government of West Pokot, 5; Ministry of Agriculture, Livestock, and Cooperatives, 4; Food Agricultural Organization (FAO), 2; Kenya Agricultural and

Livestock Research Organization (KALRO), 3; The Kenya Climate Smart Agriculture Project (KCSAP), 2; National Biosafety Authority, 2; Media representative, 3; University of Nairobi, 1; Mt. Kenya University, 1; Consultative Group for International Agricultural Research, 4 and International Livestock Research Institute (ILRI), 2.

Table 3.2 Sample Distribution of Key Informants

Institution	Count
County Government of West Pokot	5
Ministry of Agriculture, Livestock, and Cooperatives	4
Food Agricultural Organization (FAO)	2
Kenya Agricultural and Livestock Research organization (KALRO)	3
The Kenya Climate Smart Agriculture Project (KCSAP)	2
National Biosafety Authority	2
Media representative	3
University of Nairobi	1
Mt. Kenya University	1
Consultative Group for International Agricultural Research	4
International Livestock Research Institute (ILRI)	2
Total	**29**

Source: Author 2023

3.6.2 Sampling Techniques

Sampling is the systematic method of selecting individuals for research to reflect a larger population from which they were drawn (Gay, 1987). A sampling strategy is a framework that is used to aid in sample selection (Mugenda, 2008). A sampling procedure is the formulation of the rules that specify how the system calculates sample size. The technique includes information on the value of an inspection feature as well as the recording of the results (manual, variable, attributive, and so on). Sampling procedures were typically used at the characteristic level of a material specification or task list.

The respondents for quantitative data were chosen using cluster random sampling and purposive sampling methods. Farmers in West Pokot County were divided into four clusters based on the four Sub-Counties. Simple random sampling was used to choose specific respondents in each cluster (Sub-County) using a computerized random procedure. Respondents (farmers) were chosen at random from each cluster (Sub-County) until the number of participants from the Sub-County was reached.

Purposive sampling is also known as judgmental sampling since the respondents from the public are chosen at the convenience of the researcher (Rahi, 2017). The primary goal of a purposive sample was to generate a sample that could be reasonably presumed to reflect the population. The researcher chose 29 key interviewees from various agricultural institutions/organizations on purpose. The key informants chosen were thought to have appropriate experience with agricultural information transmission and the use of climate-smart technology in West Pokot County. Key people who lead agricultural institutions and key communication personnel for organizations were chosen at random from among the many agricultural institutions/organizations based on their positions and knowledge of the topic under study. In-depth interviews were conducted with carefully selected key informants to gain a better understanding of communication and the use of climate-smart technologies.

3.7 Data Collection Instruments

The research was based on primary data. According to Kothari (2004), primary data is new material gathered in its original form. The primary data for this study was collected by administering questions guided by questionnaires using an online data kit app and

conducting in-depth interviews guided by guides. To collect data quantitative data, the researcher development an online questionnaire that was designed through the ODK, an automated data collection kit (ODK) app-based questionnaire containing a mix of open-ended and closed-ended questions was used.

The Open Data Kit (ODK) is a collection of open-source applications that allow you to create a questionnaire form in the form format, upload it to a server, fill it out on a mobile phone or tablet running the Android operating system, store and view the aggregated data on the central server, and retrieve the aggregated data to your computer for analysis (Jeffrey-Coker, Basinger, and Modi, 2010). The questionnaire was created with the Kobo toolbox and then linked to ODK. Enumerators were then selected and trained on how to collect data through ODK and to understand the questions. The ODK was convenient as the researcher was able to monitor the data that was collected daily from my server.

3.7.1 Questionnaires

An online questionnaire was used to collect primary data from the 494 farmers in West Pokot County who were sampled. A questionnaire, according to Mugenda (2008), is a data-gathering and measuring instrument that details a group of questions in sections in a specified order in a written form. According to Kothari (2004), the benefits of questionnaires are as follows: they are low cost with a large population and extensive geographical coverage, they are free of interviewer bias, they provide respondents with adequate time for well-thought-out responses, and they are ideal because unapproachable respondents can be easily reached. With a focus on the benefits and the necessity to collect

data from a wide population, enumerators in West Pokot County distributed online surveys directly to farmers.

The information gathered through surveys was mostly quantitative, with a few qualitative (open-ended) questions thrown in for good measure. Closed-ended queries are more likely to convey the same idea. Furthermore, closed-ended questions are more efficient and cost-effective to administer in large-scale surveys. The majority of the closed-ended questions used a Likert scale, with respondents asked to rate themselves on a range of 1-5, with 5 being highly agree, 4 agree, 3 neutral, 2 disagree, and 1 strongly disagree.

The qualitative questions in the online questionnaire were designed to supplement some of the quantitative questions and provide insight into people's attitudes, behaviors, and values toward communication and how they influence the use of climate-smart technologies in West Pokot County. This means that both quantitative and qualitative methodologies were used concurrently during the delivery of the questionnaire.

3.7.2 In-depth interview guides

Kumar (2012) defined an interview as any encounter between two or more people for a specific goal. Interviews can engage in both verbal and nonverbal communication, provide accurate information, and allow for greater flexibility in question delivery (Wilson, 2010). In contrast to using a questionnaire, its completion is immediate and straightforward. However, conducting interviews can be difficult in terms of setting up the venue, administering the interview, and transcribing. Data analysis from an interview schedule takes time and is subjective (Grimshaw, 2016). Bryman (2012) agrees, arguing that

interview schedules take time and that the quality of data collected is governed by the quality of contact.

The interview guide was used to conduct in-depth interviews with 29 carefully chosen key informants from various agricultural institutions/organizations (see Table 3.2). According to Burton (2004), in-depth interviews are especially effective for learning the story behind a participant's experiences. To direct the interviews with the main informants, open-ended questions were developed. The key informants were critical in providing further information on the impact of communication on farmers' use of climate-smart agriculture in West Pokot.

To reduce bias during the interview, the researcher used a structured interview in which she asked a planned series of questions using the same wording as in the interview schedule (Kumar, 2012). As a result, only 29 important informants from various agricultural institutions/organizations were questioned, according to the interview schedule shown in Appendix I.

3.8 Data collection procedure

Before administering the instruments, the researcher obtained authorization to perform the research from NACOSTI and the University via a letter of authority. This increased respondents' confidence that the information provided will be used just for academic reasons and not for any other purpose. The researcher recruited and trained eight (4) research assistants (RAs), one in each of West Pokot County's four Sub-Counties, to assist in administering questionnaires to the 494 sampled farmers and conducting in-depth interviews with the 29 carefully selected key informants. The face-to-face method was

used, with professional enumerators assisting in administering online questionnaires and performing in-depth interviews.

The research assistants discussed the goal of the study and what was anticipated of the respondents before giving the questionnaire. Respondents were guided through illustrated answers to ensure that they understood the questions and responded appropriately. The researcher informed respondents that the material provided was just for academic purposes and that no other parties would have access to it. The researcher scheduled appointments with the main informants for the in-depth interviews. The respondents were then emailed an online interview guide for their convenience, which simplified their replies. This was followed by phone interviews in which the interaction was taped.

Because of the constraints imposed to manage the COVID-19 pandemic, there has been an increase in online survey-based research due to their capacity to collect data more easily and quickly than traditional techniques. The study was carried out during a time when the COVID-19 virus was on the rise in Kenya, and one of the rules put in place by Kenya's Ministry of Health (2020) was social distancing and limited travel. In this scenario, the researcher recommended sending the interview guide online, followed by a recorded phone call to help limit the spread of COVID-19.

When compared to other methods of data collection, such as physically meeting the person, sending an interview guide, and following it up with a phone call provided a more cost-effective and faster method of data collecting (Hlatshwako *et al*., 2021). The researcher

was able to obtain the connections of the main informants through their profiles and other persons who work with them at the same place.

During the data collecting process, the researcher and one of the research assistants met at the end of each day of data collection to double-check the data collected from the ODK questionnaires and interview replies, as well as report any difficulties encountered. Their comments will focus mostly on the time required to give questionnaires/interviews with various respondents; the respondents' attitude when responding to questions; and issues of bad weather circumstances. This will aid in developing solutions to the difficulties in preparation for the next day of data collection.

3.9 Pilot test

A pilot test, according to Kombo and Tromp (2009), is the duplicate and preparation of the main study. A pilot study or test, according to Kothari (2004), is a small-scale version or trial run conducted in preparation for a major study. Pilot testing was conducted to improve the precision and applicability of the examination outline and apparatus (Saunders, Lewis, & Thornhill, 2012). It improves the questionnaire so that respondents have no trouble marking their responses and recording the information. Furthermore, it enables one to obtain some assessment of the validity of the question and the reasonable dependability of the information that will be acquired (Saunders, Lewis, & Thornhill, 2012).

A pilot study was conducted for this study to ensure the validity and reliability of the research tools in gathering the necessary data. The pilot test should consist of 5% to 10% of the intended sample size, according to the rule of thumb (Cooper & Schilder, 2014;

Harper, 2012). As a result, the study used 10% of the sample size for piloting, resulting in 18 questionnaire respondents and 2 key informants for in-depth interviews.

According to Mugenda (2008), pilot research participants should not be included in the sample size of the real data collection. According to Mugenda, the pilot study was carried out in Baringo County, which has similar features to West Pokot County. A random sample of 18 farmers and two key informants from the Ministry of Agriculture and FAO were chosen to participate in the pilot project. The pilot study data was statistically examined to ensure the validity and reliability of the research tools.

3.9.1 Validity of research instrument

The validity of a questionnaire determines whether it measures what it is supposed to assess or how honest the research results are (Golafshani, 2003). According to Kimberlin and Winterstein (2008), validity is defined as the precision and seriousness of inductions based on the findings of the inquiry. To ensure content authenticity, the online questionnaire and interview guides were thoroughly reviewed by the proposal development supervisors and agricultural experts. Supervisors and agricultural experts from the County agricultural officers, FAO, KALRO, KCSAP, a lecturer from the University of Nairobi, MoALF&C, Ministry of Agriculture Irrigation and Pastoral Economy Pokot South, International Service for the Acquisition of Agri-biotech Applications (ISAAA) AfriCenter, IITA, FAO, and AATF assessed the questionnaire and interview guides for relevance. Based on their judgment, the instrument was appropriately changed before the final data collection activity. As a result, the content and construct validity were achieved with the assistance of the supervisors and specialists who would countercheck the research

instruments to ensure that the information contained inside was sufficient and justifiable for the study.

3.9.2 Reliability of instrument

Cronbach (1951) defines reliability as the consistency of estimation, or how much an instrument measures in the same way each time it is used under the same conditions with related people. The Cronbach alpha coefficient was determined to assure reliability. Cronbach Alpha was used to assess the internal consistency of questionnaire items (Carmines & Zeller, 1979). According to Morse, Barrett, Mayan, Olson, and Spiers (2002), reliability is the degree to which an experiment or any measuring process produces the same results on repeated trials. Any measure is regarded as legitimate if it can measure what it is designed to measure (Stellmack, Konheim-Kalkstein, Manor, Massey, & Schmitz, 2009). According to Taber (2018), Cronbach's alpha values of the items included in the study should not be less than 0.8. Cronbach alpha should not be less than 0.7, according to Gliem and Gliem (2003), and it should be greater than 0.7. Cronbach's alpha correlation coefficient was used to assess the reliability of the questionnaire in the study. The better the internal consistency and reliability, the closer Cronbach's alpha is to 1. As a result, only Cronbach alpha coefficients of 0.7 and higher were judged appropriate in this investigation.

Analysts frequently use 0.7 as a benchmark value for Cronbach’s alpha. At this level and higher, the items are sufficiently consistent to indicate the measure is reliable. Typically, values near 0.7 are minimally acceptable but not ideal. Extremely high values can indicate that the questions are redundant. For example, if respondents always give the same

response to two items, you might be able to remove one of them (Stellmack, Konheim-Kalkstein, Manor, Massey, & Schmitz, 2009).

3.10 Data Processing and Analysis

The process of transforming raw data into a legible format that can be processed, analyzed, and used is known as data processing (Chakravarthy& Jiang, 2009). Furthermore, Mugenda & Mugenda (2003) define data analysis as the process of giving order, structure and meaning to a large amount of information. Data editing/cleaning was performed on completed questionnaires and interview guides obtained from the field, preparing the data for coding and analysis (Zikmund *et al*., 2013).

The questionnaire data was sorted and coded by the study's objectives. The data was analyzed and displayed in statistical distribution figures and tables using the Statistical Package for the Social Sciences (SPSS) version 25.0. The SPSS software facilitates data processing and can create a variety of outputs, which was critical for the study. The questionnaire quantitative data was examined using descriptive and inferential statistical techniques.

3.10.1 Descriptive Statistics

Descriptive statistics enabled the researcher to characterize and summarize data using metrics that an observer might easily understand (Healey, 2011). Frequencies, percentages, averages, and standard deviations are used to summarize data in simpler, more intelligible terms. The findings were displayed in the form of charts, tables, and graphs.

3.10.2 Inferential statistics

The inferential statistics that were conducted included correlation and linear regression models. The two inferential statistics determined the relationship between each of the independent variables with the dependent variable. A regression analysis of Variance (ANOVA) was conducted to establish whether the whole regression models are substantially fit for the data. The regression equation that was used to test the statistical significance of the relationship between independent and dependent variables of the study hypotheses is:

$$Y= \beta_0 + \beta_1X_1+ \beta_2X_2+ \beta_3X_3+ \beta_4X_4+ \beta_5X_5+ \beta_6X_6 +\varepsilon$$

Where:

Y = Utilization of climate-savvy agricultural technologies

X_1= Principles of communication

X_2= Types/Methods of communication

X_3= Adoption of climate-wise technologies

X_4 = Communication barriers

X_5 = Role of communication

X_6 = Communication interventions

β_0, β_1, β_2, β_3, β_4, β_5, β_6= Regression coefficients of changes included in Y by each X value

ε= Error term, which ordinarily is distributed with a mean and variance of zero.

The Statistical Package for the Social Sciences (SPSS) was used to organize, code, analyze information, and generate the quantitative report.

3.10.3 Diagnostic Tests

Before executing a regression model, pre- and post-estimation tests were performed. Normality tests, linearity tests, multicollinearity tests, and heteroscedasticity tests were among those administered.

3.10.3.1 Normality Tests

A histogram was used to determine if the data provided by the dependent variable was normally distributed to determine the normality of the use of climate-smart agricultural technologies as a dependent variable (Hussey & Hussey, 1997). The normality assumption (ut N (0, 2) was necessary to perform single or combined tests on the model parameters. To ascertain if the data was distributed regularly, two alternative methodologies were used. In the beginning, normal probability plots were used; if the plots systematically departed from a straight line, the data was not normally distributed (Das & Imon, 2016).

However, it was discovered that the data was regularly distributed if the plots were slightly close to the line. Second, since it may not always be possible to tell if the data are normally distributed by simply looking at the scatter plot, Bera and Jarque's (1981) tests for normality will be carried out. The study provided an answer to the research issue that the disturbances are not distributed properly. The research questions have been resolved if the p-value is less than 0.05. If the data were not evenly distributed, a nonparametric test was the most appropriate.

3.10.3.2 Linearity Test

According to Luukkonen, et al. (2008), linearity assesses how strongly a dependent variable and one or more independent variables are correlated. The primary objective of the linearity test is to locate variables that significantly predict the outcome variable (Rao & Gabr, 2010). The study will employ the linearity test to assess whether the independent and dependent variables have a linear relationship. The linearity was examined using the graphs.

3.10.3.3 Multicollinearity test

The occurrence of correlations between predictor variables is referred to as multicollinearity (Katrutsa & Strijov, 2017). Multicollinearity inflates standard errors and confidence intervals, resulting in unstable coefficient estimates for individual predictors. The variance inflation factors (VIF) were used in this work to assess multicollinearity. The presence of multicollinearity is indicated by a VIF greater than 5 and a tolerance less than 0.2 when using the VIF approach (Runkle, et al. 2013; Katrutsa & Strijov, 2017).

3.10.4 Analysis of Qualitative Data

The analytical process includes making meaning of the qualitative information from interviews and open-ended questions (Creswell, 2009). Thematic analysis was utilized to examine qualitative information from key informant interviews in-depth and open-ended questionnaire questions. Theme analysis is one of the methods for data analysis that is most frequently employed in qualitative data, according to Jwan and Ong'ondo (2011). It is a method for finding patterns (themes) in data and reporting those (Braun & Clarke, 2006).

Based on the objectives and open-ended questions of the study, thematic analysis categorized and elaborated the data. Because of its versatility in providing a rich and complete yet complex account of data, thematic data analysis was chosen for qualitative data in this study.

Thematic analysis's adaptability enables the researcher to identify themes. According to Braun and Clarke (2006), a theme captures a significant aspect of the data about the research question and denotes a certain degree of patterning or meaning in the data. The systematic process of transcribing, compiling, editing, coding, and reporting the data in a way that makes it understandable and accessible to the reader and researcher for interpretation and discussion is known as thematic data analysis in qualitative data, according to Jwan and Ong'ondo (2011).

These stages are not all exclusive to thematic analysis because some phases of thematic analysis resemble phases of other qualitative research (Braun and Clarke, 2006). The process starts when the analyst observes and looks for significant pattern patterns and potential relevant subjects in the data; this could happen during data collection. The endpoint is the reporting of the content and significance of data patterns (themes), where themes are abstract (and usually ambiguous) structures that investigators identify before, throughout, and after analysis. In the subsections that follow, each phase of the thematic data analysis approach is described in depth.

3.10.4.1 Transcribing and Checking

The primary data sources for this study were field notes and transcripts of audio phone-recorded interviews. The transcripts were accurate and represented the main informant

records because the data was verbatim transcribed, which denotes that the recordings were entirely typed out. The most important portions of transcription included paying close attention to the participants' statements, typing up all of the audio from the phone interviews, carefully listening to the recordings again, and proofreading the transcript.

Whatever the read-aloud readability of the transcript, all audio recordings will be faithfully transcribed. Lines of text will be numbered. Anonymize the transcript so that the participant cannot be identified from anything said (for example, names, places, significant events), add notations for pauses and laughter, and insert any punctuation, such as commas and full stops (periods) after the researcher has read the transcription while listening to the recording.

Make sure to double-verify that transcripts are accurate and contain everything about the interview, including pauses, punctuation, and nonverbal information, to aid in interpretation. The researcher must become fully immersed in the data and 'experience' it to interpret it. The researcher will look for significance and key patterns in the transcripts over the incubation phase to compile reliable and meaningful findings. To better understand the data, the researcher will also become familiar with it by carefully reading and rereading transcripts. All interviews will be recorded and then verbatim transcribed by the researcher.

3.10.4.2 Reading Between the Lines

The researcher will get a feel of the participant's experience with the phenomenon at hand during the aforementioned transcription process, and they will start to think about topics that could be covered in additional interviews or focus groups (if appropriate). In this way, the story of one person will inform the story of the next, and so on. The researcher will

interview participants in this way until no more information is obtained, or, as the textbooks put it, "saturation is reached." It will be crucial to take into account both what the participants will say and what they will not say while carrying out the coding and theming processes. Is a protracted silence, for instance, a sign that the participant is having trouble understanding the topic, or is the person simply pondering what to say? The intention is to communicate participant stories using examples from their narratives throughout the data gathering and presentation process, grounding the study findings in the participants' own experiences.

Smith (1996) asserts that there are two key principles involved in reading between the lines: first, the researcher must make an effort to understand the meaning that people attribute to their lived experiences, and second, the researcher must make an effort to interpret this meaning in the context of the research. The researcher has a lot of latitude in interpreting the participant's experiences because he or she has some knowledge and expertise in the research topic. Larkin and colleagues (2006) talked about how it's important to go beyond merely retelling what participants say. Instead, interpretive phenomenological analysis focuses on digging beneath the surface of what someone is saying to completely understand the world from their perspective.

3.10.4.3 Familiarizing with the Data

After all of the transcriptions have been completed, the researcher will go over all of the transcribed data to ensure that it accurately reflects the content of the interviews. Where there is ambiguity, the researcher will listen to the interviews again, comparing them to the transcriptions to check that what has been transcribed is correct. This will be quite helpful

for the researcher to become acquainted with the data. At this point, the researcher will tidy up the material by removing extraneous words or phrases, such as repeats.

3.10.4.4 Coding

Once all of the research interviews have been transcribed and validated, coding can begin. Coding is an aspect of analysis since it organizes data into meaningful categories. Field notes taken during an interview will be a useful complementary source of information to aid in this process, as the time lag between interviews, transcription, and coding can result in memory bias regarding nonverbal or environmental context issues, which may affect data interpretation. The identification of subjects, issues, similarities, and contrasts disclosed by the participants' narratives and interpreted by the researcher is referred to as coding. This is an open coding approach for establishing categories and abstraction. For this study, the researcher will closely examine what emerges from the data and assign as many labels as necessary. Then, a coding sheet will be created to collect the labels and cluster them in preliminary groups depending on interpretation. The following step is to group related or dissimilar categories into broader higher-order groups.

Content-characteristic terms will be used to name each group. The researcher will then employ abstraction by developing a basic description of the phenomenon under investigation: subcategories with similar events and information will be brought together as categories, and categories will be grouped as primary categories.

3.10.4.5 Theming

The term "theming" refers to the grouping of subcategories/categories with related events and content. The significance of going through this procedure is that at the end, you will be able to present the facts from the interviews using quotations from the individual transcripts to show where the researchers' opinions came from. As a result, when the findings are grouped for presentation, each topic might serve as the header for a portion of the report or presentation. Each topic will have the codes, instances from the transcripts, and the researcher's assessment of what the themes signify beneath it. Real-world implications will also be discussed. The codes will be sorted into potential themes, which will then be polished by ensuring that each theme has a consistent pattern. The themes will be validated against the entire data set to ensure that they accurately and completely represent what will be in the data. This will necessitate numerous trips back to the original data. The themes will then be organized according to the research questions for descriptive analysis and reporting. Reporting will take the form of descriptive tables and narratives comprised of quotes from respondents.

3.11 Ethical Considerations

The term "theming" refers to the grouping of subcategories/categories with related events and content. The significance of going through this procedure is that at the end, you will be able to present the facts from the interviews using quotations from the individual transcripts to show where the researchers' opinions came from. As a result, when the findings are grouped for presentation, each topic might serve as the header for a portion of the report or presentation. Each topic will have the codes, instances from the transcripts,

and the researcher's assessment of what the themes signify beneath it. Real-world implications will also be discussed. The codes will be sorted into potential themes, which will then be polished by ensuring that each theme has a consistent pattern. The themes will be validated against the entire data set to ensure that they accurately and completely represent what will be in the data. This will necessitate numerous trips back to the original data. The themes will then be organized according to the research questions for descriptive analysis and reporting. Reporting will take the form of descriptive tables and narratives comprised of quotes from respondents.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.0 Introduction

This chapter presents the findings of the study, analysis of data and presentations of major findings. The general objective of the study was to explore how communication has influenced utilization of climate smart agriculture among farmers in West Pokot County, Kenya, thus, in enhancing agricultural productivity. The study explored communication as a potential tool in the utilization of climate smart agriculture by examining the concepts of communication and knowledge dissemination by agricultural researchers, extension officers/agents and value chain actors. The research hypotheses that were tested include;

H_{01}. The types of communication used by agricultural researchers/officers in dissemination of information to farmers about climate smart agriculture do not influence the utilization of climate smart technologies in West Pokot County.

H0. The types of communication used by agricultural researchers/officers in dissemination of information to farmers about climate smart agricultural technologies influence the utilization of climate smart technologies in West Pokot County.

H_{02}. The extent to which farmers have adopted and applied climate smart technologies based on information received from agricultural researchers/officers have significantly influenced utilization of climate smart agricultural technologies in West Pokot County.

H_{02}. The extent to which farmers have adopted and applied climate smart technologies based on information received from agricultural researchers/officers does not influence utilization of climate smart agricultural technologies in West Pokot County.

H_{03}. The barriers of communication in dissemination of information to farmers about climate smart technologies significantly influence the utilization of climate smart agricultural technologies in West Pokot County.

H_{03}. The barriers of communication in dissemination of information to farmers about climate smart technologies has no significant influence to the utilization of climate smart agricultural technologies in West Pokot County.

H_{04}. The interventions of communication put in place significantly influenced the utilization of climate smart agricultural technologies among farmers in West Pokot County.

H_{04}. The interventions of communication put in place does not influence the utilization of climate smart agricultural technologies among farmers in West Pokot County.

4.1 Demographic Information

4.1.1 Gender of the respondents

The field data established that 262(53%) of the respondents are male while 232(47%) of the respondents are female. During the research, it was found out that female was mostly available within the homestead while men were a way looking for pasture for their cattle

since it was dry season. It was also found out that women are more involved in crop farming than men.

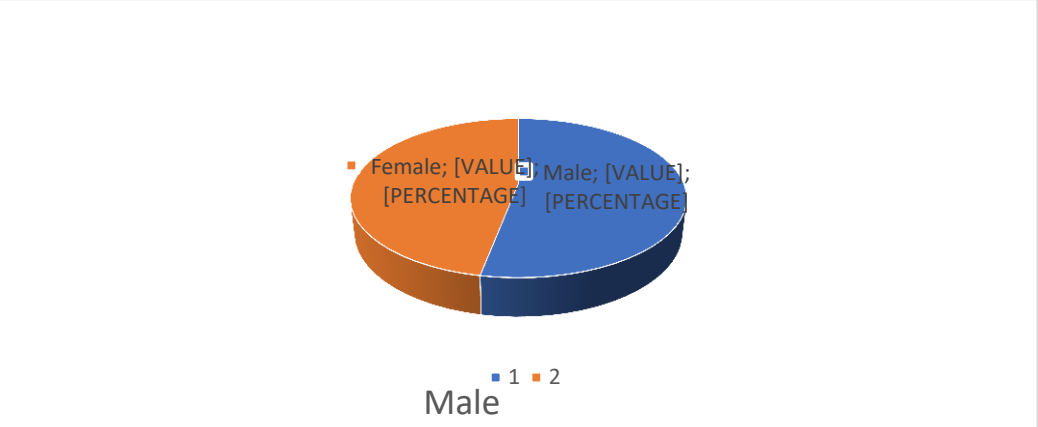


Figure 4.1 A pie-chat showing Gender of the respondents

4.1.2 Education level

The majority of the respondents, 26.1% had not attained any level of education followed very closely by primary education at 24.9%, secondary at 22.7%, certificate at 13.6% and diploma at 9.3%. However, the smallest number of the respondents had attained undergraduate and master's level as indicated by 3% and 0.4% respectively.

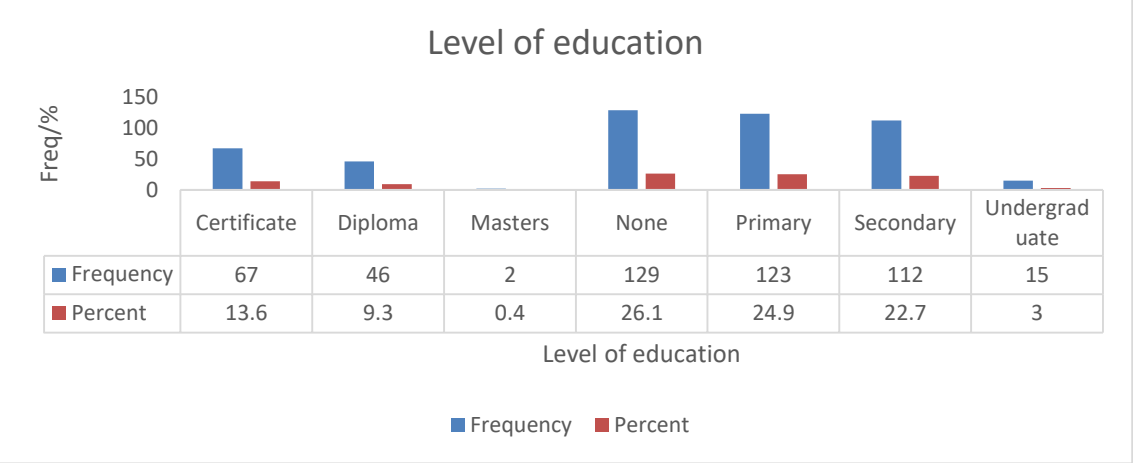


Figure 4.2 A bar graph showing Education level of the respondents

4.1.3 Research Sites

21.3% of the respondents were drawn from central Pokot, 30% from North Pokot, 18.8% from Pokot South, and 30% from West Pokot. According to the 2019 census, the county has a population of 621,241 with four constituencies, West Pokot 155,310, North Pokot150,500, Central Pokot 200,100 and Pokot South 115, 350. From the census (2019), Pokot South has the smallest number in terms of population and that's why 18.8% of the respondents were picked. While in central Pokot, the majority of the population are pastoralist and most of them were not available and that's why 21.3% of the respondents were involved in the study.

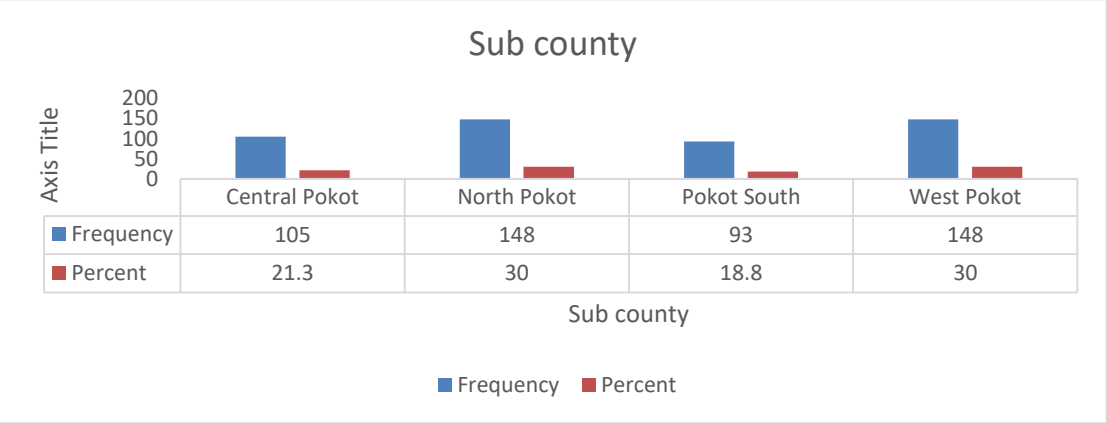


Figure 4.3 A bar graph showing Research sites

4.1.4 Duration of stay

The majority (71.7%) had stayed in their respective sub counties for more than 20 years followed by 16-20 years at 13.4% then 11-15 years which accounted for 8.7%. The minority had stayed there for between 5-10 years and below 5 years as shown by 4.9% and 1.4% respectively. This justify that majority of the respondents has stayed are natives of West Pokot.

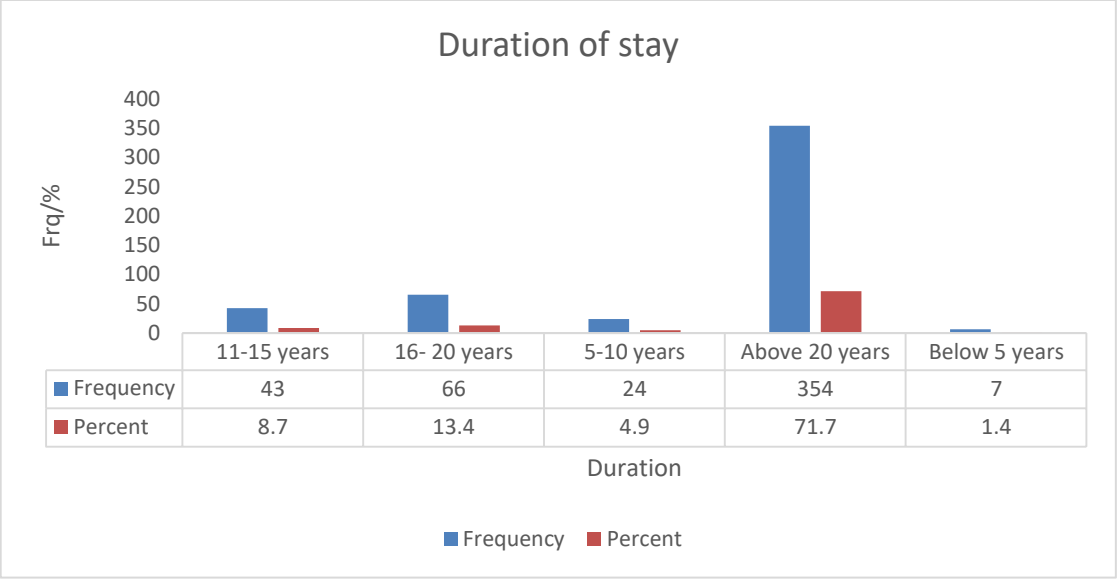


Figure 4.4 A bar graph showing Duration of stay in West Pokot

4.1.5 Main Agricultural Practice * Sub County Cross Tabulation

The majority (78.5%) of farmers reported to be practicing mixed farming. A chi square test of dependence found that there is significant relationship between the Sub counties and main agricultural activity ($X^2 = 29.246^a$, $p<0.001$.

Table 4.1 Main Agricultural Practices in West Pokot

			Sub-County				
			Pokot Central	**Pokot North**	**Pokot South**	**West Pokot**	**Total**
Main Agricultural Activity	Crops Farming	Count	14	13	18	11	**56**
		%	2.8%	2.6%	3.6%	2.2%	**11.3%**
	Livestock Farming	Count	13	26	7	4	**50**
		%	2.6%	5.6%	1.4%	0.8%	**10.1%**
	Mixed Farming	Count	78	109	68	133	**388**
		%	15.8%	22.1%	13.8%	26.9%	**78.5%**
Total		**Count**	**105**	**148**	**93**	**148**	**494**
		%	**21.3%**	**30.0%**	**18.8%**	**30%**	**100%**

Chi-Square Tests	**Value**	**Df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	29.246[a]	6	**.**000
Likelihood Ratio	30.457	6	.000

Source: Author 2023

4.1.6 Key informants' information

From the key informant interview, 29 respondents were interviewed, among them 13 were from the County government, 3 were from WAO, 3 were from KALRO, 2 from KCSAP and one person was interviewed from the following organizations; University of Nairobi, MoALF&C, Ministry of Agriculture, Irrigation and Pastoral Economy, Pokot South, International Service for the Acquisition of Agri-biotech Applications (ISAAA) AfriCenter, IITA, FAO and AATF

From the 29 respondents who were interviewed as key informants, 10 were Ward Agriculture officers, 7 were Ward agriculture extension officers, 2 were ADCC and one person was interviewed from the following positions; Animal health officer, Associate Professor, Corporate Communications Officer, Information & Communication Specialist, Member, P.I.A, Program Associate, Programme Officer, Regulatory Affairs and Scientist.

4.2 The Role of Communication in the Utilization of Climate Smart Agriculture

Whether there has been increased utilization of Climate Smart agriculture among farmer s in West Pokot County 42(8.5%) strongly disagreed, 60(12.1%) disagreed, 77(15.6%) were neutral, 192(38.9%) agreed while 123(24.9%) strongly agreed. A mean of 3.6 indicate that the majority of the respondents agreed there has been increased utilization of Climate Smart agriculture among farmers in West Pokot County.

When asked whether effective communication about Climate Smart agriculture has enhanced accessibility of the technologies by farmers in West Pokot, strongly disagree

were 45(9.1%), Disagree 75(15.2%), Neutral 112(22.7%), Agree 168(34.0%) and strongly agree 94(19.0%). There was agreement as shown by a mean of 3.4.

Concerning communication about climate smart agriculture is reliable hence enhanced utilization of the technologies among farmers in West Pokot 50(10.1%) strongly disagreed, 102(20.6%) disagreed 101(20.4%) were neutral, 150(30.4%) agreed while 91(18.4%) strongly agreed. A mean of 3.3 indicate agreement among the farmers.

A mean of 3.6 shows the majority agreed with the statement effective communication to farmers about climate smart agriculture has improved agricultural productivity in West Pokot County. This was further reported by 34(6.9%) strongly disagreed, 50(10.1%) disagreed, 111(22.5%) neutral, 168(34.0%) agreed and 131(26.5%) strongly agreed. The results are summarized in table 4.2.

Table 4.2 Showing data from the respondents on the role of communication in the Utilization of climate smart agriculture

Statement	1 SD	2 D	3 N	4 A	5 SA	M
Generally, there has been increased utilization of Climate Smart agriculture among farmers in West Pokot County.	42	60	77	192	123	3.6
	8.5%	12.1%	15.6%	38.9%	24.9%	
Effective communication about climate smart agriculture has enhanced accessibility of the technologies by farmers in West Pokot	45	75	112	168	94	3.4
	9.1%	15.2%	22.7%	34.0%	19.0%	
Communication about climate smart agriculture is reliable hence enhanced utilization of the technologies among farmers in West Pokot	50	102	101	150	91	3.3
	10.1%	20.6%	20.4%	30.4%	18.4%	
Personalized agricultural advice about climate smart agriculture has enhanced the utilization of the technologies among farmers in West Pokot	49	73	100	179	93	3.4
	9.9%	14.8%	20.2%	36.2%	18.8%	
Overall, effective communication to farmers about climate smart agriculture has improved agricultural productivity in West Pokot County	34	50	111	168	131	3.6
	6.9%	10.1%	22.5%	34.0%	26.5%	

Personalized agricultural advice about climate smart agriculture has enhanced the utilization of the technologies among farmers in West Pokot as evidenced by a mean of 3.4. from the farmers, 49(9.9%) strongly disagreed, 73(14.8%) disagreed, 100(20.2%) were neutral, 179(36.2%) agreed while 93(18.8%) strongly agreed.

4.3 Principles of Communication to enhance Utilization of Climate Smart Agriculture

Table 4.3 Showing data from the respondents on the principles of communication to enhance utilization of climate smart agriculture

Statement	1 SD	2 D	3 N	4 A	5 SA	M
Communication about climate smart agriculture is one-way aiming at just sharing information, i.e., farmers are basically included by just being informed about the technologies.	82 16.60%	55 11.10%	38 7.70%	140 28.30%	179 36.20%	3.6
Communication about climate smart agriculture is one-way with a stronger emphasis on getting feedback, i.e. farmers are allowed to provide their input on climate smart technologies but do not have a significant say in the decision-making process	74 15.00%	85 17.20%	131 26.50%	138 27.90%	66 13.40%	3.1
Communication about climate smart agriculture is two-way between farmers and agricultural officers/agents, thus, supporting open interaction in decision making on appropriate climate smart technologies.	105 21.30%	83 16.80%	87 17.60%	110 22.30%	109 22.10%	3.1

Whether communication about climate smart agriculture is one-way aiming at just sharing information, i.e., farmers are basically included by just being informed about the technologies 82(16.60%) strongly disagreed, 55(11.10%) disagreed, 38(7.70%) were neutral, 140(28.30%) agreed and 179(36.20%) strongly agreed. The majority agreed as indicated by a mean of 3.6.

With a mean of 3.1, the majority were neutral on the statement communication about climate smart agriculture is one-way with a stronger emphasis on getting feedback, i.e., farmers are allowed to provide their input on climate smart agriculture but do not have a significant say in the decision-making process. This is further shown by 74(15.00%) strongly disagree, 85(17.20%) disagree, 131(26.50%) neutral, 138(27.90%) agreed while 66(13.40%) strongly agreed.

Regarding whether communication about climate smart agriculture is two-way between farmers and agricultural officers/agents, thus, supporting open interaction in decision making on appropriate climate smart technologies, 105(21.30%) strongly disagreed, 83(16.80%) disagreed 87(17.60%) neutral, 110(22.30%) agreed while 109(22.10%) strongly agreed. The majority were neutral as shown by a mean of 3.1.

According to the research study, consistent messaging helps the public manage their feelings of self-efficacy, reassurance, and doubt (Reynolds & Seeger, 2005). By doing this, successful communication is ensured throughout, particularly when engaging the audience in conversation (Bruine de Bruin & Bostrom, 2013; Reynolds & Seeger, 2005). Messages that are constant and regular are also seen as more credible than those that are irregular (Clampitt, 1991 in Coombs, 2019).

4.3.1 Data from Key informants

From the key informant interviews on the key principles of communication that have been adopted by agricultural researchers/officers to enhance utilization of climate smart technologies among farmers and other value chain actors, 5 themes emerged from the transcribed data. The themes include; clarity of information, reliability of information,

frequent communication, use of simple language and Farmers to be taught in local languages.

4.3.1.1 Clarity of information

Majority of the respondents that were interviewed respondent from ISAAA said, “we should ensure that information we pass to farmers should be clear, most farmers do not adopt the climate smart agriculture because the information we give is more scientific.”

Another respondent from KALRO said,

> “There is a lot of information which have not been adopted because scientist make their presentation in seminars, conferences and assume that everyone has got the information yet the information is passed in a scientific language to the other scientist but not to the farmers. They don’t understand the professionalism of effective communication.”

4.3.1.2 Reliability of information

From the key informant interviews, the respondents indicated that the information is provided to farmers and it’s reliable. This is according to one of the agricultural extension officers who said,

> “We share reliable information to all farmers in West Pokot, we ensure all farmers access the information from the national through county government and its agricultural agencies.”

4.3.1.3 Frequent communication

Majority of the respondents indicated that there should be consistent and continuous communication to farmers so that most of them can adopt climate smart agriculture, Corporate Communications Officer said,

> “Scientist do not budget for how they are going to disseminate information to farmers and therefore, in most cases there is no frequent communication to farmers

> to ensure that they adopt to the new climate smart agriculture that is invented by the scientist."
>
> The officer added that "appropriate budget should be allocated in the initial and along the technology development to ease the utilization of the climate smart agriculture".

Cost-effective communication techniques are required, in accordance with Leah *et al*. (2013), to encourage the wider adoption of agricultural technologies in poor nations. IPM approaches, for instance, are still widely underutilized despite having potential economic, health, and environmental advantages. Through the use of a linear programming model, their study analyzed the current IPM dissemination program run by the Bangladesh Department of Agricultural Extension and looked at potential improvements. In their analysis, the authors hypothesized that technology transfer programs may have a greater impact if financing was redirected from intense but expensive interpersonal communication means (such as farmer field schools) to less intensive but more widely disseminated ways (such as mass media and field days).

4.3.1.4 Use of simple language

From the key informant interviews, majority of the respondents indicated that there should be use of simple language that farmers can understand better. Information & Communication Specialist who was interviewed said,

> "The scientific terms used by our researchers are not sometimes understood by our farmers in the field therefore they end up not adopting the climate smart agriculture. For this reason, scientist should ensure that their language is simple and clear to farmers"

4.3.1.5 Farmers to be taught in local languages

From the key informant interviews, majority of the respondents said that farmers should be communicated to through local languages that they understand better. One of the Ward agriculture extension officers said,

"The main challenge that we are facing in passing information is the language used in communicating to these farmers. Most of us don't understand the local language and therefore we can't communicate to them from their local language and this has made us not to communicate effectively to our farmers." The various research institutions should utilize the local FM stations to send out information in West Pokot for instance Kalya FM station.

4.4 Types of communication used by agricultural researchers in dissemination of information to farmers

Please rate the following statements concerning the types of communication used by agricultural researchers/officers in dissemination of information to farmers about climate smart agriculture in West Pokot County, whereby, 1= Strongly Disagree, 2= Disagree, 3=Neutral, 4= Agree, 5= Strongly Agree.

It was evident that agricultural researchers/agents use mobile phones in dissemination of information to farmers about climate smart agriculture in West Pokot County as registered by a mean of 3.3. 85(17.2%) of the respondents strongly disagreed, 55(11.1%) disagreed, 94(19.0%) remained neutral, 130(26.3%) agreed while 130(26.3%) strongly agreed. Wanjohi (2015) sought to determine how mobile phone technologies among smallholder

dairy farmers in Kenya have enhanced communication. The study revealed the adoption of mobile phone technologies in farming had stimulated the access of information. The development of mobile phone technologies has spearheaded communication between farmers in various parts of the country. This was similar to study findings in West Pokot that found out that researchers/agents use mobile phones to communicate to farmers about climate smart agriculture. The use of mobile phones according to Wanjohi (2015) using mobile phone technologies for payment, animal health and complementary dairy services improve communication between farmers and experts or consumers.

A mean of 2.3 shows that the majority of the farmers disagreed with the statement agricultural researchers/agents use landline calls (call centers) in dissemination of information to farmers about climate smart agriculture in West Pokot County. 189(38.3%) strongly disagreed, 140(28.3%) disagreed, 66(13.4%) were neutral, 50(10.1%) agreed while 49(9.9%) strongly agreed.

When asked whether agricultural researchers/agents use face to face communication in dissemination of information to farmers about climate smart agriculture in West Pokot County, 53(10.7%) strongly disagreed, 47(9.5%) disagreed, 43(8.7%) were neutral, 150(30.4%) agreed while 201(40.7%) strongly agreed. The majority agreed as recorded by a mean of 3.8. The study findings were similar to findings of Ndungu *et al*. (2000) who also found out that neighbors, family, market and community-based organizations are the major sources of disseminating agricultural information to farmers through face-to-face communication.

Table 4.4 Showing data from the respondents on the types of communication used by agricultural researchers/officers in dissemination of information to farmers

Statement	1 SD	2 D	3 N	4 A	5 SA	M
Agricultural researchers/agents use mobile phones in dissemination of information to farmers about climate smart agriculture in West Pokot County	85	55	94	130	130	
	17.2%	11.1%	19.0%	26.3%	26.3%	3.3
Agricultural researchers/agents use landline calls (call centers) in dissemination of information to farmers about climate smart agriculture in West Pokot County	189	140	66	50	49	
	38.3%	28.3%	13.4%	10.1%	9.9%	2.3
Agricultural researchers/agents use face to face communication in dissemination of information to farmers about climate smart agriculture in West Pokot County	53	47	43	150	201	
	10.7%	9.5%	8.7%	30.4%	40.7%	3.8
Agricultural researchers/agents use radio e.g FM stations in dissemination of information to farmers about climate smart agriculture in West Pokot County	41	30	62	202	159	
	8.3%	6.1%	12.6%	40.9%	32.2%	3.8
Agricultural researchers/agents use television in dissemination of information to farmers about climate smart agriculture in West Pokot County	79	81	104	140	90	
	16.0%	16.4%	21.1%	28.3%	18.2%	3.2
Agricultural researchers/agents use print media such as newspapers and magazines in dissemination of information to farmers about climate smart agriculture in West Pokot County	97	96	98	120	83	
	19.6%	19.4%	19.8%	24.3%	16.8%	3.0
Agricultural researchers/agents use social media such as Facebook, twitter and WhatsApp in dissemination of information to farmers about climate smart agriculture in West Pokot County	102	85	111	110	86	
	20.6%	17.2%	22.5%	22.3%	17.4%	3.0

There was an agreement with the statement agricultural researchers/agents use radio e.g FM stations in dissemination of information to farmers about climate smart agriculture in West Pokot County. In line with that 41(8.3%) strongly disagreed, 30(6.1%) disagreed,

62(12.6%) neutral 202(40.9%) agreed and 159(32.2%) strongly agreed. The responses recorded a mean of 3.8.

When asked whether agricultural researchers/agents use television in dissemination of information to farmers about climate smart agriculture in West Pokot County, 79(16.0%) strongly disagreed, 81(16.4%) disagreed, 104(21.1%) neutral, 140(28.3%) agreed while 90(18.2%) strongly agreed. The majority agreed with the statement as indicated by a mean of 3.2.

A mean of 3.0 shows there was a neutral belief with the statement agricultural researchers/agents use print media such as newspapers and magazines in dissemination of information to farmers about climate smart agriculture in West Pokot County. 97(19.6%) strongly disagreed, 96(19.4%) disagreed, 98(19.8%) neutral, 24.3%) agreed, 83(16.8%) strongly agreed.

Concerning agricultural researchers/agents use social media such as Facebook, twitter and WhatsApp in dissemination of information to farmers about climate smart agriculture in West Pokot County, 102(20.6%) strongly disagreed, 85(17.2%) disagreed, 111(22.5%) neutral 110(22.3%) agreed while 86(17.4%) strongly agreed. There was a neutral agreement as marked by a mean of 3.0.

The studies done by Rogers (2003) and Das (2012) shows that mass media and interpersonal communication are the important channels used in sharing the findings emanating from agricultural researchers, extension officers, knowledgeable famers and research institutions. Mass media and interpersonal communication plays an important role

in passing information to farmers in the rural areas, since they help in creating awareness between them and stakeholders. In West Pokot mass media and interpersonal communication was also widely used to communicate climate smart agriculture to farmers.

4.4.1 Data from key informants

From the key informants, the following themes were deduced from the interviews on the channels of communication used by agricultural researchers/ officers in dissemination of information to farmers and other value chain actors; social media, print media, broadcast media, face to face communication and phones.

4.4.1.1 Social media

Social media is not highly used to pass information to farmers in West Pokot, this was said by majority of the ward agricultural extension officers. One of them said,

> "Most of this people do not have smartphones therefore we do not communicate with them through social media."

4.4.1.2 Print media

Print media is not commonly used in West Pokot, this was according to the respondents that were interviewed. One of the ward agricultural extension officers said,

> "We rarely use print media to communicate to our farmers, most of the farmers are unable to read therefore we don't prefer using print media in communicating to farmers."

4.4.1.3 Broadcast media

From the respondents who were interviewed, majority indicated that they rarely use broadcast media to communicate to farmers in West Pokot. However, a few mentioned that

sometimes they use the local radio stations to pass information concerning smart climate technology. One of the wards agricultural officers said,

> "We don't use television to broadcast smart climate agriculture to our farmers, most of the farmers in this region do not have television and therefore sometimes we only use radio station that speak our language that these farmers understand best. You know radio is cheap and almost all farmers can afford and you can easily tune to local language."

4.4.1.4 Face to face communication

Majority of those who were interviewed supported this type of communication as the best method to reach farmers. County Agricultural Officer interviewed said,

> "Face to Face is the best method to reach farmers since they get the whole concept and they can ask questions for clarification, I recommend this type of communication in passing information to farmers. Government and other organizations dealing with farmers can embrace this through the barazas to ensure all farmers get information"

This was also supported by Corporate Communications Officer who said,

> "When scientist meet farmers through barazas or visit them in the field, then they will be able to explain themselves more clearly to the farmers, this will also allow farmers also to ask question whenever they don't understand the concept."

The communication type also is credited since WAO said

> "Farmers learn from each other through observation and interactions, whenever one succeeds in planting a drought resistant grass for instance and during dry seasons the farmer have plenty to give to his cattle then other farmers adopt easily"

4.4.1.5 Phones

Agricultural officers and ward agricultural extension officers all said that they mostly use phones to communicate to farmers in West Pokot, one of them said,

"Most of the farmers have mobile phones, so it's easy to communicate to them through this especially if you want to meet them or pass new information to them."

Corporate Communication officer at KALRO said that,

> "We have established a Call Centre Farmer platform as an innovative and modern way of the government for expeditiously delivering farmer agricultural information and support to the farmers, using the vast network service providers which have grown remarkably. It has helped to overcome the handicaps of the traditional personal extension system which is often inadequate in meeting the pressing queries and demands for the latest information by the farmers."

4.5 The Extent Farmers in West Pokot County have Adopted and applied Climate Smart Agriculture

Please rate the following statements the extent to which farmers in West Pokot County have adopted and applied climate smart agriculture based on information received from agricultural researchers/officers. Use the scale: 1= Strongly Disagree, 2= Disagree, 3=Neutral, 4= Agree, 5= Strongly Agree.

The farmers were neutral on the statement that famers in West Pokot access adequate communication that allow them to adopt climate smart agriculture as indicated by a mean of 3.1. 78(15.8%) strongly disagreed, 98(19.8%) disagreed, 87(17.6%) were neutral 135(27.3%) agreed, 96(19.4%) strongly agreed.

Concerning whether farmers are able to apply information on climate smart agriculture that they receive from various communication platforms, 49(9.9%) strongly disagreed, 75(15.2%) disagreed, 126(25.5%) were neutral 157(31.8%) agreed while 87(17.6%) strongly agreed. The majority agreed as indicated by a mean of 3.3.

A mean of 2.6 indicate the majority disagreed with the statement farmers are updated weekly about climate smart agriculture and are able to adopt the weekly information. 135(27.3%) strongly disagreed, 137(27.7%) disagreed, 62(12.6%) were neutral 99(20.0%) agreed while 61(12.3%) strongly agreed.

Table 4.5 The Extent to which Farmers in West Pokot County have adopted and applied Climate-Smart Agriculture

Statement	1 SD	2 D	3 N	4 A	5 SA	M
Famers in West Pokot access adequate communication that allow them to adopt climate smart agriculture	78	98	87	135	96	
	15.8%	19.8%	17.6%	27.3%	19.4%	3.1
Farmers are able to apply information on climate smart agriculture that they receive from various communication platforms	49	75	126	157	87	
	9.9%	15.2%	25.5%	31.8%	17.6%	3.3
Farmers are updated weekly about climate smart agriculture and are able to adopt the weekly information	135	137	62	99	61	
	27.3%	27.7%	12.6%	20.0%	12.3%	2.6
Farmers are updated monthly about climate smart agriculture and are able to adopt the monthly information	87	127	79	114	87	
	17.6%	25.7%	16.0%	23.1%	17.6%	3.0
Farmers are updated semi-annually about climate smart agriculture and are able to adopt the semi-annually information	99	106	114	98	77	
	20.0%	21.5%	23.1%	19.8%	15.6%	2.9
Farmers are updated quarterly about climate smart agriculture and are able to adopt the quarterly information	101	105	115	108	65	
	20.4%	21.3%	23.3%	21.9%	13.2%	2.9
Farmers are updated annually about climate smart agriculture and are able to adopt the annually information	104	95	73	109	113	
	21.1%	19.2%	14.8%	22.1%	22.9%	3.1

Regarding whether farmers are updated monthly about climate smart agriculture and are able to adopt the monthly information, 87(17.6%) strongly disagreed, 127(25.7%) disagreed, 79(16.0%) neutral, 114(23.1%) agreed, 87(17.6%) strongly agreed. The majority were neutral as shown by a mean of 3.

Most of the farmers were neutral with a mean of 2.9 when asked whether farmers are updated semi-annually about climate smart agriculture and are able to adopt the semi-annually information. 99(20.0%) strongly disagreed, 106(21.5%) disagreed, 114(23.1%) neutral, 98(19.8%) agreed while 77(15.6%) strongly agreed.

There was also a neutral stand at a mean of 2.9 whether farmers are updated quarterly about climate smart agriculture and are able to adopt the quarterly information. 101(20.4%) strongly disagreed, 105(21.3%) disagreed, 115(23.3%) were neutral, 108(21.9%) agreed while 65(13.2%) strongly agreed.

The majority agreed with a mean of 3.1 when asked if farmers are updated annually about climate smart agriculture and are able to adopt the annually information. 104(21.1%) strongly disagreed, 95(19.2%) disagreed, 73(14.8%) neutral, 109(22.1%) agreed while 113(22.9%) strongly agreed.

The adoption of the climate smart agriculture was best explained using the technology acceptance model. Climate smart agricultural agriculture is concerned with creating better value for the information provided (Nizam & Hassan, 2017). Technology is changing all the aspects in life, including the way of communication and conducting of activities (Park, Nam, & Cha, 2012). From the respondents in West Pokot, majority indicated that they have

adopted the information they receive concerning climate smart agriculture. Therefore, most of the farmers accept and adopt the information they receive from extension officers and other organizations on climate smart agriculture. This shows that farmers in West Pokot adopt to new technology with a lot of ease and they are not resistant to new technology. They have positive attitude towards climate smart agriculture and its absorption so long us they have the information about the technology. From the diffusion and innovation theory, the adoption of the climate smart agriculture by the respondents might be as a result of taking key note of key features which include its relative advantage, compatibility, complexity, trialability, and observability (Dingfelder & Mandell, 2011). From the farmers' response, majority strongly disagree that they access information on climate smart agricultural technologies. This implies that most farmers in West Pokot did not receive the innovation from the researchers. This affected the utilization of climate smart agricultural technologies by farmers.

4.6 Communication barriers in dissemination of agricultural information to farmers

Please rate the following statements on communication barriers in dissemination of information to farmers about climate smart agriculture in West Pokot County, where, 1= Strongly Agree, 2= Agree, 3=Neutral, 4= Disagree, 5=. Strongly Disagree.

A mean of 2.0 shows that the majority agreed there is limited number of agricultural extension officers to disseminate information about climate smart agriculture. 237(48.0%) strongly agreed, 145(29.4%) agreed, 24(4.9%) neutral, 36(7.3%) disagree while 52(10.5%) strongly disagree. A study by Mubofu and Elia (2017) investigated the extent to which agricultural research information is disseminated to farmers. The study established that the

extent of disseminating agricultural research information to farmers was low due to inadequate numbers of extension officers and centers. Therefore, the study recommended the government recruit more extension officers with more centers and station them in rural areas. This was similar to data obtain from West Pokot where it was established that there is need to increase the number of agricultural extension officers in the wards.

The proportion of Kenyan farmers who receive extension advice is low, according to another survey. In a survey conducted in 38 of the 47 counties, 21% of selected households used extension services in 2013–14, with 80% of them being headed by men and 19% by women. The majority (59%) made use of the public extension system.5 Lack of qualified workers is a significant barrier; for example, the national extension staff to farmer ratio is 1:1,000 rather than the suggested 1:400 (Wanyama *et al*., 2016, p. 23). In comparison, Ethiopia spends practically all of its sizable agriculture budget—or one extension agent—for every 472 farmers (World Bank, 2018, p. 36). Wanyama *et al*. (2016) observed that state extension providers and private for-profit providers were better represented among higher income groups, with the distribution of private non-profit providers being slightly more equal. Extension services in Kenya also frequently benefit the wealthy.

Regarding whether the language used to disseminate climate smart agricultural information affects how farmers use the information they receive, 136(27.5%) strongly agreed, 189(38.3%) agreed, 82(16.6%) neutral 44(8.9%) disagreed while 43(8.7%) strongly disagreed. This was further evidenced by a mean of 2.3. Lwoga, Stilwell and Ngulube (2011) found that farmers 'illiteracy level posed a challenge to the dissemination and use of agricultural research information in Tanzania. The study findings were similar to the

findings in West Pokot as majority of the farmers indicated that language used to disseminate climate smart agriculture is a barrier to their access to information.

Whether the sources of information are inadequate hence hindering the effective dissemination of agricultural research information on climate smart technologies, 160(32.4%) strongly agreed, 176(35.6%) agreed, 71(14.4%) neutral 51(10.3%) disagreed while 36(7.3%) strongly disagreed. A mean of 2.2 shows that the majority agreed. The study findings were in line with the study that were reviewed. A study by Isaya (2015) conducted research in Tanzania on how information was disseminated among women farmers in Hai and Kilosa districts, the study found that farmers faced challenges such as inadequate knowledge on how to apply the information acquired from extension officers and researchers, lack of credit to purchase farm inputs, improved seeds and chemical fertilizers.

Table 4.6 Communication Barriers in Dissemination of Agricultural Information to Farmers

Statement	1 SA	2 A	3 N	4 D	5 SD	M
There is limited number of agricultural extension officers to disseminate information about climate smart agriculture	237	145	24	36	52	**2.0**
	48.0%	29.4%	4.9%	7.3%	10.5%	
The language used to disseminate climate smart agricultural information affects how farmers use the information they receive	136	189	82	44	43	**2.3**
	27.5%	38.3%	16.6%	8.9%	8.7%	
The sources of information are inadequate hence hindering the effective dissemination of agricultural research information on climate smart agriculture	160	176	71	51	36	**2.2**
	32.4%	35.6%	14.4%	10.3%	7.3%	
There are no information centers in West Pokot County where farmers can easily access and timely information about climate smart agricultural agriculture	107	153	80	99	55	**2.7**
	21.7%	31.0%	16.2%	20.0%	11.1%	
There is limited agricultural information infrastructure, such as; communication networks, electricity, etc., which run electronic media such as radio, TV, and mobile phones that can accelerate and promote the transfer of information on CSA to the farmers	183	171	51	36	53	**2.2**
	37.0%	34.6%	10.3%	7.3%	10.7%	
There is political interference in dissemination of climate smart agriculture	99	104	94	92	105	**3.0**
	20.0%	21.1%	19.0%	18.6%	21.3%	

A mean of 2.7 shows the majority agreed there are no information centers in West Pokot County where farmers can easily access and timely information about climate smart agricultural agriculture. 107(21.7%) strongly agreed, 153(31.0%) agreed, 80(16.2%) neutral, 99(20.0%) disagreed while 55(11.1%) strongly disagreed.

Concerning whether there is limited agricultural information infrastructure, such as; communication networks, electricity, etc., which run electronic media such as radio, TV, and mobile phones that can accelerate and promote the transfer of information on CSA to the farmers, 183(37.0%) strongly agreed, 171(34.6%) agreed, 51(10.3%) neutral 36(7.3%) disagreed while 53(10.7%) strongly disagreed. As shown by a mean of 2.2, the majority agreed.

A mean of 3.0 shows the majority agreed there is political interference in dissemination of climate smart agriculture. 99(20.0%) of the farmers strongly agreed, 104(21.1%) agreed, 94(19.0%) neutral, 92(18.6%) disagreed while 105(21.3%) strongly disagreed. The study's conclusions matched those of one that was done in Tanzania. Barakabitze, Kitindi, Sanga, Shabani, Philipo, and Kibirige (2015) investigated how a variety of information and communication technologies (ICTs) offered in agricultural research institutes (ARIs) might increase agriculture productivity in Tanzania if used successfully by agricultural researchers. The study's findings show that inadequate computers and the technological infrastructure that supports them, a lack of electricity needed to run computers, erratic Internet connectivity, a lack of systematic ICTs investment, and poor coordination of agriculture stakeholders due to institutional diversity and departmental fragmentation are among the obstacles preventing the use of ICTs in ARIs.

Ifukor (2013) discovered in a study conducted in Nigeria that other factors, such as the use of inappropriate communication channels, illiteracy level, usage of foreign languages, and an excessive reliance on oral rather than written modes of communication, can impede the spread of information. Oladele (1999) noted that insufficient connections between researchers, extension agents, and farmers also hampered the communication of findings from agricultural research. The farmers' ability to take part in earlier planning, which requires information, is hampered by the weak relationships. Ferris (2005) also pointed out that one of the primary obstacles to efforts to strengthen the agricultural sector in developing countries is the fact that small-scale farmers in many African nations lack reliable and pertinent agricultural information.

4.6. 1 Data from key informants

From the key informants, the following themes were deduced from the interviews on communication barriers in dissemination of information to farmers about climate smart agriculture in West Pokot County; language barrier and poor communication.

4.6.1.1 Language barrier

Language barrier was one of the communication barriers that was mentioned by the respondents that were interviewed. This was mentioned by Ward Agriculture officers and Ward agriculture extension officers who interact mostly with the farmers. They said that some of the scientific terms used by the scientist are not easy to translate therefore it is not easy to translate. They also said that most of the farmers do not understand English or Kiswahili so the best language is their mother language that at times when translated some meanings are lost. One of them said, “Most of our farmers do not understand English or

Kiswahili, therefore the best language to communicate to them is local language, for me I don't speak their local language so I need someone to translate and you know when we translate, some meaning might be lost. I think most of the farmers have not implemented the climate smart agriculture because of language."

4.6.1.2 Poor communication

Poor communication was also mentioned by those who were interviewed as a communication barrier in disseminating information to farmers. According to Associate Professor from University of Nairobi, "Most of us researchers use poor communication techniques to communicate our findings to main target audience. Most of us do not share our reports to the extension officers, farmers, instead we only publish and assume that farmers will read our published articles. I think we should organize face to face visits which entails field demonstrations, farmer trainings, Barazas etc. and even share our findings with the farmers in their farms."

4.7 Communication interventions to improve utilization of climate smart agricultural technologies

The researcher wanted to know some of the communication interventions that can be put in place to improve utilization of climate smart agricultural technologies among farmers in West Pokot County. The majority 57.5% stated the need to improve infrastructures, 23.9% stated the need for capacity building while 10.1% hinted on the need to employ extension officers with 7.5% emphasizing on the use of local language when training farmers and only 1% suggesting on the need of subsidy programs such as reduced cost of seeds and data bundles to access information.

Table 4.7 Communication Interventions to Improve Utilization of Climate Smart Agriculture

Communication interventions	Frequency	Percent
Capacity building	118	23.9
Improve on infrastructures	284	57.5
Employment	50	10.1
Subsidy programs	5	1.0
Use of local language	37	7.5
Total	**494**	**100.0**

Source: Author 2023

Wamalwa (2017) looked at variables influencing farmers in Kitutu and Nyaribari Chache in Kisii County to adopt climate-smart practices. A survey research design was used for the study. The report suggested expanding the exchange of meteorological and climate data, fostering expertise and awareness of wise climate practices, creating a strong regulatory and legal framework, and raising finances.

A study on the effects of an ICT-based initiative (mobile phone) on women farmers' access to the market in Nigeria was done by Chete and Fayosiro in 2014. The study made the recommendation that in order to assist farmers in getting access to ICTs, the government and other stakeholders need to get involved. In order to better communicate the results of agricultural research to farmers in Tanzania's Iringa District, Mubofu and Malekani (2020) looked at the sources of agricultural information and methods for doing so. The study concluded that in addition to repackaging agricultural research findings to suit farmers' needs, there is a need to use other disseminators, such as important persons, religious

leaders, political leaders, primary school instructors, and students. These remedies from the studied literature were consistent with West Pokot data findings.

When the government and other organizations can work on the interventions then through knowledge-based theory, farmers in West Pokot will increase their awareness about the importance of implementing knowledge and best practices to improve the production system to yield more food.

4.7.1 Data from key informants

4.7.1.1 Communication policies

From the respondents, they all indicated that have policies in their organization. The respondents were also interviewed on how the polices have been aligned to climate smart agricultural technologies utilization and the following themes were deduced from their responses; Chain of information flow.

4.7.1.1. 1 Chain of information flow

The chain of communication flow among the Agricultural officers for public consumption – The Corporate Communication officers from KALRO and Information Officer from MoALF indicated that,

> "For any information to be shared publicly it has to be approved by the highest office in the organization this is important since the information approved must be factual this is informed by the various national issues in place."

According to the County Agricultural Officer Technology Transfer guideline is available, he said,

> "The guideline has not captured the use of other forms of communication like media, since we do face to face communication"

Government institution has strict Protocols to be followed in issues of public engagement on policy issues, this is according to the Information officer MoALF. She said "the moment government officers engage publicly on matters which touches policy interventions it affects the entire country, and thus the strict protocol in public engagement".

According to the Associate Professor from UON "engagement on policy issues is done with the advice of the top management downwards, the communication department work from the officer of the Vice Chancellor in any public engagement for approval"

Improve communication through use of social media, digital platforms and more face to face e.g. barazas. The Corporate Communication from KALRO and ISAAA said "the use of Science Communication will be the most effective way of Communicating Climate Smart agricultural technologies towards successful utilization in West Pokot and other regions"

4.7.1.2 Communication interventions

The following themes were deduced from the interviews that were done to the key informant interviews on the communication interventions to increase the utilization of Climate Smart Agriculture in West Pokot; Increase the number of extension officers, use of local languages and capacity building.

4.7.1.2.1 Increase the number of extension officers

From the respondents who were interviewed, majority indicated that there should be increase in the number of extension officers in West Pokot. One of the extension officers said,

> "*Currently we don't have the right number to reach all farmers in this area, at least the county government should add us more staff. This will help us ensure all farmers get our services."*

4.7.1.2.2 Use of local language

Another intervention that was proposed by key informants was use of local language by the scientist and the agricultural extension officers to communicate about climate smart agriculture. One of the ward agricultural extension officers said,

> "*I don't speak the local language, therefore, communicating in English or Kiswahili sometimes is not effective to everyone in this Ward. To curb this, I do use one of them who understand English to translate to their local language, if we can use local language, then I am sure most of them will benefit and will be able to adopt smart climate agriculture*."

4.7.1.2.3 Capacity building

Capacity building was also proposed by majority of the respondents who were interviewed, they proposed that capacity building helps to bring farmers closer to the extension officers in the field. Regulatory Affairs and Scientist said,

> *"The government and other organizations dealing with climate smart agriculture should use capacity building to educate farmers about smart climate agriculture. This will increase the adoption among farmers. Monitoring and evaluation of the current communication status will be very important for one to understand which area to capacity build"*

4.8 Mean of the variables

The field data found that, there has been increased utilization of climate smart agricultural technologies necessitated by communication among farmers as registered by a mean of 3.48. This shows that the respondents agreed there is utilization of climate smart agricultural technologies by farmers in West Pokot County. This increased utilization has been facilitated by principles and types of communication as indicated by a mean of 3.24 and 3.2. The adoption and application of climate smart agriculture registered a neutral agreement as evidenced by a mean of 2.98.

However, the majority of the respondents as shown by a mean of 2.41 acknowledge and take cognizance of the existing barriers that have hampered utilization of technologies. To reverse this worrying trend, they stated that a number of communication interventions such as capacity building through training, employing agricultural extension officers, improving of infrastructures like (security, information, communication and roads), use of local language when educating them, tree planting/provision of seeds, subsidy programs, and water harvesting need to be in place. The major interventions suggested by respondents from West Pokot were capacity building through training and improvement of infrastructures as indicated by a mean of 2.11. The results are summarized in the table 4.8.

Table 4.8 Mean of the variables

Communication concepts	Mean	Std. Deviation	N
Utilization of climate smart agricultural technologies	3.48	.938	494
principles of communication	3.24	.911	494
Types of Communication	3.20	.835	494
Adoption and application of climate smart technologies	2.98	.823	494
Barriers of communication	2.41	.785	494
Interventions of communications	2.11	1.022	494

Source: Author 2023

4.9 Correlation analysis

The Pearson product correlation of principles of communication and utilization of climate smart agricultural agriculture found a very weak positive and statistically significant relationship ($r=0.241$, $p<0.001$) hence the null hypothesis ($H_{1.}$) was rejected. Therefore, there was an increase in utilization of climate smart agriculture in West Pokot County with an increase in principles of communication.

The Pearson product correlation of types communication and utilization of climate smart agriculture found a very weak positive and statistically significant relationship ($r=0.281$, $p<0.001$) hence the null hypothesis ($H_{2.}$) was rejected. Therefore, there was an increase in utilization of climate smart agriculture in West Pokot County with an increase in types of communication used by agricultural researchers/officers in dissemination of information to farmers about climate smart agriculture.

The Pearson product correlation of adoption and application of climate smart agriculture and utilization of climate smart agricultural technologies found a weak positive and statistically significant relationship ($r=0.336$, $p<0.001$) hence alternative hypothesis ($H_{3.}$) was upheld. Therefore, there was an increase in utilization of climate smart agriculture in West Pokot County with an increase in adoption and application of climate smart agriculture based on information received from agricultural researchers/officers.

The Pearson product correlation of barriers of communication and utilization of climate smart agricultural technologies found a very weak negative and statistically significant relationship ($r= -0.225$, $p<0.001$) hence alternative hypothesis ($H_{4.}$) was upheld. Therefore, there was a decrease in utilization of climate smart agriculture in West Pokot County with an increase in barriers of communication in dissemination of information to farmers about climate smart agriculture.

The Pearson product correlation of interventions of communication and utilization of climate smart agriculture found a markedly low positive and statistically significant relationship ($r=0.096$, $p<0.05$) hence alternative hypothesis ($H_{5.}$) was upheld. Therefore, there was an increase in utilization of climate smart agriculture in West Pokot County with an increase in interventions of communication.

Table 4.9 Correlations

		Utilization of climate smart agriculture
	Pearson Correlation	.241**
Principles of communication	Sig. (2-tailed)	.000
	N	494
	Pearson Correlation	.281**
Types of Communication	Sig. (2-tailed)	.000
	N	494
	Pearson Correlation	.336**
Extent of adoption and application of climate smart agriculture	Sig. (2-tailed)	.000
	N	494
	Pearson Correlation	-.225**
Barriers to communication	Sig. (2-tailed)	.000
	N	494
	Pearson Correlation	.092*
Interventions of Communications	Sig. (2-tailed)	.042
	N	494

4.10 Regression Analysis

4.10.1 Coefficients of Determination

Analysis of how utilization of climate smart agriculture by farmers in West Pokot County is affected by Communication was run through testing the following research hypotheses H01, H02, H03, H04 and H05. The model summary table generated models reflective of the five predictors. The coefficient of determination (R2) of the model provided the lowest fit (R2= 0.174) meaning that the model explained 17.4% of the variations in communications on utilization of climate smart agriculture and was considered to provide a less fit as illustrated below in model summary table below.

Table 4.10 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.417a	.174	.165	.857

a. Predictors: (Constant), Interventions, principles of communication, Barriers, Extent of adoption and application of climate smart agriculture, Types of Communication

b. Dependent Variable: Utilization of climate smart agriculture

ANOVA[a]

An overall assessment of the significance of the regression model using ANOVA analysis shows the model was significant ($p<0.001$) in explaining the linear relationship between communication and utilization of climate smart agriculture in West Pokot County. The $p<0.001$ and ($Fp=0.95= 2053$), thus significant difference between independent and dependent variables.

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	75.317	5	15.063	20.530	.000[b]
	Residual	358.053	488	.734		
	Total	433.370	493			

a. Dependent Variable: Utilization of climate smart agriculture

b. Predictors: (Constant), Interventions, principles of communication, Barriers, Extent of adoption and application of climate smart agriculture, Types of Communication.

4.10.2 Parameter estimates

As presented in **regression model table 4.11**, the utilization of climate smart agriculture in West Pokot County was greatly affected by communication. This is because when it is changed by one unit there was a resultant increase of 25.4% in utilization of climate smart agriculture. Consequently, changing principles of communication with one unit would enhance utilization of climate smart technologies by up to 9.3%, while a variation in Types

of Communication by one unit would result in 15.1% improvement in utilization of climate smart agriculture. Further, increasing interventions of communication with a unit improved utilization of climate smart agriculture by 4%. However, barriers of communication negatively influenced utilization of climate smart agriculture because with every unit increase in barriers, the utilization of climate smart technologies reduced by 18.6%. Overall, the most impactful factor was the adoption and application of climate smart technologies as this led to the highest positive change in the utilization of climate smart agriculture. Types of Communication, principles of communication and Interventions of communication had the second, third and fourth highest impact and with barriers having the least impact of the five factors as shown below in regression model table.

Table 4.11 Regression model

Coefficients[a]

Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**T**	**Sig.**	**Collinearity Statistics**	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.308	.262		8.811	.000		
	Principles of communication (PoC)	.093	.046	.090	2.001	.046	.830	1.205
	Types of Communication (ToC)	.151	.053	.135	2.854	.004	.762	1.311
	Extent of adoption and application of climate smart technologies (ACT)	.254	.054	.223	4.733	.000	.763	1.311
	Barriers of Communication (BoC)	-.187	.051	-.157	-3.685	.000	.938	1.067
	Interventions of Communication (IoC)	.040	.038	.044	1.062	.289	.980	1.020

a. Dependent Variable: Utilization of climate smart agricultural agriculture

Principles of Communication (PoC) significantly influence the Utilization of Climate Smart Agriculture (UCA). The significant value was less than the p-value of 0.05 (P=0.046) as indicated hence the study reject the null hypothesis that holds that the principles of communication that have been adopted by agricultural researchers/officers does not influence the utilization of climate smart technologies in West Pokot County. Besides, the principles of communication positively predict utilization of climate smart technologies.

The utilization of climate smart technologies was significantly influenced by Types of Communication (ToC). The significance value was less than the alpha value of 0.05 (P= 0.004) as indicated therefore the study reject the null hypothesis that holds that the types of communication used by agricultural researchers/officers in dissemination of information to farmers about climate smart technologies does not influence the utilization of climate smart technologies in West Pokot County. Types of communication also predicted the utilization of climate smart technologies positively.

This study also found that the extent to which farmers have adopted and applied Climate Smart Technologies (ACT) based on information received from agricultural researchers/officers have significantly influenced utilization of climate smart technologies in West Pokot County. The significance level for the t-statistic was less than 0.001 ($P<0.001$) as indicated hence the study upholds the alternative hypothesis which states that adoption and application of climate smart technologies have a significant effect on the utilization of climate smart technologies in West Pokot County.

The utilization of Climate Smart Agriculture (UCA) among farmers was not significantly influenced by interventions of communication. The significance value was more than the P-value 0.05 (P = 0.289) as presented hence the study reject the alternative hypothesis which holds that the communication interventions put in place significantly influenced the utilization of climate smart technologies among farmers in West Pokot County.

To conclude, this study also found that the Barriers of Communication (BoC) in dissemination of information to farmers about climate smart technologies have significantly influenced utilization of climate smart technologies in West Pokot County. The significance level for the t-statistic was less than 0.001 ($P<0.001$) as indicated hence the study upholds the alternative hypothesis which states that barriers of communication have a significant effect on the utilization of climate smart technologies in West Pokot County. Despite being significant, the barriers predicted the utilization of climate smart technologies among farmers negatively.

The fitted regression equation and interpretation of the equation for regression of (utilization of climate smart technologies) and independent variables (principles of communication-PoC, Types of Communication-ToC, adoption and application of Climate Smart Agriculture-ACA, Barriers of Communication-Boc and Interventions of Communication-IoC).

To analyse and establish the relationship between the dependent variable (utilization of climate smart agriculture) and independent variables (principles of communication-PoC, types of communication-ToC, adoption and application of climate smart Agriculture-ACA,

barriers of communication-BoC and interventions of communication-IoC)), a regression analysis was performed between the combined variable of the factors as shown in coefficients table above for linear regression. The R square value was 0.174 implying that 17.4% of the variation in utilization of climate smart technologies was caused by the variations in principles of communication-PoC, types of communication-ToC, adoption and application of climate smart agriculture-ACA, barriers of communication-BoC and interventions of communication-IoC), and was considered to provide a little fit. An analysis of the ANOVA shows that the F value was 2053.0 ($p<0.001$), and therefore, significant. This implies that there is linear relationship between utilization of climate smart agriculture (UCA) and the five independent variables (principles of communication-PoC, types of communication-ToC, adoption and application of climate smart agriculture-ACA, barriers of communication-BoC and interventions of communication-IoC). An analysis of the coefficients revealed that on regression, the variables were significant ($p<0.05$) except interventions of communication ($p>0.05$). Below is the analytical framework which guided the study $UCA = \beta_0+\beta_1PoC+ \beta_2ToC + \beta_3ACA+ \beta_4BoC + \beta_5IoC + \varepsilon_i$ Where UCA= utilization of climate smart agriculture, β_0=Constant term, β_1, β_2, β_3, β_4, β_5 are beta coefficients, PoC= principles of communication, ToC= types of communication, ACa= adoption and application of climate smart agriculture, BoC= barriers of communication-BoC; IoC=interventions of communication and ε_0 = Error Term Substituting the factors result into the equation:

$UCA = 2.308+0.093PoC+ 0.151ToC + 0.254ACA-0.187BoC + 0.040IoC + 0.857.$

This implies that holding all factors constant there is an increase in utilization of climate smart agriculture in West Pokot County, and with every unit increase in principles of communication-PoC, types of communication-ToC, adoption and application of climate smart agriculture-ACA, and interventions of communication-IoC) increases utilization of climate smart technologies but decreases with a unit increase in barriers of communication-BoC. This equation is therefore derived from the coefficients table above.

4. 11 Determining Multicollinearity

The data was subjected to the assumptions of regression analysis with no major violation reported. All the variables had variance inflation factor below 10 as indicated in the regression model table/coefficients above. From the collinearity diagnostics table below, the condition index points the exact causes. It was evident that the dimensions have a condition index below 50 with each having a variance proportion below 0.8 except 2nd dimension. The assumptions showed no evidence of multicollinearity as the relationships between the independent variables was no strong thus acceptable. The table below summaries the results.

Table 4.12 Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions (Constant)	principles of communication	Types of Communication	Extent of adoption and application of climate smart agriculture	Barriers of communication	Interventions of communication
1	1	5.601	1.000	.00	.00	.00	.00	.00	.01
	2	.175	5.661	.00	.01	.00	.01	.06	.86
	3	.119	6.868	.00	.08	.03	.05	.47	.05
	4	.051	10.490	.00	.71	.11	.30	.00	.00
	5	.037	12.343	.00	.01	.79	.57	.00	.00
	6	.017	17.908	.99	.19	.06	.07	.46	.08

a. Dependent Variable: Utilization of climate smart agriculture

4.12 Determining Normality

The normalized residual histogram and normal P-P plot of the regression can be used to verify the normality. While the histogram depicts the standardized residuals as a bell-shaped symmetrical curve with greatest values in the middle and minimum values at the end, normal P-P plots compare them to the normal distribution, which is represented by a straight diagonal line. Since the maximum values in the studied data were inside the histogram's curve and along the straight diagonal line for normal p-p plots, the distribution of the data was normal. The figures below provide an overview of the findings.

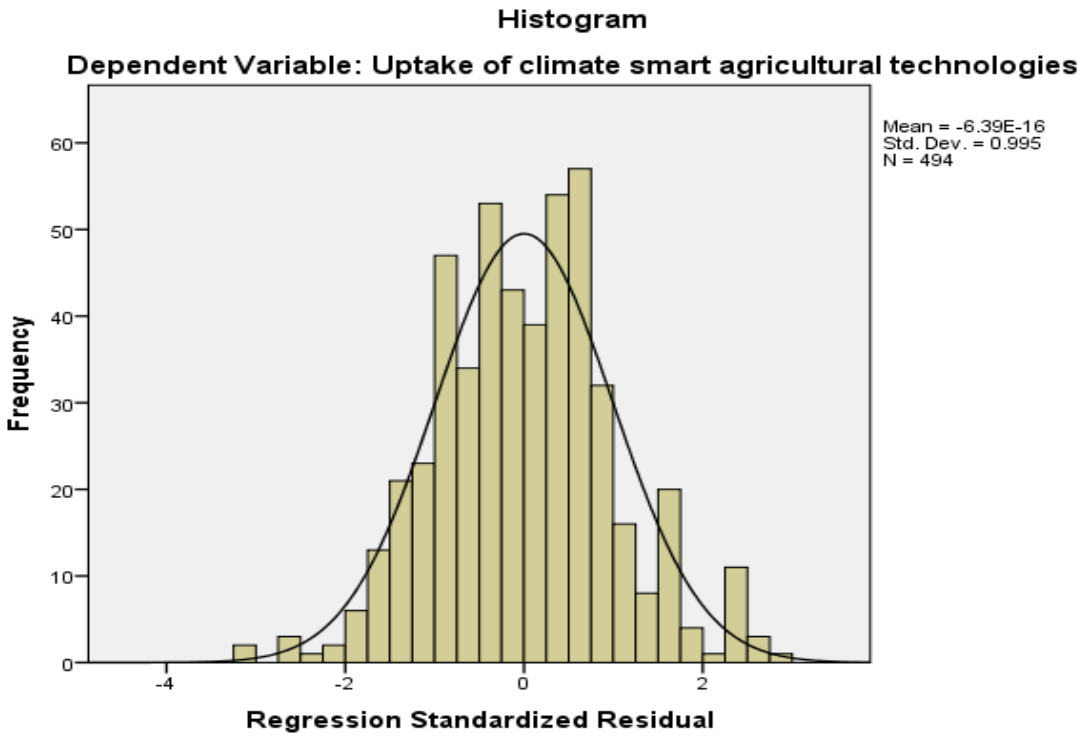


Figure 4.5 Determining normality

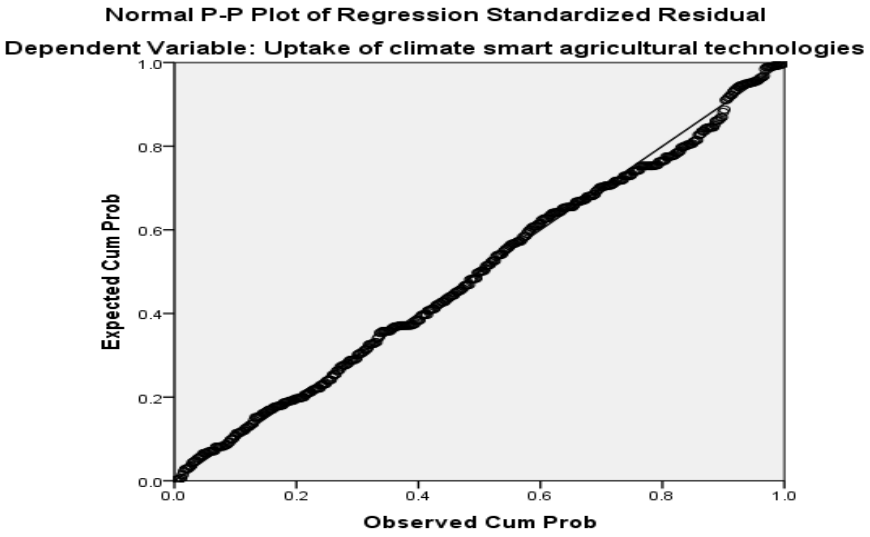


Figure 4.6 Normal P-P Plot of Regression

4.13 Determining linearity

According to Pallant (2010), Linearity is checked by observing the scatter plots of standardized residual of dependent and independent variables. From the scatter plot below, the data were scattered closely therefore there was no linearity related issues as shown in figure 4.7.

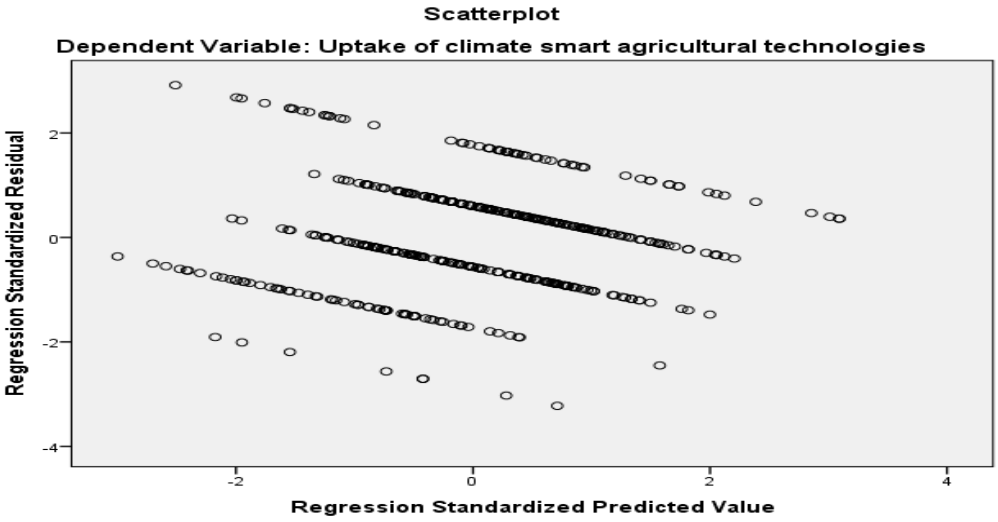


Figure 4.7 Linearity

CHAPTER FIVE

SUMMARY, CONCLUSION, AND RECOMMENDATION

5.1. Introduction

This chapter contains a study summary, conclusions, and recommendations based on the research findings on the use of climate-smart agricultural technologies in West Pokot County, Kenya.

5.2 Summary of the study

5.2.1 Principles of Communication to enhance the utilization of climate-smart Agriculture

The hypothesis examined was that the communication principles used by agricultural researchers/officers do not affect the use of climate-smart agriculture in West Pokot County. The Pearson product correlation of communication principles and exploitation of climate-smart agricultural agriculture discovered a very modest positive and statistically significant association (r=0.241, p0.001), hence the null hypothesis (H1) was rejected. As a result, there was an increase in the use of climate-wise agriculture in West Pokot County, as well as an increase in communication concepts. Communication had a significant impact on the use of climate-smart agriculture in West Pokot County, as shown in the regression model. This is because changing it by one unit resulted in a 25.4% rise in the adoption of climate-smart agriculture. As a result, modifying communication principles with one unit could increase the usage of climate-smart technologies by up to 9.3%.

According to key informant interviews on the key communication principles adopted by agricultural researchers/officers to increase utilization of climate-smart technologies among farmers and other value chain actors, an increase in the following: clarity of information, reliability of information, frequent communication, use of simple language, and Farmers being taught in local languages will lead to an increase in communication and thus an increase in utilization.

According to the findings, an increase in the use of two-way communication with farmers, frequent communication with farmers, clarity of information, instant feedback, and other communication principles will positively increase the adoption of climate-smart agriculture in West Pokot, Kenya, such as soil management, drought-tolerant maize, dairy development, and rainfall forecasts, among other things.

Two-way communication is required for research agents, extension officials, and others who communicate with farmers. Feedback from the receiver to the sender is part of two-way communication. This lets the sender know that the message was correctly received by the receiver. Communication is also negotiated, which implies that the sender and receiver listen to each other, and the messages gather information to reply. Farmers will be able to effectively receive information on climate-smart agriculture as well as provide comments on climate-smart agriculture as a result of this. As a result of information sharing and feedback on adoption progress, more climate-smart agriculture technologies will be adopted.

The two key components of technology adoption theory are perceived utility and perceived ease of use. As farmers will be instructed on new technology and will be able to ask

questions that will be answered, it will be easier to demonstrate the ease of use and utility of the new technologies that come with climate-smart agriculture in West Pokot using two-way communication principles.

5.2.2 Types of communication used by agricultural researchers in the dissemination of information to farmers

The hypothesis examined was that the communication principles used by agricultural researchers/officers do not affect the use of climate-smart agriculture in West Pokot County. The Pearson product correlation of communication principles and exploitation of climate-smart agricultural agriculture discovered a very modest positive and statistically significant association (r=0.241, p0.001), hence the null hypothesis (H1) was rejected. As a result, there was an increase in the use of climate-wise agriculture in West Pokot County, as well as an increase in communication concepts. Communication had a significant impact on the use of climate-smart agriculture in West Pokot County, as shown in the regression model. This is because changing it by one unit resulted in a 25.4% rise in the adoption of climate-smart agriculture. As a result, modifying communication principles with one unit could increase the usage of climate-smart technologies by up to 9.3%.

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5.2.3 The extent farmers in West Pokot County have adopted and applied climate-smart agricultural technologies

The hypothesis that was investigated claimed that the amount to which farmers embraced and utilized climate-smart technologies based on information received from agricultural researchers/officers had a substantial influence on climate-smart agriculture utilization in West Pokot County. The Pearson product correlation of climate-smart agriculture adoption and application and usage of climate-smart agricultural technology revealed a slight positive and statistically significant link (r=0.336, p0.001), implying that the alternative hypothesis (H3.) was supported. As a result of information collected from agricultural researchers/officers, there was an increase in the use of climate-smart agriculture in West Pokot County, as well as an increase in acceptance and application of climate-smart agriculture.

A mean of 3.1 suggested that farmers in West Pokot have access to appropriate communication that allows them to practice climate-smart agriculture. Concerning whether farmers can implement climate-smart agriculture knowledge obtained from various communication networks. A mean of 3.3 indicates that the majority agreed. A mean of 2.6 indicates that the majority of farmers disagreed with the statement that farmers are updated weekly on climate-smart agriculture and can implement the weekly knowledge. As a result of a lack of information, most farmers have not adopted climate-smart agriculture.

Even though there is more information on climate-smart agriculture in the world, the data show that most farmers do not have access to the information needed to be knowledgeable about climate-smart agriculture, hence they do not implement climate-smart agriculture.

Farmers must be given access to and explained the available information so that they can conduct climate-aware agriculture. Farmers will use climate-smart agricultural technologies more effectively if they receive regular information on the new technologies and how to use them. As a result, researchers, extension workers, and other stakeholders who provide climate-smart agricultural information to farmers must ensure that the information is consistent, accurate, repeated, and timely. This will increase trust and, as a result, the utilization of the technology.

5.2.4 Communication barriers in the dissemination of agricultural information to farmers

The hypothesis examined was that communication hurdles in the transmission of information to farmers about climate-smart agricultural technologies have a substantial impact on the use of climate-smart agricultural technology in West Pokot County. The Pearson product correlation between communication barriers and usage of climate-smart agriculture technologies revealed a very mild negative and statistically significant association (r= -0.225, p0.001), supporting the alternative hypothesis (H4). As a result, there was a drop in the use of climate-smart agriculture in West Pokot County, as well as an increase in communication hurdles in the transmission of climate-smart agricultural information to farmers. Communication obstacles had a detrimental impact on the usage of climate-smart agriculture because every unit increase in barriers lowered the use of climate-smart technologies by 18.6%.

ANOVA analysis reveals that the F value was 2615.7, the p-value was 0.001 (p0.001), and thus significant. This implies that there is a linear link between the use of climate-smart

agriculture (UCA) and the independent variable (communication barriers, BoC). Changing communication obstacles within one unit could increase the use of climate-smart devices by up to 21.9%. Communication barriers (BoC) have a significant impact on the use of climate-smart agriculture (UCA) (p0.001). As the significance level for the t-statistic was less than 0.001 (P0.001), the study supports the alternative hypothesis that communication constraints have a substantial impact on the use of climate-smart technologies in West Pokot County. Despite their importance, the hurdles anticipated a decrease in farmer use of climate-smart technologies. According to the findings, removing barriers in West Pokot County will enhance farmers' use of climate-smart agriculture such as soil management, drought-tolerant maize, dairy development, and rainfall forecasts, among other things, in West Pokot, Kenya.

Language hurdles and poor communication were identified as communication barriers by key informants during interviews on communication barriers in the transmission of information to farmers regarding climate-wise agriculture in West Pokot County.

The study discovered that communication barriers affecting West Pokot farmers' use of climate-smart agriculture include language barriers, poor communication techniques, and insufficient information centers, a limited number of extension officers in the field, and insufficient information infrastructures to facilitate communication. This has hampered West Pokot farmers' adoption of climate-smart agriculture practices such as the use of quality seeds and planting materials of well-adapted crops and varieties, biodiversity management, integrated pest management, improved water use and management, sustainable soil, and land management for increased crop productivity, and sustainable

mechanization. As a result, the study recommends that academics and extension officers discover ways to remove the described hurdles so that farmers may obtain information about climate-smart agriculture on time. This will encourage farmers in West Pokot County to practice climate-smart agriculture.

5.2.5 Communication interventions to improve utilization of climate-smart agricultural technologies

The hypothesis investigated was that communication interventions significantly influenced farmers in West Pokot County's use of climate-smart agriculture. The use of climate-smart agriculture (UCA) by farmers was not significantly influenced by communication strategies. The significance value was greater than the P-value 0.05 (P = 0.289), hence the study rejected the alternative hypothesis that communication interventions implemented significantly influenced the use of climate-smart technologies among farmers in West Pokot County.

According to key informant respondents, the following policies should be implemented to promote climate-smart agriculture in West Pokot: information flow, communication interventions, increased number of extension officers, use of local language, and capacity building.

Following these findings, there is a need to recognize differences in the use of various information and communication dissemination strategies by stakeholders, researchers, agents, and extension officers to increase the use of climate-smart agricultural technologies among West Pokot farmers. Furthermore, a wide assessment of various information

sources has the potential to result in increased use of climate-smart agriculture among farmers in West Pokot.

According to the findings, there is a need to strengthen communication interventions employed between farmers, researchers, and extension agents in West Pokot to boost the usage of climate-smart agricultural technologies among farmers. According to the study's findings, the following interventions are suggested: Information flow chain, in which information should flow from researchers to farmers without any communication barriers. Increase the number of extension officers; as the number of extension officers increases, more farmers will be reached through face-to-face communication, which was commonly used in West Pokot; thus, there is a need to increase the number of extension officers to ensure that more farmers can get information on climate-smart agriculture. The study also discovered that while dealing with farmers, it is necessary to use the local language. In comparison to English and Kiswahili, the majority of farmers were found to be fluent in the native language.

5.3 Conclusion

According to the study's findings, farmers in West Pokot agree that communication about climate-smart agriculture is one-way with a stronger emphasis on getting feedback, i.e., farmers are allowed to provide their input on climate-smart agriculture. However, the majority of farmers were neutral on the statement communication about climate-smart agriculture is one-way with a stronger emphasis on getting feedback, i.e., farmers are allowed to provide their input on climate-smart agriculture. When asked if communication on climate-smart agriculture is two-way between farmers and agricultural officers/agents,

the majority agreed that it is, therefore supporting open dialogue in decision-making on appropriate climate-smart technologies. As a result, effective communication principles to increase the use of climate-smart technologies among farmers and other value chain actors should include clarity of information, reliability of information, frequent communication, use of simple language, and farmers being taught in local languages.

It was clear that agricultural researchers/agents in West Pokot County utilize mobile phones to provide information to farmers regarding climate-wise agriculture. The majority of farmers disagreed with the notion that agricultural researchers/agents in West Pokot County use landline calls (call centers) to provide information to farmers about climate-wise agriculture. The majority of respondents also dispute that agricultural researchers/agents in West Pokot County employ face-to-face contact to disseminate information to farmers regarding climate-wise agriculture. There was agreement with the assertion that agricultural researchers/agents in West Pokot County use radio, like FM stations, to provide information to farmers about climate-smart agriculture. When asked if agricultural researchers/agents in West Pokot County utilize television to disseminate information to farmers about climate-smart agriculture, the majority of respondents strongly disagreed. With the statement agricultural researchers/agents use print media such as newspapers and magazines to disseminate information to farmers about climate-smart agriculture in West Pokot County, there was a neutral belief. There was a neutral agreement on the assertion that agricultural researchers/agents use social media like as Facebook, Twitter, and WhatsApp to provide information to farmers about climate-wise agriculture in West Pokot County.

According to the findings, farmers in West Pokot have access to enough communication that allows them to practice climate-smart agriculture. The majority of farmers also agree that they can utilize climate-smart agricultural knowledge they obtain from various communication platforms. The majority of farmers disagreed with the statement that farmers are updated weekly on climate-smart agriculture and can implement the weekly information. The majority of farmers were neutral when asked whether they are updated monthly about climate-smart agriculture and can implement the monthly information. When asked whether farmers are updated semi-annually about climate-smart agriculture and can apply the semi-annually knowledge, the majority of farmers were neutral. There was also a neutral position on whether farmers receive quarterly updates on climate-wise agriculture and can implement the quarterly information. When asked if farmers are updated on climate-smart agriculture annually and can implement the information, the majority agreed.

According to the data, the majority of agricultural extension officers agree that there is a limited number of agricultural extension officers to disseminate knowledge about climate-wise agriculture. The majority of farmers agree with the statement that the language chosen to distribute climate-wise farming information affects how farmers use the information they get. The majority also felt that there are insufficient information sources, which impedes the effective transmission of agricultural research knowledge on climate-smart technology. The study also discovered that the majority of farmers in West Pokot County agreed that there are no information centers where farmers can easily obtain timely information regarding climate-wise agricultural agriculture.

According to the survey findings, the majority mentioned the need for infrastructure improvements, capacity building, the employment of extension staff, the use of local language while training farmers, and the necessity for subsidy programs such as reduced seed costs and data packages to access information.

Farmers in West Pokot County are using climate-wise agriculture methods, it may be inferred. Principles and modes of communication have aided in this greater utilization. The adoption and implementation of climate-smart agriculture resulted in a neutral agreement. However, the majority of responders recognize and recognize the current constraints that have slowed technology usage. They stated that several communication interventions such as capacity building through training, hiring agricultural extension officers, improving infrastructure such as (security, information, communication, and roads), and using local language when educating them would help to reverse this worrying trend. The main solutions proposed by West Pokot respondents were capacity building through training and infrastructural enhancement.

5.4. Recommendations

The study discovered that the communication principles usually used by agricultural extension staff in West Pokot about climate-wise agriculture is one-way. It is a communication principle that tries to inform farmers without taking into account their inputs. As a result, farmers are not efficiently utilizing some of the technologies. As a result, this study recommends that agricultural extension officers and other scientists communicating with farmers use two-way communication between farmers and agricultural officers/agents that supports open interaction in decision-making on

appropriate climate-smart technologies regularly. This allows farmers to be essentially included in the discussion about the deployment of farming technologies. The study also recommends that information be clear and that farmers be communicated with on new technologies regularly, as the study discovered that sometimes the message is not clear due to scientific terms used that are not clear to farmers, and there was also no frequent and continuous communication with farmers.

According to the findings, the majority of farmers receive their information face-to-face and via local radio; thus, the study recommends that agricultural officers/agents who want to communicate with farmers about climate-smart technology should frequently use radio and face-to-face communication. Face-to-face communication was also encouraged by field visits; thus, the study suggests that agricultural officers visit farmers on their farms and have face-to-face communication with them so that they can understand the information about climate-smart technology.

The majority of farmers indicated that they do not receive weekly or monthly updates on information communicating climate-smart technology, which has affected their use of climate-smart technology; thus, this study recommends that farmers receive frequent communication about climate-smart technology. Farmers will be more likely to use climate-smart technologies as a result of this.

The majority of West Pokot farmers cited language constraints as a primary impediment to communicating knowledge about climate-smart technologies. According to the key informant interviews, some of the scientific jargon used is not widely understood, and the print media generally uses English to connect with farmers, a language that some of the

farmers are not familiar with. The language chosen to distribute climate-smart agricultural information influences how farmers use it. As a result, the study suggests that agricultural officers/agents comprehend and communicate with farmers in the local language that farmers understand. Climate-smart technology print material created in English can be translated into farmers' languages. Climate-smart agricultural information can also be disseminated through local radio stations that broadcast in the farmers' native language.

The survey also discovered that there was a lack of communication between academics and farmers; most researchers do not communicate their research findings with farmers, instead publishing publications that most farmers do not read at the conclusion. As a result, this study suggests that academics share their results on climate-smart technology with farmers through face-to-face visits to farms, demonstrations, farmer training, and barazas.

The majority of farmers proposed using local language to convey agricultural information on climate-smart agriculture to farmers, as well as improving communication infrastructure and expanding the number of extension agents in the region. As a result, the study suggests that some of the interventions that can be used to improve communication on the use of climate-smart agriculture include the need to use other disseminators such as influential people, religious leaders, political leaders, primary school teachers, and students to disseminate such information, as well as repackaging agricultural research findings to tailor it to the farmer's needs. The report also suggests that the government and other stakeholders provide network services and make mobile phones available to farmers so that they may quickly obtain climate-smart agricultural information.

The study also suggests that the government uses the power of digital technology to centralize all agriculture data and information, allowing communicators and other dissemination teams to get information that can be packaged and shared according to the mapped stakeholders; this system is known as Agricultural Big Data. This will scale up services and enhance productivity in the industry; ultimately, governments must cease being reactive to sector difficulties and instead use data to become proactive and foresee challenges in advance. Such insights into user and consumer behavior would not be feasible without the communication professionals' big data analytics.

Researchers frequently aim to use mass media channels to disseminate their study findings in a way that a wide range of audiences can understand. Nonetheless, many study findings provide critical information that could help enormously in resolving the sector's difficulties.

Effective research communication increases the relevance of science to communities and facilitates its incorporation into policy and decision-making, contributing to increased agricultural productivity. Among agricultural production-boosting interventions, there is a strong desire for research-driven, practical, and inexpensive alternatives. Policymakers and farmers are at the center of this demand because they are critical to the adoption, scalability, and implementation of agricultural innovations.

Science communication encompasses any activity in which one party transmits synthesized scientific information to an individual, group, or mass communication. Effective scientific communication raises the relevance of science in communities and supports its incorporation into policy and decision-making, ultimately contributing to the enhancement of people's quality of life. For example, science products used to manage devastating Fall

Armyworm pests devouring farmers' maize crops, locust invasions, and aflatoxin contamination of food crops in Africa must be effectively communicated to various categories of agricultural value chain actors.

According to Chandra Mohan (2010), most articles in newspapers about science events depict the topic as either too specialized or too general, with little science or inaccurate facts. The author goes on to say that one of the key evaluation criteria for scientists' success by their employers is their ability to publish their discoveries in peer-reviewed journals rather than grey literature and other forms of communication. While many people regard peer-reviewed journals as the gold standard for information sources, the style, content representation, and occasional restrictions imposed by publishers make them inaccessible to the bulk of information users. As a result, the helpful concepts generated by scientists for society are not always obvious to potential users.

Furthermore, because they do not factor heavily into their performance evaluation, few scientists spend in improving their communication skills or investigating the various distribution alternatives available and suitable for reaching different target groups.

Scientific outputs are increasingly finding their way into mass media channels such as newspapers, television, radio, magazines, and online information dissemination outlets such as blogs and podcasts as information dissemination options expand and the general public's appetite for knowledge grows.

Scientists are thus urged to develop their science communication abilities and to use the available communication venues to disseminate their innovations. Employers should encourage scientists to incorporate science communication abilities and applications as one

of the primary performance evaluation factors. Such techniques will fill the current vacuum in science communication coverage. As a result, the importance of research results in increasing farmers' well-being will be emphasized. Furthermore, excellent science communication might improve scientists' prospects of obtaining funds to further their research.

5.5. Recommendation for Further Study

The study was conducted in West Pokot; future research should be conducted in other arid and semi-arid locations to compare how communication has influenced their adoption of climate-smart agriculture.

This study examined all communication channels; a similar study may be undertaken to examine the influence of a particular communication channel, such as social media, on the application of climate-smart agriculture among farmers in West Pokot.

A study towards science communication funding in agricultural sector should be undertaken to guide in allocating enough resources towards dissemination of modern technologies for food security and economic development.

A similar study might be carried out in other sections of the country that are not arid or semi-arid to see if communication influences their use of climate-smart technology. Kenya should conduct research on Big Data and scientific communication for development.

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APPENDICES

Appendix I: Introduction Letter

Dear Participant,

I am carrying a study on **"Utilization of Communication in Adoption of Climate Smart Agricultural Technologies among Farmers in West Pokot County".** The completion of this research will be in partial fulfillment for the award of the degree of doctor of philosophy in communication studies of Moi University. Your information is of high value and will guarantee the success of this study. I therefore request you to spend some of your time to answer the questions in this questionnaire. Thank you in advance for your help and co-operation.

Yours faithfully,

Floridah Chelangat Maritim

ADM.NO SIS/PHD/C/001/19

Appendix II: Questionnaires for representatives from West Pokot farmers

This questionnaire is meant to gather information regarding **Utilization of Communication in Adoption of Climate Smart Agricultural Technologies among Farmers in West Pokot County**.

CONFIDENTIALITY CLAUSE:

The responses you provide will be used for academic purposes and will be strictly confidential.

SECTION A: Demographic Data

1. What is your gender?

   Male [ ] Female [ ]

2. What is your highest level of education?

   None [ ] Primary [ ] Secondary [ ] Certificate [ ]

   Diploma [ ] Undergraduate [ ] Masters [ ] PhD [ ]

3. Which Sub County do you come from?

   West Pokot [ ] North Pokot [ ] Central Pokot [ ] Pokot South [ ]

4. Which kind of farming do you practice:

   Livestock keeping [ ] Crops farming [ ] Mixed farming [ ] Others [ ]

SECTION B: Principles of Communication to Enhance Utilization of Climate Smart Agricultural Technologies

5. Please rate the following statements regarding principles of communication that have been adopted by agricultural researchers/officers to enhance utilization of climate smart technologies in West Pokot County, whereby, 1= Strongly Disagree, 2= Disagree, 3=Neutral, 4= Agree, 5= Strongly Agree.

Statement	**5**	**4**	**3**	**2**	**1**
a) Communication about climate smart technologies to farmers is correct.					
b) Communication about climate smart technologies is clear to farmers.					
c) Communication about climate smart technologies to farmers is conscious					
d) Communication about climate smart technologies to farmers is complete					
e) Communication about climate smart technologies to farmers is considering the farmers needs					
f) Communication about climate smart technologies to farmers is concrete					
g) Communication about climate smart technologies to farmers has courtesy					

SECTION C: Types of Communication used by Agricultural Researchers in Dissemination of Information to Farmers

6. Please rate the following statements concerning the types of communication used by agricultural researchers/officers in dissemination of information to farmers about climate smart technologies in West Pokot County, whereby, 1= Strongly Disagree, 2= Disagree, 3=Neutral, 4= Agree, 5= Strongly Agree.

Statement	**1**	**2**	**3**	**4**	**5**
a) Agricultural researchers/agents use mobile phones in dissemination of information to farmers about climate smart technologies in West Pokot County					
b) Agricultural researchers/agents use landline calls (call centers) in dissemination of information to farmers about climate smart technologies in West Pokot County					
c) Agricultural researchers/agents use face to face communication in dissemination of information to farmers about climate smart technologies in West Pokot County					
d) Agricultural researchers/agents use radio e.g. FM stations in dissemination of information to farmers about climate smart technologies in West Pokot County					
e) Agricultural researchers/agents use television in dissemination of information to farmers about climate smart technologies in West Pokot County					
f) Agricultural researchers/agents use print media such as newspapers and magazines in dissemination of information to farmers about climate smart technologies in West Pokot County					
g) Agricultural researchers/agents use social media such as Facebook, twitter and WhatsApp in dissemination of information to farmers about climate smart technologies in West Pokot County					

SECTION E: Please Rate the Following Statements on the the Extent Farmers in West Pokot County Have Adopted and Applied Climate Smart Technologies

7. Please rate the following statements the extent to which farmers in West Pokot County have adopted and applied climate smart technologies based on information received from agricultural researchers/officers. Use the scale: 1= Strongly Disagree, 2= Disagree, 3=Neutral, 4= Agree, 5= Strongly Agree.

Statement	**1**	**2**	**3**	**4**	**5**
a) Famers in West Pokot access adequate communication that allow them to adopt climate smart technologies					
b) Farmers are able to apply information on climate smart technologies that they receive from various communication platforms					
c) Farmers are updated weekly about climate smart technology and are able to adopt the weekly information					
d) Farmers are updated monthly about climate smart technology and are able to adopt the monthly information					
e) Farmers are updated semi-annually about climate smart technology and are able to adopt the semi-annually information					
f) Farmers are updated quarterly about climate smart technology and are able to adopt the quarterly information					
g) Farmers are updated annually about climate smart technology and are able to adopt the annually information					

SECTION F: Communication Barriers in Dissemination of Agricultural Information to Farmers

8. Please rate the following statements on communication barriers in dissemination of information to farmers about climate smart technologies in West Pokot County, where, 1= Strongly Disagree, 2= Disagree, 3=Neutral, 4= Agree, 5= Strongly Agree.

Statement	**1**	**2**	**3**	**4**	**5**
a) There is limited number of agricultural extension officers to disseminate information about climate smart technologies					
b) The language used to disseminate climate smart agricultural information affects how farmers use the information they receive					
c) The sources of information are inadequate hence hindering the effective dissemination of agricultural research information on climate smart technologies					
d) There are no information centers in West Pokot County where farmers can easily access and timely information about climate smart agricultural technologies					
e) There is limited agricultural information infrastructure, such as; communication networks, electricity, etc., which run electronic media such as radio, TV, and mobile phones that can accelerate and promote the transfer of information on CSA to the farmers					
f) There is political interference in dissemination of climate smart agriculture					

SECTION G: Communication Interventions to Improve Utilization of Climate Smart Technologies

9. In your opinion, what are some of the communication interventions that can be put in place to improve utilization of climate smart technologies among farmers in West Pokot County

i. ……

……

ii. ……

……

iii. ……

……

iv. ……

……

v. ……

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vi. ……

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vii. ……

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viii. ……

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……

SECTION H: Utilization of Climate Smart Agricultural Technologies

10. Please rate the following statements on the utilization of climate smart agricultural technologies by farmers in West Pokot County, where, 1= Strongly Disagree, 2= Disagree, 3=Neutral, 4= Agree, 5= Strongly Agree.

Statement	**1**	**2**	**3**	**4**	**5**
a) Generally, there has been increased utilization of Climate Smart Technologies among farmers in West Pokot County.					
b) Effective communication about climate smart technologies has enhanced accessibility of the technologies by farmers in West Pokot					
c) Communication about climate smart technologies is reliable hence enhanced utilization of the technologies among farmers in West Pokot					
d) Personalized agricultural advice about climate smart technologies has enhanced the utilization of the technologies among farmers in West Pokot					
Overall, effective communication to farmers about climate smart technologies has improved agricultural productivity in West Pokot County					

THANK YOU

Appendix III: Interview guide for Key Informants

Bio Data:

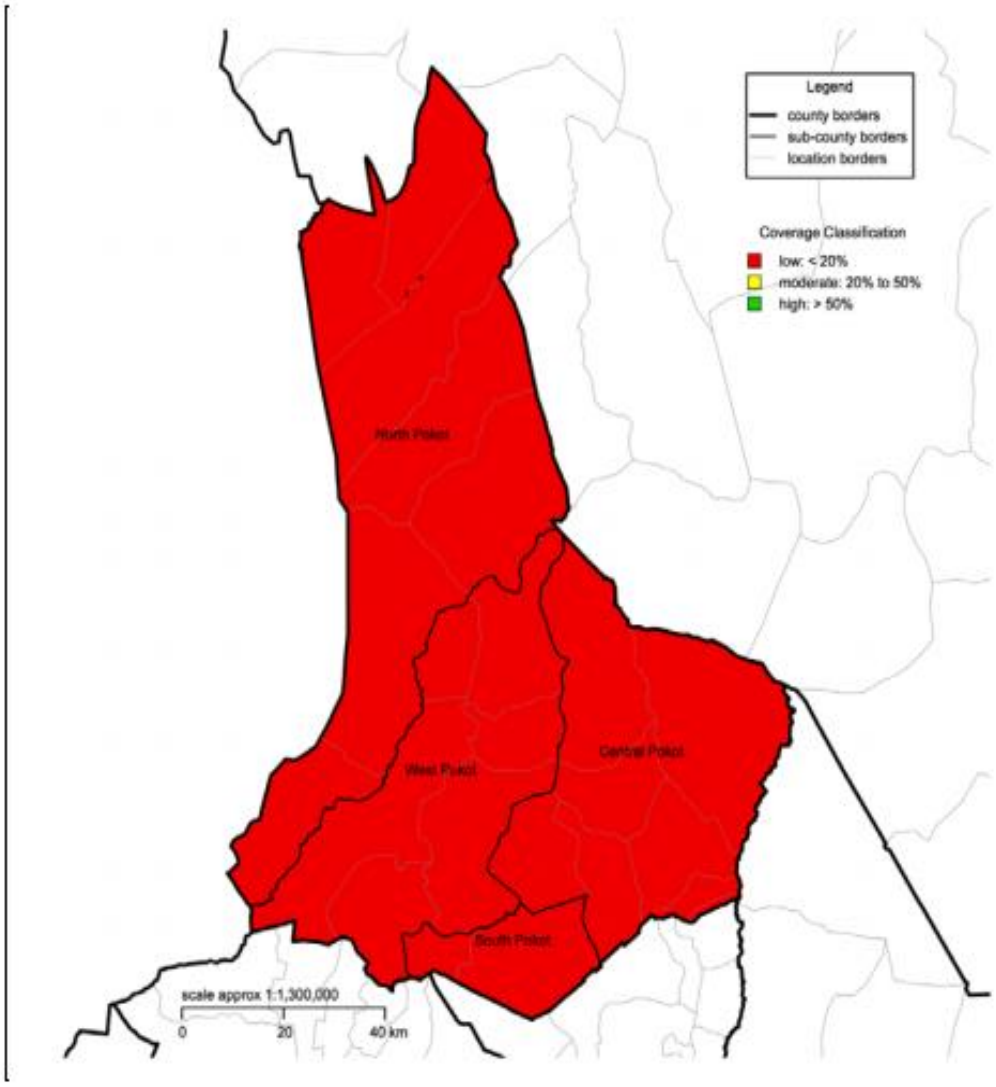
Your Organization: _____

Your Position: _____

Questions:

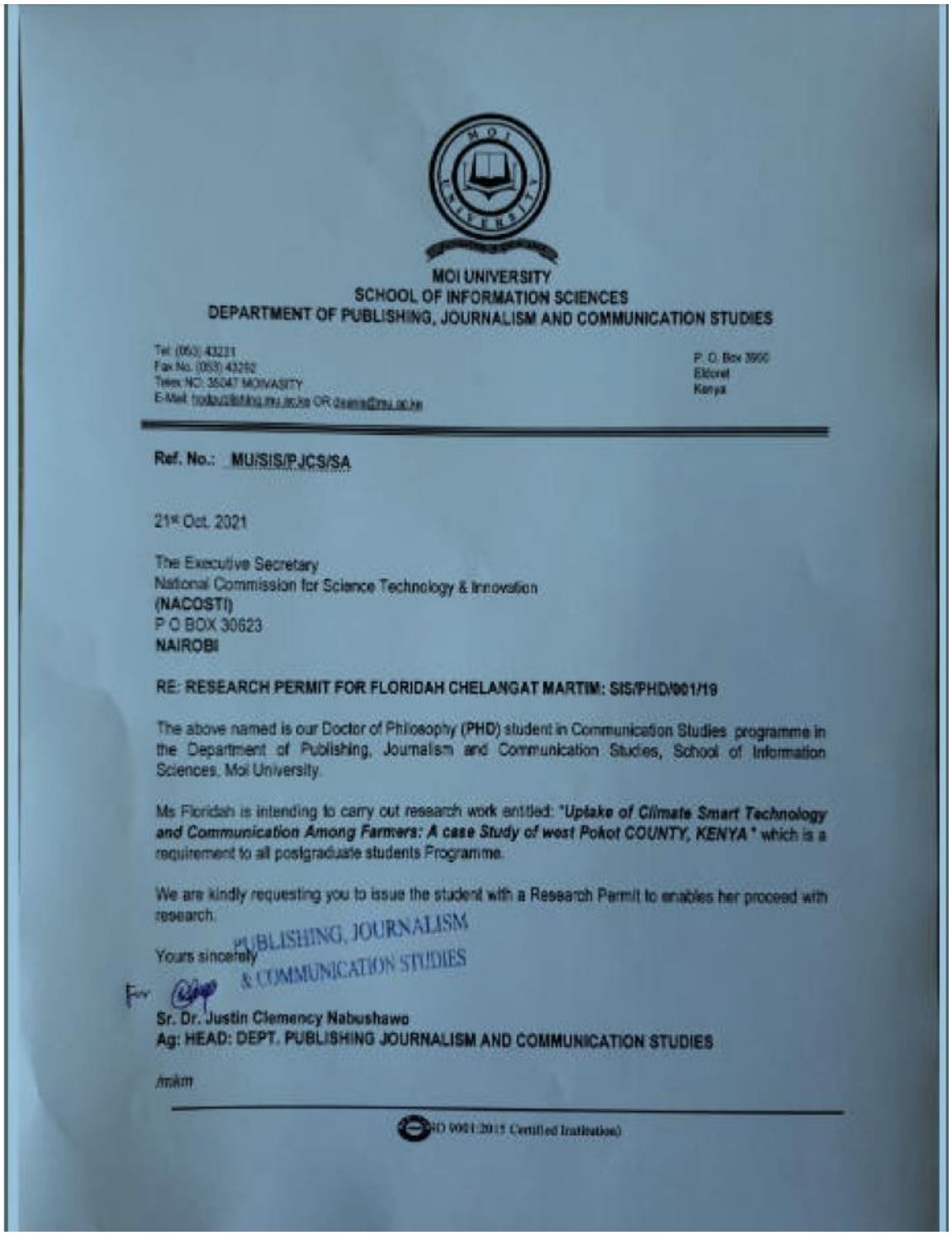
1. What are the principles of communication that have been adopted by agricultural researchers/officers to enhance utilization of climate smart technologies in West Pokot County?
   ……
   ……
   ……
2. What are the types of communication used by agricultural researchers/officers in dissemination of information to farmers about climate smart technologies in West Pokot County?……
   ……
   ….……
3. Do you have communication policies in your organization?
   ……
   ……
4. To what extent to which farmers in West Pokot County have adopted and applied climate smart technologies based on information received from agricultural researchers/officers?
   ……
   ……
5. What are the communication barriers in dissemination of information to farmers about climate smart technologies in West Pokot County?
   ……
   ……
6. What communication interventions that can be put in place to improve utilization of climate smart technologies among farmers in West Pokot County?
   ……

Appendix IV: Study Area Map



Source: Google Maps 2023

Appendix V: University Letter of Research Permit



MOI UNIVERSITY
SCHOOL OF INFORMATION SCIENCES
DEPARTMENT OF PUBLISHING, JOURNALISM AND COMMUNICATION STUDIES

Tel: (053) 43231
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E-Mail: hodpjcs@mu.ac.ke OR dsims@mu.ac.ke

P. O. Box 3900
Eldoret
Kenya

Ref. No.: MU/SIS/PJCS/SA

21st Oct. 2021

The Executive Secretary
National Commission for Science Technology & Innovation
(NACOSTI)
P O BOX 30623
NAIROBI

RE: RESEARCH PERMIT FOR FLORIDAH CHELANGAT MARTIM: SIS/PHD/001/19

The above named is our Doctor of Philosophy (PHD) student in Communication Studies programme in the Department of Publishing, Journalism and Communication Studies, School of Information Sciences, Moi University.

Ms Floridah is intending to carry out research work entitled: ***"Uptake of Climate Smart Technology and Communication Among Farmers: A case Study of west Pokot COUNTY, KENYA"*** which is a requirement to all postgraduate students Programme.

We are kindly requesting you to issue the student with a Research Permit to enables her proceed with research.

Yours sincerely

PUBLISHING, JOURNALISM & COMMUNICATION STUDIES

For

Sr. Dr. Justin Clemency Nabushawo
Ag: HEAD: DEPT. PUBLISHING JOURNALISM AND COMMUNICATION STUDIES

/mkm

ISO 9001:2015 Certified Institution

Appendix VI: NACOSTI Letter of Research Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **677694**

Date of Issue: **08/March/2022**

RESEARCH LICENSE

This is to Certify that Ms.. Floridah Chelangat Maritim of Moi University, has been licensed to conduct research in Baringo, Westpokot on the topic: UPTAKE OF CLIMATE SMART TECHNOLOGIES AND COMMUNICATION AMONG FARMERS: A CASE OF WEST POKOT COUNTY, KENYA for the period ending : 08/March/2023.

License No: **NACOSTI/P/22/15844**

677694

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

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