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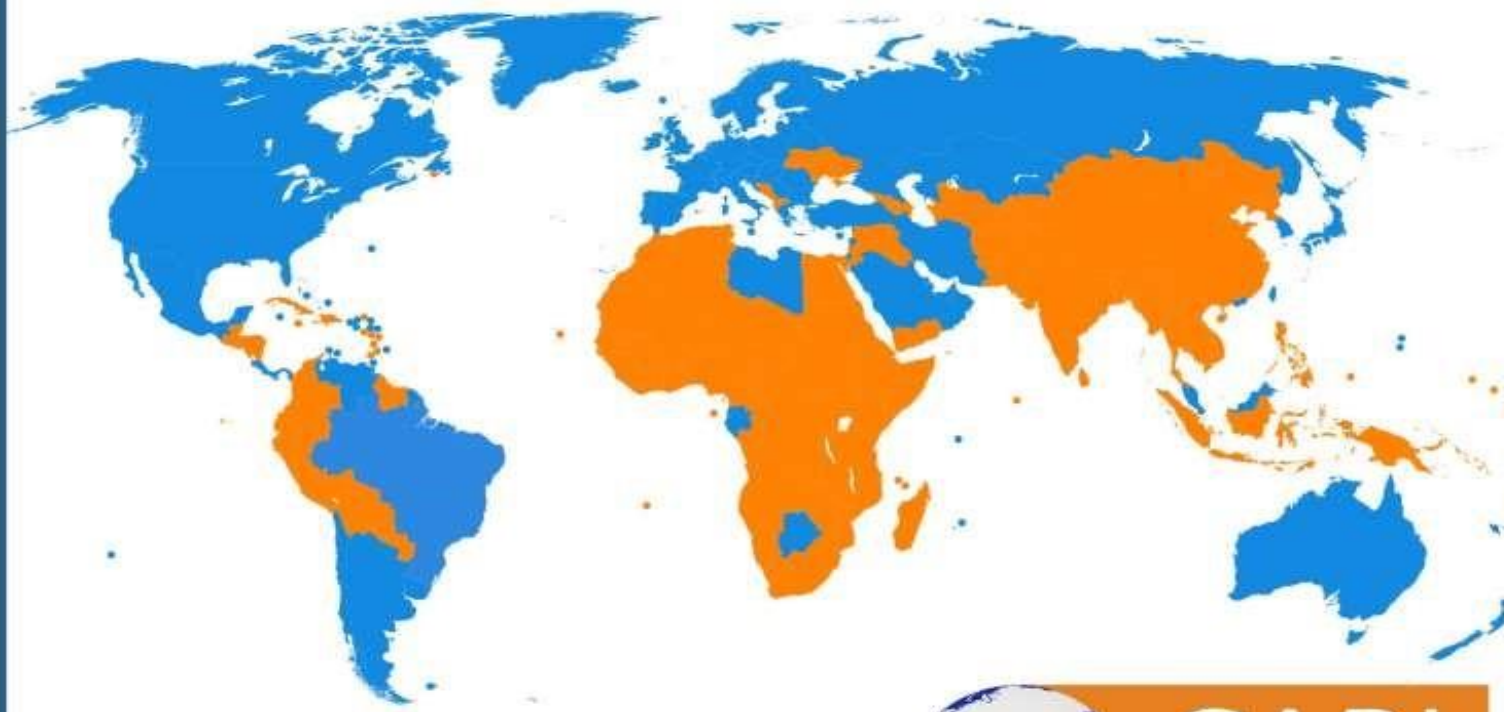

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The Role of Agricultural Innovation in Enhancing Food Security in Sub-Saharan Africa

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Abstract

Purpose: The general objective of the study was to investigate the role of agricultural innovation in enhancing food security in Sub Saharan Africa.

Methodology: The study adopted a desktop research methodology. Desk research refers to secondary data or that which can be collected without fieldwork. Desk research is basically involved in collecting data from existing resources hence it is often considered a low cost technique as compared to field research, as the main cost is involved in executive's time, telephone charges and directories. Thus, the study relied on already published studies, reports and statistics. This secondary data was easily accessed through the online journals and library.

Findings: The findings reveal that there exists a contextual and methodological gap relating to the role of agricultural innovation in enhancing food security in Sub Saharan Africa. Preliminary empirical review revealed that agricultural innovation was critical in addressing the pervasive food insecurity in Sub-Saharan Africa. It found that innovations in crop breeding, sustainable farming practices, precision agriculture, and improved agricultural inputs significantly increased productivity and food availability. However, the study emphasized that these innovations needed to be context-specific due to the diverse agro-ecological and socio-economic conditions in the region. Additionally, barriers such as limited access to finance, inadequate extension services, and poor infrastructure were identified as significant obstacles to the adoption of agricultural innovations. The study also highlighted the importance of integrating sustainability and resilience into agricultural practices to ensure long-term food security.

Unique Contribution to Theory, Practice and Policy: Diffusion of Innovations Theory, Sustainable Livelihoods Framework and Innovation Systems Theory may be used to anchor future studies on food security in Sub Saharan Africa. The study recommended further research into the contextual factors influencing the adoption and impact of agricultural innovations, suggesting that more region-specific studies could provide deeper insights. It also emphasized strengthening agricultural extension services and leveraging digital technologies to enhance farmers' access to information. Improving financial access for smallholder farmers through tailored credit products and public-private partnerships was also advised. On the policy front, the study called for supportive policies that reduce regulatory barriers and promote sustainable practices. Additionally, fostering collaboration among stakeholders and enhancing capacity-building initiatives were recommended to empower farmers and facilitate the widespread adoption of agricultural innovations.

Keywords: *Agricultural Innovation, Food Security, Sub-Saharan Africa, Sustainable Farming Practices, Smallholder Farmers*

1.0 INTRODUCTION

Food security exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO, 2013). Achieving food security involves multiple dimensions, including the availability of food, access to food, utilization of food, and the stability of these factors over time. Availability refers to the supply of food through production, distribution, and exchange. Access involves having adequate resources to obtain appropriate foods for a nutritious diet. Utilization is determined by the quality of the diet and the body's ability to process nutrients, which can be affected by sanitation, clean water, and healthcare. Stability entails having consistent access to food at all times, without the risk of losing access due to economic or environmental shocks (FAO, 2013). Globally, food security is a dynamic issue, continually shaped by various factors such as population growth, climate change, economic instability, and political conflicts. The Food and Agriculture Organization (FAO) reports that over 2 billion people globally do not have regular access to safe, nutritious, and sufficient food, with the majority residing in low- and middle-income countries (FAO, 2020). Climate change exacerbates food insecurity by affecting agricultural productivity, altering water availability, and increasing the frequency of extreme weather events. Moreover, economic disparities and poverty hinder access to food, while political instability and conflicts can disrupt food production and distribution systems. Therefore, achieving global food security requires multifaceted strategies addressing production efficiency, economic equity, and sustainable resource management (FAO, 2020).

In the USA, food security is primarily influenced by economic access rather than availability. Despite being one of the world's largest food producers, about 10.5% of American households were food insecure at some point during 2019, which translates to approximately 13.7 million households (USDA, 2020). Food insecurity in the USA often stems from poverty and economic inequality, with significant variations across different states and demographic groups. Households with children, single-parent families, and Black and Hispanic households experience higher rates of food insecurity compared to the national average. For example, in 2019, 14.6% of households with children were food insecure, highlighting the vulnerability of younger populations to economic challenges (Coleman-Jensen et al., 2020). The federal government has implemented various programs to mitigate food insecurity, such as the Supplemental Nutrition Assistance Program (SNAP), which provides food-purchasing assistance to low-income individuals and families. SNAP is the largest federal nutrition assistance program, serving about 38 million people in 2019. Additionally, the National School Lunch Program (NSLP) and the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) play crucial roles in supporting food access among vulnerable populations, particularly children and pregnant women (USDA, 2020). Despite these efforts, disparities remain, especially in minority and rural communities, where access to grocery stores and fresh food is limited, often referred to as "food deserts" (Ver Ploeg, Nulph & Williams, 2012). Addressing these disparities requires targeted policies that not only provide financial support but also improve the availability and accessibility of nutritious foods in underserved areas.

In the United Kingdom, food security issues are closely linked to economic factors and social inequality. According to the Food Foundation, approximately 8.4 million people in the UK experienced food insecurity in 2018, including 1.9 million children (Taylor & Loopstra, 2019). The COVID-19 pandemic has further exacerbated food insecurity, with millions of households struggling to afford basic necessities. A survey conducted by the Food Foundation in 2020 found that 14% of adults experienced moderate or severe food insecurity in the first six months of the pandemic (Food Foundation, 2020). The UK government and various non-governmental organizations have implemented several measures to address food insecurity, such as food banks and community food

programs. The Trussell Trust, the largest network of food banks in the UK, distributed over 1.9 million food parcels in 2019-2020, with a significant increase observed during the pandemic (Trussell Trust, 2020). Additionally, initiatives like the Healthy Start scheme provide vouchers to low-income pregnant women and families with young children to purchase healthy foods. However, critics argue that these measures are insufficient and call for more comprehensive policies addressing the root causes of food insecurity, such as low wages and inadequate social support systems (Taylor & Loopstra, 2019). Long-term solutions should focus on improving economic stability, enhancing social welfare programs, and ensuring that all citizens have access to affordable, nutritious food.

Japan, as a high-income country, faces unique challenges in ensuring food security. While Japan has a high level of food availability, it is heavily reliant on food imports, with only 38% of its food supply being domestically produced as of 2018 (Ministry of Agriculture, Forestry and Fisheries, 2019). This dependency on imports makes Japan vulnerable to global market fluctuations and trade disruptions. Additionally, Japan's aging population and declining agricultural workforce pose significant challenges to maintaining domestic food production levels. To address these issues, Japan has implemented various policies aimed at increasing food self-sufficiency and promoting sustainable agriculture. The Basic Plan for Food, Agriculture, and Rural Areas sets targets for increasing domestic production and improving the resilience of food supply chains (MAFF, 2019). Initiatives such as promoting local consumption of locally produced food (chisan-chisho) and supporting young farmers are part of these efforts. Furthermore, Japan has invested in advanced agricultural technologies, including precision farming and biotechnology, to enhance productivity and sustainability (Takahashi & Todo, 2020). These measures aim to balance the need for economic efficiency with the imperative of food security, ensuring that Japan can provide sufficient and safe food for its population even in the face of external shocks.

Sub-Saharan Africa faces some of the most severe food security challenges globally, driven by a combination of economic, environmental, and political factors. According to the FAO, over 250 million people in Sub-Saharan Africa were undernourished in 2019, representing about 19% of the population (FAO, 2020). Factors such as poverty, conflict, climate change, and inadequate infrastructure significantly hinder food security in the region. For example, in countries like South Sudan and Nigeria, ongoing conflicts have disrupted agricultural production and food distribution, leading to widespread hunger and malnutrition (FAO, 2020). Climate change exacerbates these challenges by affecting rainfall patterns, causing droughts and floods, and reducing agricultural productivity. In East Africa, prolonged droughts have led to significant crop failures and livestock losses, impacting food availability and livelihoods. For instance, the 2016-2017 drought in Kenya, Ethiopia, and Somalia affected over 25 million people, leading to severe food shortages and increased malnutrition rates (Nicholson, 2017). To address these issues, various initiatives focus on improving agricultural productivity, enhancing resilience to climate change, and promoting sustainable farming practices. Programs such as the Comprehensive Africa Agriculture Development Programme (CAADP) aim to boost agricultural growth, reduce poverty, and achieve food security through increased investment and policy reforms (NEPAD, 2013).

Nigeria, as the most populous country in Africa, faces significant food security challenges. According to the Global Hunger Index, Nigeria ranks 98th out of 107 countries, with a serious level of hunger (Global Hunger Index, 2020). Food insecurity in Nigeria is driven by factors such as poverty, conflict, and climate change. The Boko Haram insurgency in the northeast has displaced millions of people, disrupting agricultural activities and access to food. Additionally, climate change impacts, such as desertification in the north and flooding in the south, further exacerbate food insecurity (Akinyele, 2009). The Nigerian government and various organizations have implemented programs to address these challenges. For example, the National Food Security Programme aims to enhance agricultural

productivity, improve access to food, and build resilience against climate change. Initiatives such as the Agricultural Transformation Agenda focus on modernizing agriculture, promoting value chain development, and encouraging private sector investment (Federal Ministry of Agriculture and Rural Development, 2011). However, achieving food security in Nigeria requires addressing underlying issues such as poverty, infrastructure deficits, and political instability. Ensuring effective implementation of policies and programs, along with fostering collaboration between government, private sector, and international partners, is crucial for sustainable progress (Akinyele, 2009).

Ethiopia has made significant strides in improving food security over the past few decades, yet challenges remain. According to the World Food Programme, about 20% of the population still experiences food insecurity, primarily due to poverty, climate variability, and population growth (WFP, 2019). Ethiopia's economy is heavily reliant on agriculture, which employs about 70% of the workforce. However, frequent droughts and land degradation limit agricultural productivity and food availability. The Ethiopian government has prioritized food security in its national development plans, implementing policies to enhance agricultural productivity, improve infrastructure, and build resilience to climate change. The Productive Safety Net Programme (PSNP) is one such initiative, providing food and cash transfers to vulnerable households while promoting sustainable land management practices (Berhane, Hoddinott, Kumar & Taffesse, 2014). Additionally, investments in irrigation, improved seeds, and agricultural extension services aim to increase crop yields and reduce dependency on rain-fed agriculture. These efforts have contributed to significant reductions in poverty and malnutrition rates, yet ongoing challenges such as population growth and climate change require sustained and innovative approaches to achieve long-term food security (WFP, 2019).

Kenya, with its diverse climate and agricultural potential, faces regional disparities in food security. While some regions enjoy relative food security, arid and semi-arid areas, particularly in the northern and eastern parts of the country, experience chronic food insecurity. According to the Kenya National Bureau of Statistics, about 36% of the population was food insecure in 2019, with higher rates observed in pastoralist communities (KNBS, 2020). Factors such as poverty, climate variability, and inadequate infrastructure contribute to food insecurity in these regions. The Kenyan government has implemented various policies and programs to address food security, including the Agricultural Sector Development Strategy and the Big Four Agenda, which prioritizes food and nutrition security. Initiatives such as the Hunger Safety Net Programme (HSNP) provide cash transfers to vulnerable households in arid regions, improving their access to food and resilience to shocks (NDMA, 2019). Additionally, investments in irrigation, climate-smart agriculture, and improved seed varieties aim to enhance agricultural productivity and reduce vulnerability to climate change. However, achieving food security in Kenya requires addressing underlying issues such as poverty, inequality, and access to markets and services. Collaborative efforts between government, private sector, and international partners are essential for sustainable progress (KNBS, 2020).

South Africa, as one of the more developed countries in Sub-Saharan Africa, still faces significant food security challenges. Despite being a net food exporter, about 11% of South African households experienced hunger in 2018, primarily due to poverty and inequality (Statistics South Africa, 2019). Food insecurity is more prevalent in rural areas and among low-income households, highlighting the need for targeted interventions to address these disparities.The South African government has implemented various programs to improve food security, such as the National School Nutrition Programme, which provides meals to millions of children in schools, and the Integrated Food Security Strategy, aimed at enhancing access to nutritious food through agricultural development and social protection measures (DAFF, 2014). Additionally, initiatives such as the Comprehensive Agricultural Support Programme (CASP) and the Land Redistribution for Agricultural Development (LRAD) seek to empower smallholder farmers and improve agricultural productivity. However, challenges such as

land tenure issues, climate change, and economic inequality continue to hinder progress. Addressing these challenges requires sustained investments in agriculture, social protection, and rural development to ensure that all South Africans have access to sufficient, safe, and nutritious food (Statistics South Africa, 2019).

Agricultural innovation encompasses the development and application of new technologies, practices, and products aimed at improving agricultural productivity, sustainability, and efficiency. These innovations can range from advancements in crop breeding, precision farming technologies, and sustainable farming practices to the development of improved agricultural inputs such as fertilizers and pesticides. The primary goal of agricultural innovation is to enhance the productivity and profitability of farming, ensuring environmental sustainability and resilience to climate change. This is particularly important in the context of global challenges such as population growth, changing dietary preferences, and the impacts of climate change (Alston, 2018). By introducing new methods and technologies, agricultural innovation plays a critical role in addressing food security challenges and ensuring that agricultural systems can meet the growing demand for food.

One of the most significant areas of agricultural innovation is crop breeding and biotechnology. This field involves the development of new crop varieties that are more resistant to pests, diseases, and environmental stresses such as drought and salinity. Traditional breeding methods have been enhanced by modern biotechnology techniques, including genetic modification and genome editing. Genetically modified (GM) crops, for instance, have been engineered to improve yields and reduce the need for chemical inputs. Bt cotton and Bt maize are examples of GM crops that have significantly increased productivity and reduced pesticide use in several countries (James, 2015). These innovations are vital for ensuring food security by increasing food production and reducing the vulnerability of crops to environmental challenges. The adoption of GM crops has shown positive impacts on yield and farm income, particularly in developing countries where smallholder farmers benefit from reduced input costs and increased productivity (Brookes & Barfoot, 2018).

Precision farming technologies represent another critical aspect of agricultural innovation. These technologies utilize data and advanced tools to optimize agricultural practices, leading to increased efficiency and productivity. Precision farming includes the use of GPS-guided equipment, remote sensing, and data analytics to monitor and manage crop health, soil conditions, and resource use. For example, precision irrigation systems can deliver the exact amount of water needed by crops, reducing water wastage and improving yields (Gebbers & Adamchuk, 2010). By providing farmers with precise information about their fields, these technologies help in making informed decisions that enhance crop management and resource use efficiency. This, in turn, contributes to food security by maximizing production while minimizing the environmental footprint of agriculture (Basso, Cammarano & Carfagna, 2013).

Sustainable farming practices are essential for maintaining soil health, conserving water, and reducing the environmental impact of agriculture. Innovations in sustainable farming include conservation tillage, crop rotation, agroforestry, and integrated pest management (IPM). Conservation tillage, for instance, reduces soil erosion and improves water retention by minimizing soil disturbance. Crop rotation and agroforestry enhance biodiversity and soil fertility, while IPM reduces reliance on chemical pesticides by promoting biological control methods (Pretty, Benton, Bharucha, Dicks, Flora, Godfray & Wratten, 2018). These practices contribute to long-term agricultural sustainability and resilience, which are crucial for ensuring a stable food supply. By adopting sustainable farming practices, farmers can maintain productivity and profitability while preserving the natural resources essential for future food production.

The development of improved agricultural inputs, such as fertilizers, pesticides, and seeds, plays a crucial role in enhancing agricultural productivity. Innovations in fertilizers and pesticides aim to increase their efficiency and reduce their environmental impact. For example, slow-release fertilizers provide nutrients to crops over an extended period, reducing the need for frequent applications and minimizing nutrient runoff (Chen, Liu & Wang, 2018). Similarly, biopesticides derived from natural sources offer effective pest control with fewer environmental side effects compared to synthetic chemicals (Marrone, 2014). Improved seed varieties, developed through both traditional breeding and biotechnology, offer higher yields, better nutritional quality, and increased resistance to pests and diseases. These inputs are essential for increasing crop productivity and ensuring food security, particularly in regions with limited access to resources.

Information and Communication Technologies (ICT) are transforming agriculture by providing farmers with access to information, markets, and services. Mobile phones, the internet, and digital platforms enable farmers to receive weather forecasts, market prices, and agricultural advice, which can improve decision-making and productivity (Aker, 2011). For instance, mobile-based platforms can disseminate information on best farming practices, pest and disease management, and climate adaptation strategies. Digital marketplaces connect farmers with buyers, reducing transaction costs and improving market access. ICT innovations empower farmers, particularly smallholders, by providing them with the knowledge and tools needed to enhance their agricultural practices and economic outcomes. This digital transformation of agriculture is crucial for improving food security by enhancing the efficiency and effectiveness of agricultural systems.

Climate-smart agriculture (CSA) is an integrated approach to managing landscapes—cropland, livestock, forests, and fisheries—that addresses the interlinked challenges of food security and climate change. CSA aims to achieve three main objectives: sustainably increasing agricultural productivity and incomes, adapting and building resilience to climate change, and reducing or removing greenhouse gas emissions where possible (Lipper, Thornton, Campbell, Baedeker, Braimoh, Bwalya & Wollenberg, 2014). Innovations in CSA include the development of climate-resilient crop varieties, efficient water management systems, and agroecological practices that enhance soil health and biodiversity. By integrating these approaches, CSA helps farmers adapt to changing climatic conditions, mitigate the impacts of climate change, and ensure food security for future generations. The adoption of CSA practices is particularly important in regions vulnerable to climate variability and extreme weather events, where traditional farming methods may no longer be viable.

Policy and institutional innovations are critical for creating an enabling environment that supports agricultural innovation and food security. Effective policies can promote research and development, provide incentives for adopting new technologies, and facilitate access to markets and financial services. For example, policies that support agricultural research and extension services can accelerate the development and dissemination of innovative practices and technologies (Pingali, 2012). Institutional innovations, such as farmer cooperatives and public-private partnerships, can enhance the capacity of smallholder farmers to access resources, share knowledge, and negotiate better market terms. Strengthening agricultural policies and institutions is essential for fostering innovation, improving productivity, and ensuring food security at both local and global levels.

The link between agricultural innovation and food security is evident in the improvements in food availability, access, and stability that result from adopting innovative practices and technologies. Agricultural innovations increase crop yields, enhance resource use efficiency, and reduce vulnerability to environmental and economic shocks. For example, the adoption of high-yielding crop varieties and precision farming techniques has significantly increased food production in many regions, contributing to greater food availability (Fischer, Byerlee & Edmeades, 2014). Improved agricultural practices also enhance food access by increasing farmers' incomes and reducing

production costs. Moreover, sustainable farming practices and climate-smart agriculture contribute to the stability of food systems by building resilience to climate change and other risks. Overall, agricultural innovation is a key driver of food security, enabling the agricultural sector to meet the growing global demand for food in a sustainable and resilient manner.

1.1 Statement of the Problem

Despite significant advancements in agricultural practices and technology, Sub-Saharan Africa continues to face severe food security challenges. According to the Food and Agriculture Organization (FAO), over 250 million people in the region were undernourished in 2019, representing about 19% of the population (FAO, 2020). This widespread food insecurity is exacerbated by factors such as climate change, economic instability, and political conflicts, which disrupt agricultural productivity and food distribution systems. While agricultural innovation has the potential to significantly enhance food security by improving crop yields, reducing post-harvest losses, and promoting sustainable farming practices, the adoption and impact of these innovations in Sub-Saharan Africa remain inconsistent and poorly understood. This study aims to explore the role of agricultural innovation in enhancing food security in Sub-Saharan Africa, identifying the barriers to adoption and the strategies that can effectively address these challenges. The existing body of research highlights the potential benefits of agricultural innovation, yet significant gaps remain in understanding the specific contextual factors that influence the adoption and effectiveness of these innovations in Sub-Saharan Africa. For instance, while there is considerable evidence on the positive impacts of genetically modified crops and precision farming technologies in other regions, there is limited research on how these innovations perform in the diverse agro-ecological and socio-economic contexts of Sub-Saharan Africa (Morris, Tripp & Dankyi, 2013). Additionally, there is a need to investigate the role of policy frameworks, extension services, and local knowledge systems in facilitating or hindering the adoption of agricultural innovations. By addressing these gaps, this study seeks to provide a comprehensive analysis of the factors that can enhance the effectiveness of agricultural innovations in improving food security in Sub-Saharan Africa. The findings of this study will benefit a wide range of stakeholders, including policymakers, agricultural researchers, extension service providers, and smallholder farmers. Policymakers will gain insights into the most effective policy interventions and support mechanisms needed to promote the adoption of agricultural innovations. Agricultural researchers will benefit from a deeper understanding of the contextual factors that influence the success of different innovations, guiding future research and development efforts. Extension service providers will be equipped with evidence-based strategies to effectively disseminate and support the adoption of innovative practices among farmers. Finally, smallholder farmers, who are often the most vulnerable to food insecurity, will benefit from increased productivity, sustainability, and resilience of their farming systems, ultimately leading to improved food security and livelihoods (Pingali, 2012). By addressing the research gaps and providing actionable recommendations, this study aims to contribute to the broader efforts of achieving food security and sustainable agricultural development in Sub-Saharan Africa.

2.0 LITERATURE REVIEW

2.1 Theoretical Review

2.1.1 Diffusion of Innovations Theory

The Diffusion of Innovations Theory, developed by sociologist Everett M. Rogers in 1962, is one of the most influential theories in understanding how new ideas, practices, or products gain traction and spread within a society. The main theme of this theory is that innovation adoption follows a predictable pattern, which can be categorized into different stages: innovators, early adopters, early majority, late majority, and laggards. According to Rogers, several factors influence the adoption process, including

the perceived advantages of the innovation, compatibility with existing values and practices, simplicity, trialability, and observable results (Rogers, 2003). This theory is particularly relevant to agricultural innovation in Sub-Saharan Africa because it provides a framework for understanding how new agricultural technologies and practices can spread among farmers. By identifying the characteristics that influence the adoption of innovations, policymakers and extension services can design targeted interventions to promote the uptake of beneficial agricultural practices, thereby enhancing food security. Understanding the social dynamics and communication channels that facilitate innovation diffusion can help address barriers and accelerate the adoption process, ultimately improving agricultural productivity and food security in the region.

2.1.2 Sustainable Livelihoods Framework

The Sustainable Livelihoods Framework, developed by the UK Department for International Development (DFID) in the late 1990s, offers a holistic approach to understanding and improving the livelihoods of the poor, particularly in rural areas. The main theme of this framework is that sustainable livelihoods depend on the ability to access and effectively utilize a variety of assets, including human, social, natural, physical, and financial capital. The framework emphasizes the importance of understanding the vulnerability context, such as shocks and stresses, and the role of policies, institutions, and processes in shaping livelihood outcomes (Scoones, 1998). This framework is highly relevant to the study of agricultural innovation in Sub-Saharan Africa, as it provides a comprehensive lens through which to assess the impacts of innovations on food security. By considering the diverse assets that farmers rely on and the external factors that affect their livelihoods, researchers can better understand how agricultural innovations can contribute to sustainable improvements in food security. The framework highlights the need for integrated approaches that address multiple dimensions of farmers' livelihoods, ensuring that innovations not only increase productivity but also enhance resilience and sustainability.

2.1.3 Innovation Systems Theory

Innovation Systems Theory, originating from the work of scholars such as Christopher Freeman and Bengt-Åke Lundvall in the late 1980s and early 1990s, focuses on the complex interactions between various actors and institutions that contribute to the development and diffusion of innovations. The main theme of this theory is that innovation is not an isolated process but rather the result of dynamic interactions within a system comprising research institutions, universities, government agencies, private enterprises, and civil society organizations (Freeman, 1987; Lundvall, 1992). This theory is pertinent to the study of agricultural innovation in Sub-Saharan Africa because it emphasizes the importance of creating an enabling environment that supports innovation. By analyzing the agricultural innovation system, researchers can identify the strengths and weaknesses of different components, such as research and development capacity, extension services, and market access. Understanding these interactions can inform policies and strategies to enhance the innovation system, ensuring that new agricultural technologies and practices are effectively developed, disseminated, and adopted by farmers. This systemic perspective is crucial for addressing the multifaceted challenges of food security and fostering sustainable agricultural development in Sub-Saharan Africa.

2.2 Empirical Review

Adegbola & Gardebroek (2015) aimed to analyze the impact of improved maize varieties on farm productivity and food security in Benin. The authors used a combination of household surveys and econometric analysis to assess the adoption rates and impacts of improved maize varieties. Data was collected from a sample of 500 maize farming households across different regions in Benin. The study found that the adoption of improved maize varieties significantly increased maize yields by an average of 30%. This increase in productivity was associated with improved household food security, as

evidenced by higher food consumption scores and reduced hunger incidence. The authors recommended scaling up the dissemination of improved maize varieties through extension services and farmer field schools. They also emphasized the need for policies that support seed distribution systems and address barriers to adoption, such as limited access to credit and information.

Manda, Alene, Gardebroek, Kassie & Tembo (2016) examined the impact of conservation agriculture practices on maize productivity and food security among smallholder farmers in Zambia. a cross-sectional survey of 600 households, the authors employed propensity score matching to estimate the impact of conservation agriculture on maize yields and household food security. The results indicated that conservation agriculture practices, such as minimum tillage and crop rotation, increased maize yields by 25-30%. Households practicing conservation agriculture also reported improved food security status, with reduced food gaps and increased dietary diversity. The study recommended promoting conservation agriculture through targeted extension services and training programs. It also suggested enhancing farmer access to conservation agriculture tools and inputs to encourage widespread adoption.

Melesse (2018) investigated the role of agricultural extension services in the adoption of improved wheat varieties and their impact on food security in Ethiopia. The study utilized a mixed-methods approach, combining quantitative household surveys with qualitative interviews. Data was collected from 450 wheat farming households and analyzed using logistic regression and thematic analysis. The findings showed that households receiving agricultural extension services were more likely to adopt improved wheat varieties, leading to higher wheat yields and better food security outcomes. The extension services provided crucial information and support that facilitated the adoption process. The study recommended strengthening agricultural extension systems by increasing the number of extension agents and improving their training. It also highlighted the importance of farmer-to-farmer extension networks to enhance the dissemination of agricultural innovations.

Nyasimi, Amwata, Hove, Kinyangi & Wamukoya (2014) assessed the effectiveness of climate-smart agricultural practices in enhancing food security and resilience among smallholder farmers in Kenya. The authors conducted a longitudinal study involving 800 smallholder farmers in various agro-ecological zones. Data was collected through surveys and focus group discussions, and analyzed using descriptive statistics and regression analysis. The study found that climate-smart agricultural practices, such as agroforestry, conservation agriculture, and integrated soil fertility management, significantly improved crop yields and household food security. These practices also enhanced farmers' resilience to climate variability. The study recommended scaling up climate-smart agriculture through policy support and investment in research and development. It also emphasized the need for capacity-building programs to equip farmers with the necessary skills and knowledge to implement these practices.

Kassie, Teklewold, Jaleta, Marenya & Erenstein (2015) explored the impacts of integrated soil fertility management (ISFM) on crop productivity and household food security in Malawi. The research employed a household survey of 1,200 farming households and used econometric models to estimate the impacts of ISFM practices on maize yields and food security indicators. The results indicated that ISFM practices, such as the combined use of organic and inorganic fertilizers, significantly increased maize yields by 20-40%. Households practicing ISFM also reported better food security outcomes, including higher food availability and reduced hunger periods. The authors recommended promoting ISFM through extension services and farmer training programs. They also suggested that policymakers should provide subsidies or financial incentives to encourage the adoption of ISFM practices.

Kassahun (2017) examined the impact of irrigation technology on crop productivity and food security among smallholder farmers in Ethiopia. A mixed-methods approach was used, combining quantitative surveys of 600 households with qualitative interviews and focus group discussions. Data was analyzed

using both descriptive and inferential statistics. The study found that the adoption of irrigation technology led to a significant increase in crop yields and income for smallholder farmers. This, in turn, improved household food security by enhancing food availability and access. The study recommended increasing investment in irrigation infrastructure and providing technical support to farmers. It also highlighted the need for policies that facilitate access to affordable irrigation technologies and water management practices.

Nkala, Mango & Zikhali (2011) focused on the adoption of conservation agriculture practices and their impact on food security among smallholder farmers in Zimbabwe. The research utilized a combination of household surveys, focus group discussions, and key informant interviews with 450 smallholder farmers. Data was analyzed using econometric techniques to assess the impact of conservation agriculture on food security indicators. The study found that conservation agriculture practices, such as minimum tillage and crop residue retention, improved soil fertility and increased crop yields. These improvements contributed to enhanced household food security by increasing food availability and stability. The authors recommended promoting conservation agriculture through farmer training programs and extension services. They also suggested that policymakers should support research on conservation agriculture and provide incentives to encourage its adoption.

3.0 METHODOLOGY

The study adopted a desktop research methodology. Desk research refers to secondary data or that which can be collected without fieldwork. Desk research is basically involved in collecting data from existing resources hence it is often considered a low cost technique as compared to field research, as the main cost is involved in executive's time, telephone charges and directories. Thus, the study relied on already published studies, reports and statistics. This secondary data was easily accessed through the online journals and library.

4.0 FINDINGS

This study presented both a contextual and methodological gap. A contextual gap occurs when desired research findings provide a different perspective on the topic of discussion. For instance, Kassahun (2017) examined the impact of irrigation technology on crop productivity and food security among smallholder farmers in Ethiopia. A mixed-methods approach was used, combining quantitative surveys of 600 households with qualitative interviews and focus group discussions. Data was analyzed using both descriptive and inferential statistics. The study found that the adoption of irrigation technology led to a significant increase in crop yields and income for smallholder farmers. This, in turn, improved household food security by enhancing food availability and access. The study recommended increasing investment in irrigation infrastructure and providing technical support to farmers. It also highlighted the need for policies that facilitate access to affordable irrigation technologies and water management practices. On the other hand, the current study focused on investigating the role of agricultural innovation in enhancing food security in Sub Saharan Africa.

Secondly, a methodological gap also presents itself, for instance, in examining the impact of irrigation technology on crop productivity and food security among smallholder farmers in Ethiopia; Kassahun (2017) used a mixed-methods approach was used, combining quantitative surveys of 600 households with qualitative interviews and focus group discussions. Data was analyzed using both descriptive and inferential statistics. Whereas, the current study adopted a desktop research method.

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study draws several critical conclusions. First and foremost, it is evident that agricultural innovation plays a pivotal role in addressing the persistent and widespread food insecurity that plagues

the region. Innovations in crop breeding, sustainable farming practices, precision agriculture, and the use of improved agricultural inputs have demonstrably increased agricultural productivity, resilience to environmental shocks, and overall food availability. The study highlights that without the adoption of these innovations, achieving significant improvements in food security would remain a distant goal. The empirical evidence shows that when farmers in Sub-Saharan Africa adopt innovative agricultural practices, there is a notable improvement in crop yields and household food security, underscoring the potential of innovation as a transformative force in agriculture.

Furthermore, the study underscores the importance of context-specific approaches to agricultural innovation. The diverse agro-ecological zones and varying socio-economic conditions across Sub-Saharan Africa mean that a one-size-fits-all approach to agricultural innovation is neither feasible nor effective. Innovations must be tailored to the specific needs, resources, and constraints of different farming communities. This requires a deep understanding of local conditions and active involvement of farmers in the innovation process. The study concludes that participatory approaches that engage farmers in the development, testing, and adaptation of agricultural innovations are crucial for ensuring their relevance, acceptability, and sustainability.

Additionally, the study reveals significant barriers to the adoption of agricultural innovations in Sub-Saharan Africa. These barriers include limited access to finance, inadequate extension services, insufficient infrastructure, and restrictive policy environments. Smallholder farmers, who constitute the majority of the farming population in the region, often lack the resources and support needed to adopt new technologies and practices. The study highlights that addressing these barriers is essential for scaling up the adoption of agricultural innovations and achieving widespread improvements in food security. Enhancing access to credit, investing in rural infrastructure, and strengthening extension services are identified as key measures to overcome these challenges. The study emphasizes the interconnectedness of agricultural innovation, environmental sustainability, and climate resilience. Agricultural innovations that enhance food security must also contribute to the sustainability of farming systems and their ability to withstand and adapt to climate change. Practices such as conservation agriculture, agroforestry, and integrated soil fertility management not only boost productivity but also improve soil health, conserve water, and enhance biodiversity. The study concludes that fostering agricultural innovations that integrate sustainability and resilience principles is critical for ensuring long-term food security in Sub-Saharan Africa. By adopting such holistic approaches, the region can achieve a balance between meeting immediate food needs and preserving the natural resource base for future generations.

5.2 Recommendations

Based on the findings of the study, several key recommendations are made to enhance the role of agricultural innovation in improving food security in Sub-Saharan Africa, addressing contributions to theory, practice, and policy. Firstly, in terms of theoretical contributions, the study recommends further research into the contextual factors that influence the adoption and impact of agricultural innovations. While the current study has identified some key barriers and facilitators, there is a need for more granular, region-specific studies that can provide deeper insights into the socio-economic, cultural, and environmental contexts that shape innovation adoption. Researchers are encouraged to develop and test new theoretical frameworks that capture the complexity and diversity of agricultural systems in Sub-Saharan Africa. This will contribute to a more nuanced understanding of how innovations can be effectively tailored and implemented in different contexts.

From a practical standpoint, the study highlights the necessity of strengthening agricultural extension services. Extension agents play a crucial role in disseminating knowledge about new technologies and practices, yet their reach and effectiveness are often limited. It is recommended that governments and

development organizations invest in training and expanding the network of extension workers. Additionally, leveraging digital technologies can complement traditional extension methods. Mobile phone-based platforms, for instance, can provide farmers with timely information on best practices, weather forecasts, and market prices, enhancing their ability to adopt and benefit from agricultural innovations.

To further support practical application, the study underscores the importance of improving access to finance for smallholder farmers. Financial constraints are a major barrier to the adoption of agricultural innovations. It is recommended that financial institutions develop tailored credit products that address the unique needs and risks faced by smallholders. This could include microloans, insurance schemes, and savings programs specifically designed for agricultural investments. Additionally, establishing public-private partnerships can mobilize resources and expertise, facilitating the development and dissemination of innovative financial products.

On the policy front, the study calls for the formulation and implementation of supportive policies that create an enabling environment for agricultural innovation. Governments should prioritize policies that reduce regulatory barriers, promote investment in agricultural research and development, and ensure that farmers have access to necessary inputs and services. This includes reforming land tenure systems to provide farmers with secure land rights, which can encourage investment in innovative practices. Furthermore, policies should incentivize sustainable agricultural practices by providing subsidies or rewards for adopting environmentally friendly technologies and methods.

In addition, the study recommends fostering collaboration and knowledge sharing among stakeholders. Agricultural innovation thrives in ecosystems where various actors, including researchers, farmers, government agencies, and private sector players, collaborate and share knowledge. Establishing platforms for multi-stakeholder engagement can facilitate the exchange of ideas, experiences, and best practices, leading to more effective and widespread adoption of innovations. Regional and international cooperation can also enhance the diffusion of successful innovations across borders, benefiting a larger number of farmers.

Finally, the study emphasizes the need for capacity-building initiatives that empower farmers with the skills and knowledge required to adopt and adapt agricultural innovations. Training programs should be designed to address the specific needs and challenges faced by farmers in different regions. These programs should focus not only on technical skills but also on enhancing farmers' business acumen and resilience to market and climate-related shocks. Empowering farmers through education and capacity-building will enable them to make informed decisions, innovate within their contexts, and ultimately improve their food security and livelihoods.

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