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Abstract

Productivity in agricultural is also important for spurring economic growth in other sectors. Farmers live in remote rural areas and make up 75% of the world's poor. In Sub-Sahara Africa (SSA), productivity in agriculture lags behind globally, and is below the required standards of achieving food security, poverty goals and food sufficiency. As an important sector in the Kenyan economy, agriculture continues to dominate other sectors despite its declining contribution to real GDP. The development in agriculture is that one which revolutionizes the industry by bringing forth profitable agriculture and environment friendly solutions. Kenya government through the Ministry of Agriculture and Livestock, have in the past tried to pass information to the farmers via agricultural extension officers. However, the quality of the information disseminated to the farmers has not been up to date, information delivery has not been good, the mode of communication also questionable owing to literacy levels of our farmers and indeed that of the extension officers, information technology has not been embraced fully making it difficult for our farmers to progress with their counterparts in other parts of the world. This study was conducted with the aim of determining the factors impacting agricultural production and the role of agricultural extension services in Kenya. This study is anchored on Diffusion of Innovations Theory. The study employed a mixed design involving a combination of both quantitative and qualitative approach. And the target population was made up of farmers, officers from the ministry of agriculture and officers from agricultural extension service providers. Data was gathered using both structured questionnaire and interview guides. The collected data was analysed with the aid of SPSS software using both descriptive and inferential statistics. The findings revealed a coefficient of determination (R squared) of 0.319 implying that agricultural extension services explains 31.9 % of the variation in agricultural production in Kenya. The study also showed a positive and statistically significant relationship between agricultural extension services and agricultural production in Kenya (β=1.561, p=.003<.05). The study concludes that agricultural extension services play a significant role in improving agricultural production in Kenya because agricultural extension services offers technical advice on agriculture to farmers. It is thus recommended that

agricultural extension service delivery should be boosted through timely recruitment, periodic training of agents and provision of adequate logistics to the farmers.

Keywords: *Agricultural extension services, agricultural factors, agricultural production, farmers in Kenya*

1.0 Background to the Study

Fundamentally, agriculture has continued to be a catalyst of development that is sustainable, enhanced food security and the reduction of poverty in countries that are developing (Sazonova, Borisova, Terentyev, Kramlikh & Sidorenkova, 2021). Productivity in agricultural is also important for spurring economic growth in other sectors. According to the World Bank (2020), farmers live in remote rural areas and make up 75% of the world's poor. In Sub-Sahara Africa (SSA), productivity in agriculture lags behind globally, and is below the required standards of achieving food security, poverty goals and food sufficiency. The World Bank report (2021) stated that about two thirds of the world population are mainly concentrated in rural areas, which are predominantly agriculture-oriented areas. Therefore in respect to poverty eradication and raising the welfare standards of the population; more focus should be put on agricultural production. Agricultural productivity can be measured at many different levels. For instance, the production systems of a single farm, a multi-farm cooperative, a region, a country or even the planet can all be measured based on agricultural productivity (Sazonova *et al.*, 2021). On a country level, agricultural productivity growth measures agricultural exports versus imports. A government that can sustain a higher level of agricultural exports supports a more robust economic growth rate, becomes more competitive globally and maintains more sustainable food prices for its population.

Agriculture is the main source of income for hundreds of millions of people around the world suffering from poverty and hunger (WFP, 2019). Most of them are affiliated with small farms or small farms- plots of land roughly the size of a soccer pitch or American football field. Agriculture began slowly with only a handful of crops, and most food was collected from the wild. According to Qader *et al*. (2021), changes in soil and weather may have supported agriculture and its continued growth. In contrast to hunting, agriculture can feed more people in the same area. Initially, agriculture was primarily for personal use, but has evolved into commercial agriculture. Agriculture has also expanded to include a variety of techniques such as crop rotation, fencing, fertilizer use, plantations, weeding, livestock and breeding. This technology is designed to increase agricultural production and production to increase yields; similarly, agriculture is widespread around the world today due to a variety of factors (Khudoynazarovich, 2021). The millennium development goals (MDGs) of reducing hunger and to promote food security are rooted in increasing agricultural productivity, especially from the crop sector. This is because agriculture is considered as the engine of growth in many developing economies, particularly in sub-Saharan Africa (SSA).

Education is the key factor that determines agricultural production in adopting inputs in general and management demanding practices in particular (Ruzzante, Labarta & Bilton, 2021). According to Isidore, Cisabu and Murhebwa (2018), educated HH farmers have a better access for agricultural information that is pertinent for decision making on what and when to produce; to adopt and use inputs efficiently thereby increase production. In Nigeria, Amaza et al. (2016) put forward as education is the principal factor that seriously determines food crop production where educated farmers are committed to go to the peripheral areas of the country and exploit the potential

reservations. Adebiyi and Okunlola (2013); Uwamariya, Kyule and Eric (2022) put forward that adopting new inputs by itself could never be a guarantee for increasing agricultural production. The rationale is that, properly utilizing and exploiting the opportunity is the most difficult thing that illiterate farmers are facing. Hence, education is a vaccination that needs to be encouraged so as to adopt and properly utilize agricultural technologies thereby increase agricultural production. Moreover, Thierfelder and Mhlanga (2022) inferred that education as a source of knowledge has had resulted in a brain wash for farmers to reject the traditional agricultural system and adopt the new technique; knowledgeable farmers are keen enough to adopt techniques that control weed, enhance residue management, encourages crop rotation and fertilizer adoption.

In agricultural-dependent economies, agricultural extension services have been the main conduit for disseminating information on farm technologies, support rural adult learning and assist farmers in developing their farm technical and managerial skills (Wang, Wang, Zhang & Wang, 2021). It is expected that agricultural extension programmes will help increase farm productivity, farm revenue, reduce poverty and minimize food insecurity. According to Kassem, Alotaibi, Muddassir and Herab (2021), the agricultural extension services include capacity building in good agricultural practices, creating linkages among the value chain actors (input dealers, farmers, wholesalers and retailers) and other value addition techniques. Thus, wider dissemination of information regarding farmer skill development, the use of improved farm technologies, general farm management practices and easy access to input and output markets have been the fundamental principles underlying delivery of agricultural extension services (Wang *et al.*, 2021). All these are geared towards improvement in productivity, reduction in poverty and enhancement in food security. Given the scale of investment from various agricultural stakeholders, the value for money regarding an increase in farm income is an important policy question.

Agricultural extension programmes have been one of the main channels of addressing rural poverty and food insecurity, because it has the means to transfer technology, support rural adult learning, assist farmers in problem-solving and getting farmers actively involved in the agricultural knowledge and information system (Antwi-Agyei & Stringer, 2021). Extension is defined by FAO as; "systems that should facilitate the access of farmers, their organizations and other market actors to knowledge, information and technologies; facilitate their interaction with partners in research, education, agribusiness, and other relevant institutions; and assist them to develop their own technical, organizational and management skills and practices". By this definition, an extension is deemed as a primary tool for making agriculture, its related activities as well as other economic activities more effective and efficient to meet the needs of the people (Nyarko & Kozári, 2021). It is, therefore, regarded as a policy tool for promoting the safety and quality of agricultural products. Agricultural extension is aimed primarily at improving the knowledge of farmers for rural development; as such, it has been recognized as a critical component for technology transfer. Thus, agricultural extension is a major component to facilitate development since it plays a starring role in agricultural and rural development efforts (Antwi-Agyei & Stringer, 2021).

In Brazil, traditionally agricultural extension services have been provided by public institutions directly, relying exclusively on government funds (Pellegrina, 2022). However, over the years rural extension services were also offered by private firms, NGOs, and rural organizations (rural labour union or farmers organizations), at the federal, state and municipal levels. The farming structure in Brazil is divided into rural settlements as a result of land reform or inhabitants of riverbanks, which could be farmers or not; smallholder farms (usually family farming producing for subsistence or local market); middle size farms (usually producing for national market); and

large size farms (usually producing for export markets) (Garofalo et al.,2022). Family agriculture corresponds to 84.4% of all agricultural establishments in Brazil, using only 24.3% of its agricultural area, and producing 30% of all agricultural products.

Africa in general and SSA in particular depends on rain fed agriculture with its erratic nature (Girma, 2022). According to Hussen and Geleta (2021), average annual rainfall in dry semi-arid areas of SSA are less than 700 millimeters; and this makes soils poor in nitrogen and phosphorus. Furthermore, Fadeyi, Ariyawardana and Aziz (2022) argue that SSA is being characterized by low and highly unpredictable levels of rainfall and high temperatures; and these features would ultimately erode the soil organic matter and would result in poor soil quality and low agricultural production. As a natural determinant factor, Dim and Ezenekwe (2018) found that a 1 % increase in rainfall will result in 1.14% increase in agricultural output in Nigeria. In the same line of reference, they surmised that, to keep the soil wet, when rain is insufficient, irrigation could serve as a proxy and would increase crop yielding. Zambia, Namonje-Kapembwa, Chiwawa and Sitko (2022) found that as one modus operandi of soil fertility preservation, conservation agriculture is primarily important in providing stable crop production and food security. In Ethiopia, Shumet (2019) found that soil fertility is the one that best describes agricultural production and technical efficiency of farmers where those with fertile land are endowed with ample agricultural production.

In Kenya, agriculture is taunted to be the backbone of her economy. Almost 20% of Kenyan's total land area is fertile as it has enough rain to enable farming to take place, (Kenya country profile 2020). According to Ministry of Agriculture, (2020) majority of Kenyans lived by farming and more than half of its agricultural production is for family consumption. Agriculture earns Kenya 25% of its GDP and it employs 75% of its workforce (Ministry of Agriculture, 2020). Kenya's Vision 2030 program emphasized the fact that agricultural growth as a sector is the main issue to be looked at (Republic of Kenya, 2019). The agriculture sector contributes 51 percent of Kenya's GDP (26 percent directly and 25 percent indirectly) and accounts for 60 percent of employment and 65 percent of exports (World Bank, 2020). A number of factors have been identified by researchers as determinants of agricultural production.

Auya, Barasa and Sambu (2022) identified land and population pressures as factors impacting agricultural production in Kenya. The asserted that average farm size in Kenya is falling and land distribution is becoming more concentrated, leading to significant constraints on production, particularly for smallholders. Elsewhere, Kogo, Kumar, Koech and Hasan (2022) pointed out that the proportion of farmers accessing extension advice in Kenya is low, while extension services tend to favour wealthier farmers; Government spending on agricultural research has fallen steadily over the past decade. Market is another factors impacting agricultural production in Kenya. Government intervention in cereal markets distorts production and diverts resources from investments that might be more effective and efficient in improving productivity. While physical access to markets has generally improved, farmers report a number of institutional barriers and transaction costs related to market information and marketing processes. Access to credit is a constraint across the sector.

1.1 Statement of the Problem

As an important sector in the Kenyan economy, agriculture continues to dominate other sectors despite its declining contribution to real GDP. The development in agriculture is that one which revolutionizes the industry by bringing forth profitable agriculture and environment friendly

solutions (Economy Watch, 2018). Development in agriculture entails giving aid to farmers by the use of different resources, and this could be done through the provision of protection, research assistance, and use of technology, control and management of diseases and pests and facilitating ion the section of diversification (Economy Watch, 2018). Kenya government through the Ministry of Agriculture and Livestock, have in the past tried to pass information to the farmers via agricultural extension officers (GoK, 2020). However, the quality of the information disseminated to the farmers has not been up to date, information delivery has not been good, the mode of communication also questionable owing to literacy levels of our farmers and indeed that of the extension officers, information technology has not been embraced fully making it difficult for our farmers to progress with their counterparts in other parts of the world.

It should be known that extension services includes more than just advising farmers on crop or livestock matters only but it includes an organized activities that educates, guides and adds value to the general welfare of the farmer (Kingiri, 2021). Emphasis should be put into the professional diversity of personnel in the extension services to enable farmers get full quality information that encompasses all aspects of agribusiness that range from crop and animal farming, quality breeds and hybrids, farm inputs, land management and marketing of the same in addition to embracing Information Technology.

The Kenyan Agricultural Sector Development Strategy 2010-2020 sets out a detailed plan to position the agricultural sector as a key driver for delivering the 10 per cent annual economic growth rate envisaged under the economic pillar of Vision 2030 (Ministry of Agriculture, 2019). The vision of the document is a food secure and prosperous nation and the strategy aimed at increasing productivity, commercialization and competitiveness of agricultural commodities and enterprises; and develop and manage key factors of production. Also important is government's goal of 10 percent farm forest cover on all agricultural land holding. However, the agricultural sector in Kenya is particularly vulnerable to adversities of weather, not only because farmers depend on rain fed agriculture, but also on small farm sizes that are not economically viable.

These smallholder farmers thus already operate under pressure from food insecurity, increased poverty and water scarcity (Evans, Samuel & Samuel, 2021). This scenario constitutes a real challenge for a government of Kenya with a population of over 50 million to feed. More worrisome is the fact that increase in the gap between population growth and agricultural production capacity is exacerbating the already declining food security, and increasing vulnerability and rural poverty, which amplify the impacts of climate change that appear to have become more severe in the recent years. The current study thus sought to determine the factors impacting on agricultural production and the role of agricultural extension services in Kenya.

1.2 Research Objectives

i. To assess the factors impacting agricultural production in Kenya.
ii. To establish the role of agricultural extension services on agricultural production in Kenya.

1.3 Research Questions

i. What are the factors impacting agricultural production in Kenya?
ii. What role does agricultural extension services play on agricultural production in Kenya?

2.1 Theoretical Framework

This study was anchored on Diffusion of Innovations Theory as proposed by Rogers (1962). This is a theory that tries to find in what way, what is the cause, and at what speed new techniques and technologies get to be known (Simin & Janković, 2014). This theory estimates that arriving at judgments, giving of opinions and information provision is done by interpersonal relations and the media. Rogers (1962) argue that for an innovation to occur some elements must be in play; the technology or innovation, the channels of communication, period of time and an interrelationship of individuals, and human resource is relied here heavily. The technology must be adopted immensely for it to be self-sustaining. The Diffusion of Innovations theory was the leading theory in agricultural extension post-World War II until the 1970s (Lavoie, Dentzman & Wardropper, 2021). It is still used today in agricultural extension, particularly when extension is concerned with an adoption of a particular technology (i.e. technology transfer approach to extension).

Basing this research on this theory the aspect of agricultural extension services comes into play, it dictates that for an innovation to be adopted it should be told over time in a given group of people in this case, the extension service providers and the farmers (Rogers, Singhal & Quinlan, 2014). According to Dan, Osterheider and Raupp (2019), the communication channel should be right and the timing is critical and the process of adoption relies heavily on human capital. Hence proper and adequate resources should be pumped into the personnel docket for the technology to be diffused properly. Tailor-made brochures with specific agricultural messages can be circulated to the farmers which are easy to read, easy to refer and easy to archive for future reference. Rogers (1962) was convinced that the adoption of innovations follows a universal process of social change. It originated in communications to explain how, over time, an idea or product gains momentum and spreads (or diffuses, hence the name) through a specific population or social system.

The field extension officers can conduct agricultural seminars where specific agricultural messages can be taught via either a recorded audiovisual or one on one (Lavoie et al., 2021). If the training is not done properly and professionally, farmers will not get that vital needed knowledge that can spur agricultural productivity. The messages should be packaged in simple terms/language for easy understanding to the farmers. The information can be disseminated via radio, television or packaged on CDs/DVDs or Tapes to be played back at the comfort of the farmer's house. The feedback element of communication entails that the extension officers can get reports from the farmers from what they were taught and trained on. This may be used as a benchmark to gauge whether learning took place or not. This theory was thus considered relevant to the current study since it explains how agricultural extensional services especially those that involves technology application can be used to enhance agricultural production in Kenya.

2.2 Empirical Review

2.2.1 Factors Impacting on Agricultural Production

Omache (2016) examined the Factors influencing agricultural productivity in Kenya: A case of Nyathuna ward in Kabete Sub-County, Kiambu County. The objectives of the study were to; establish social-economic factors influencing agricultural productivity, examine the influence of agricultural technology uptake on productivity, establish the influence of extension service delivery on agricultural productivity and assess the influence of information dissemination methods used for agricultural productivity. The study adopted a descriptive survey research design and 200 respondents were the sample size that was selected from a list of 7794 farmers in Nyathuna

Ward Kabete Sub-County. The study findings revealed a positive correlation between the methods used for the dissemination of agricultural information and agricultural productivity. The study established that social economic factors could influence agricultural productivity negatively or positively. From the findings combination of both family and hired labour is used heavily when conducting all farm activities meaning that if family labour is removed from the equation, the cost of production will go up. The study recommended that formulation of policies by the Government of Kenya may be done by the use of the findings therein; so that positive impacts to the farmers are realized as far as agricultural productivity is concerned and guide the agricultural extension officers in coming up with better ways to disseminate agricultural information to farmers in their quest to improve agricultural production.

A study by Nyinamugisha (2019) established that the major socioeconomic factors impacting agricultural productivity were mainly fertility of land, the rate of inflation in the country, ability to obtain seeds, access to fertilizers, purchasing power of maize in this area and household income. The institutional factors included poor climate change prediction by government, access to agriculture information, the distance to the market, government set prices for maize and marketing association while the major technologies factors established by the study were machinery cost, innovative farmers in terms of agricultural technology, access to high breed seed varieties and access to extension services. The study indicated that strategies which mainly included adopting genetically modified crops, improve access to financial services, land reforms to reduce on land fragmentation, improvement of infrastructure, develop high-yield crops and provision of better incentives to farmers can be adopted to boost agricultural production. The study further recommend that government should put more emphasis in getting ways to incorporate the use of genetically modified plants to improve on yields, coming up with land reforms to help curb the habit of land fragmentation, government to put in place more village banks and SACCOs to provide an alternative to farmers financial needs, government to provide more facilitation to the body concerned with weather change prediction and adopting zoning in the agricultural sector by encouraging growth of particular crops in particular areas which the nature of soils are favorable.

According to Liang, Wu, Chambers, Schmoldt, Gao, Liu and Kennedy (2017), temperature, or climate is one of the natural forces impacting on agricultural production where there is the least chance of human involvement. They believe there are specific circumstances, like greenhouses, but in terms of efficiency, greenhouses might not offer a significant return. Furthermore, although using natural means is less expensive, a greenhouse requires specialized equipment. Additionally, Liang et al. (2017) assert that the vegetative phase, which is the stage of plant reproduction, is influenced by temperature. The products get more developed the more heat they receive throughout the vegetative phase. Factors such as the humidity requirement of the plant and the temperature required by the product are the factors that determine productivity in agriculture (Hoang et al., 2021). What is meant by farmer experience is that the product that can be grown according to the climate or latitude should be selected. It is not impossible to grow the product suitable for tropical climates in the Black Sea climate. However, the productivity will not be the same.

Jha, Doshi, Patel and Shah (2019) conducted a comprehensive review on automation in agriculture using artificial intelligence and found that the traditional method which is also referred to as extensive agriculture, can lead to negativities in agriculture. They suggested that extensive agriculture should not be thought of as completely negative. A farmer who supports agriculture with only precipitation may not be able to meet the water needs of the product depending on natural

factors. Socially, only traditional agriculture is used in the environment, and not using technology irrigation methods as a method causes the crops to be exposed to drought. In cases such as spraying and fertilizing the products, ignoring modern agriculture completely can cause a waste of energy and time. The effectiveness of the equipment used for the land is another factor impacting agriculture; being able to procure products with advanced technology that enables more efficient production and harvesting ensures that it is among the economic factors (Elavarasan, Vincent, Sharma, Zomaya & Srinivasan, 2018). The productivity of agriculture is also affected when the farmer has access to products in an economic context. Sufficient labor in field planting or crop harvesting ensures both growth and harvesting of the product in a quality manner. The fast collection of products like fruits and vegetables that mature in a short period of time affects the quality of the product. At the same time, the productivity of the soil will increase as the product is collected in a high-quality manner.

A study by Rada, Helfand and Magalhães (2019) pointed out that agriculture has been an island of success in terms of productivity growth in the last decades compared to other sectors of the Brazilian economy and compared to other country's agriculture sector. Agriculture productivity growth in recent decades in Brazil has been mainly driven by investments in agriculture innovation, facilitation of sector financing, and trade liberalization. Trade liberalization has shown to be an important factor in the growth of agriculture productivity in recent decades, which can serve as an important experience for other Brazilian economic sectors that remain relatively close to trade. Rada et al. (2019) argue that agriculture productivity in Brazil has room to grow further, improving productivity of lagging mid-size farmers and regions, reforming agriculture policies towards agriculture financing, agro logistics, and research and development (R&D). Experience within Brazil shows that agriculture productivity can continue to grow without depleting natural capital nor further increasing greenhouse gas (GHG) emissions; unlike the structural economic transformation of other countries, Brazilian agriculture productivity growth has been a net job creator.

Agriculture productivity growth in Brazil can therefore continue its positive upward trend, while being environmentally sustainable, creating jobs, and increasing incomes for the rural poor. The motivation for this report is to explore the evolution and source of the strong agriculture productivity growth that has occurred in Brazil in recent decades, identifying opportunities and challenges for future development of the sector (de Mello *et al.,* 2020). The goal is to look for opportunities to accelerate agriculture productivity growth, to have an increased impact on sector growth, jobs, environmental sustainability, and poverty reduction, as well as potentially to shed light on lessons that can contribute to efforts to boost productivity in other sectors within Brazil.

Onogwu, Audu and Igbodor (2017) while examining the factors influencing agricultural productivity of smallholder farmers in Taraba State, Nigeria, established that the factors found to be highly significant and impacting farmers' productivity include access to formal credit or loan (at 5%), farm size of the respondents (5%), membership of farm based organization (FBO, at 1%)) and number of years the farmers had spent in school (at 10%), among others. The factors that were not highly significant, but exact some influence on farmers' productivity included age, experience, access to extension agent, and gender. The study also indicated that modernizing agriculture requires large infusion of credit to finance the use of purchased inputs such as fertilizers, improved seeds, insecticides, additional labour and so on. In this regard, the provision of agricultural credit can be a powerful economic force for development if used to inject appropriate capital for the purchase of agricultural inputs that are not otherwise available to farmers from their own financial,

physical and labour resources. The study thus recommended that farmers should belong to farm based organization irrespective of the volume of credit received since farm based information are most available and cheaply too, in local vernacular during farm based organization meetings.

In Ghana, Enu and Attah-Obeng (2019) evaluated macro factors influence agricultural production. The main aim of the research study was to find out the key macro factors that influence agricultural production in Ghana. The Cobb-Douglas production was employed and the Ordinary Least Squares estimation technique was used. The independent variables used included labour force, inflation, real exchange rate and Real GDP per capita. The findings revealed that an increase in labour force caused a decrease in agricultural production. In addition, the study found that an increase in inflation caused agricultural production to increase, an increase in real exchange rate caused agricultural production to increase and finally, an increase in real GDP per capita caused a decrease in agricultural production. Apart from inflation, labour force, real exchange rate and real GDP per impacting agricultural production in Ghana are labour force, real exchange rate and real GDP per capita. The study thus recommended that the agricultural sector should be made more attractive and conductive to ensure continuous production of food in Ghana.

2.2.2 Role of Agricultural Extension Services in Agricultural Production

According to Antwi-Agyei and Stringer (2021), farmers need information on various topics, at intervals, before new technology is adopted; information that farmers need may vary according to one's need and ranges from inputs, pests and disease control, prices of commodities to even weather forecasts. This information can be obtained from different areas that may include, among others, their social network and from their own trial and error. Unfortunately information is not costless in yet to fully develop countries. According to Anderson and Feder (2017), agricultural extension is the delivering of inputs information to farmers. The officer is always armed with fresh and new techniques and messages for his clients. This approach lacks a two-way flow of information. It does not separate information according to the agro systems. During the dissemination of a new technology is when extension service is of much benefit to the farmers, once most of them become aware of it the extension drive fizzles out (Byerlee, 2018). The essential components of extension service are the information and communication aspect of it but rarely do these systems and get integrated with development policies and strategies (FAO, 2022).

Wang, Wang, Zhang and Wang (2021) conducted an evaluation of agricultural extension service for sustainable agricultural development using a hybrid entropy and TOPSIS method. The study analyzed the influence of agricultural extension service on sustainable agricultural development, and constructs an evaluation system for sustainable agricultural development from the four dimensions of agricultural environment, society, economy, and agricultural extension service. The study used framework based on the combination of technique for order performance by similarity to ideal solution (TOPSIS) and entropy method to evaluate the performance of the evaluation system. Taking three national modern agriculture demonstration zones in Suzhou in Jiangsu Province as a case study, the method was verified. Moreover, the main factors affecting sustainable agricultural development were discussed, and the improvement measures and management suggestions were also put forward to reduce the obstacles to sustainable agricultural development and improve sustainable agriculture practice. The study revealed that the evaluation system of Agricultural Economics Society for sustainable agricultural development is an effective way of realizing sustainable agricultural development. It is an effective tool to promote sustainable agricultural development by analyzing the main factors affecting sustainable agricultural

development, putting forward improvement measures, improving the efficiency of AES, reducing the obstacles of sustainable agricultural development, and improving the decision-making of the agricultural sustainable system.

Sulandjari, Putra, Sulaminingsih, Adi Cakranegara, Yusroni and Andiyan (2022) evaluated agricultural extension in the context of the Covid-19 pandemic: Issues and challenges in the field. The study indicated that different environments demand different solutions. Where soils are poor and depleted, as in many parts of Africa, fertilization is an urgent need. In regions with moderate fertilizer usage, an improvement in nutrient management hand in hand with other practices is required. The study suggested that where the knowledge being communicated is embedded in, or closely associated with, market goods (e.g. tractors, hybrid seeds, fertilizers etc.), the delivery of relevant advice can be left to the private sector, within an appropriate regulatory framework. However, where the technology or practice being promoted is associated with a toll good (such as farm management or marketing information), the delivery of extension advice is best handled by a judicious combination of public and private entities. If a common-pool good (such as soil, water and air resources, community forests, fisheries, common pastures etc.) is involved, it is highly beneficial to connect the advisory activities closely with cooperative or voluntary action. Where market and participation failures are high, for instance where subsistence farming dominates, a public sector approach to agricultural extension is required. The study concluded that agricultural extension services offers technical advice on agriculture to farmers, and also supplies them with the necessary inputs and services to support their agricultural production. It provides information to farmers and passes to the farmers' new ideas developed by agricultural research stations.

Danso-Abbeam, Ehiakpor and Aidoo (2018) carried out a study that assessed agricultural extension service and its effects on farm productivity and income with an insight from Northern Ghana. The study pointed out that agricultural extension programmes have been the main conduit for disseminating information on farm technologies, support rural adult learning and assist farmers in developing their farm technical and managerial skills, and it is expected that extension programmes will help increase farm productivity, farm revenue, reduce poverty and minimize food insecurity. The study employed cross-sectional data collected from 200 farm households from two districts in the Northern region of Ghana. The robustness of the estimates was tested by the use of regression on covariates, regression on propensity scores and Heckman treatment effect model. The findings revealed that there existed positive economic gains from participating in the ACDEP agricultural extension programmes. Apart from the primary variable of interest (ACDEP agricultural extension programme), socio-economic, institutional and farm-specific variables were estimated to significantly affect farmers' farm income depending on the estimation technique used. The study concluded that critical role of extension programmes in enhancing farm productivity and household income. It was thus, recommended that agricultural extension service delivery should be boosted through timely recruitment, periodic training of agents and provision of adequate logistics.

3.0 Research methodology

This study employed a mixed design involving a combination of both quantitative and qualitative approach. The study used a survey research design, specifically a cross-sectional survey research design. Cross-sectional survey design involves collecting data from a large group of people of different stages of growth at one point in time. The target population for this study included farmers, officers from the ministry of agriculture and agricultural extension officers.

The study purposively selected 30 farmers, 5 officers from the ministry of agriculture and 5 agricultural extension officers. This study used both questionnaire and interview guide to collect primary data. The questionnaires were administered to the farmers, while interview guide was administered to both officers from the ministry of agriculture and agricultural extension officers. The quantitative data collected using the questionnaire was analyzed with the aid of SPSS. Both descriptive and inferential statistics were used. The qualitative data gathered using interviews was analyzed thematically using content analysis. The findings were presented in tables.

4.0 Findings and Discussion

The researcher administered 30 questionnaires to the 30 selected farmers, interviewed 5 officers from the ministry of agriculture and 5 agricultural extension officers. Out of the 30 questionnaires administered, 26 were dully filled and returned, yielding a response rate of 86.7%. In addition, all the sampled officers from the ministry of agriculture and agricultural extension officers agreed to be interviewed yielding a response rate of 100 percent. According to Bailey, Singarayer and Rhodes (2000) a response rate of 50% and above is adequate, while if a response rate is more than 70% is considered very good. The demographic information about the study participants revealed that majority of the farmers were male (14, 53.8%), whereas 12(46.2%) were female. Majority of the farmers were aged between 46-55 years (11, 42.3%) and most of them were master's degree holders (8, 30.8%). In terms of experience, most of the farmers had been involved in farming for a period of at least two decades (9, 34.6%) and most of them were practicing farming on their own pieces of land. Finally most of the farmers were from households with family size of between 4-5 family members (15, 57.7%).

4.1 Descriptive Analysis

Descriptive statistics was used to depict the features of the data in this study and this was because descriptive statistics provide simple summaries about the sample and the measures. Descriptive analysis simply forms the basis of every quantitative analysis of data and includes the mean and standard deviation (Trochim & Donnelly, 2001). Table 1 shows descriptive results on factors impacting agricultural production in Kenya.

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Table 1: Factors Impacting Agricultural Production in Kenya

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	Std. Dev.
Use of modern technology has revolutionized agriculture.	11.50%	7.70%	3.80%	34.60%	42.30%	3.885	1.366
Climate change has had an impact on agriculture in the country.	15.40%	0.00%	7.70%	26.90%	50.00%	3.962	1.428
Pests and disease have become serious threat to agriculture.	7.70%	11.50%	3.80%	30.80%	46.20%	3.962	1.311
Soil fertility has been declining hindering agricultural production	7.70%	3.80%	7.70%	42.30%	38.50%	4.000	1.166
The agricultural sector extension service plays a key role in disseminating knowledge, technologies and agricultural information, and in linking farmers with other actors in the economy.	15.40%	0.00%	15.40%	30.80%	38.50%	3.769	1.394
Inadequate research–extension–farmer linkages to facilitate demand-driven research and increased use of improved technologies continue to constrain efforts to increase agricultural productivity.	11.50%	0.00%	0.00%	34.60%	53.80%	4.192	1.266
Most farmers lack information on the right type of farm inputs to use and the appropriate time of application of the same.	11.50%	0.00%	7.70%	26.90%	53.80%	4.115	1.306
The rising population density has contributed to the subdivision of land to uneconomically small units hampering agricultural production.	7.70%	3.80%	0.00%	23.10%	65.40%	4.346	1.198
The reduction of fallow periods and continuous cultivation have led to rapid depletion of soil nutrients, declining yields and environmental degradation.	50.00%	11.50%	7.70%	7.70%	23.10%	2.423	1.701
Poor rural roads and other key physical infrastructure have led to high transportation costs for agricultural inputs and products.	15.40%	15.40%	15.40%	26.90%	26.90%	3.346	1.441

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Based on the descriptive results in Table 1, majority of the respondents (76.9%) agreed that the use of modern technology had revolutionized agriculture, another 76.9% did agree that climate change had an impact on agriculture in the country, while 77% of them indicated that Pests and disease had become serious threat to agriculture. The results also show that a majority (80.8%) were convinced that soil fertility had been declining hindering agricultural production, 69.30% moreover indicated that the agricultural sector extension service was playing a key role in disseminating knowledge, technologies and agricultural information, and in linking farmers with other actors in the economy. Furthermore, a majority of the farmers (88.4%) were of the opinion that inadequate research-extension-farmer linkages to facilitate demand- driven research and increased use of improved technologies was continuing to constrain efforts to increase agricultural productivity. In addition, it is evident from the findings that majority of the farmers (80.7%) were convinced that most farmers lacked information on the right type of farm inputs to use and the appropriate time of application of the same. Similarly, most (88.5%) of the farmers were in agreement that the rising population density had contributed to the subdivision of land to uneconomically small units hampering agricultural production. However, most (61.5%) disagreed with the statement that the reduction of fallow periods and continuous cultivation had led to rapid depletion of soil nutrients, declining yields and environmental degradation. Finally, the study found that most of the farmers (53.8%) were convinced poor rural roads and other key physical infrastructure had led to high transportation costs for agricultural inputs and products.

In addition to the quantitative data gathered using questionnaire from the farmers, the researcher conducted interviews with officers from the ministry of agriculture and they were asked to indicate what they would consider the major factors impacting agricultural production. One of the officers indicated that:

> *There are many factors that impact agricultural production in the country, but the most common factors includes; uncoordinated technology generation, scaling and dissemination; limited agricultural policy analyses, approval and advocacy; climate-related challenges, including prolonged droughts and floods; limited access to relevant agricultural inputs, especially seeds and fertilizers; limited smallholder farmer access to markets; limited profitability of agriculture-related activities by the farmers; frequent outbreaks of diseases and pests and limited access to extension / advisory services by the smallholder farmers.*

The officers were also asked to indicate the challenges that the ministry faces working with farmers in Kenya. In response, one of the officers said that:

> *The most common challenges we face are; limited access to reliable data and information on markets; limited access to reliable agro-meteorological data to guide farmers' predictive ability on when to plant; limited access to reliable agricultural inputs; limited access to output markets; low access to insurance services to guard them against risks, pests and diseases; limited access to reliable technologies and innovations, especially correct varieties and germplasm; emergence of invasive species, e.g. locusts; uncoordinated policy analyses and advocacy and exploitation by middlemen along the value chains.*

The officers were also asked to indicate the issues they thought farmers across Kenya face in their quest to access and use farm inputs like certified seeds and fertilizers. All the officers said that:

> *Farmers are faced with myriad of issues such as; Unclear policies on how to access these inputs, unclear protocols on how to apply these inputs once acquired, i.e. correct quantity and time; limited knowledge on what to do in case of different biophysical conditions across the farmlands, e.g. soil type, moisture content, and land topography, unstable market prices, issues related to quality of these inputs; delays in accessing these inputs to coincide with the planting seasons.*

In addition, the officers from the ministry of agriculture were asked to indicate how farmers in Kenya receive new agricultural technology based on their own assessment. The officers indicated that:

> *There are innovators (2.5%) and these farmers readily take risks, they mainly comprise younger persons with stable financial base, there are also some early adopters (13.5%) of available technologies. They generally have significant levels of leadership, and mainly comprise young farmers with good financial and education base. Some of the farmers (34%) who comprise early majority adopt the technologies after observing the innovators and early adopters. These farmers generally possess above average social status and rarely occupy positions of leadership. Other farmers (34%) fall under the category of late majority who only adopt the technology after majority of the farmers have tested and proven the technologies. They are generally very skeptical, and have below average social status, very little financial buoyancy and hardly hold leadership positions. The last group of farmers comprise the laggards (16%). These farmers have little to no leadership skills and tend to focus on traditions, and have limited financial liquidity.*

The study further sought to establish the role of agricultural extension services on agricultural production in Kenya. Table 2 shows descriptive analysis results on the role of agricultural extension services on agricultural production in Kenya.

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Table 2: Role of Agricultural Extension Services on Agricultural Production

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	Std. Dev.
I get agricultural extension service regularly	53.80%	30.80%	15.40%	0.00%	0.00%	1.615	0.752
An agricultural extension service offers technical advice on agriculture to farmers.	42.30%	15.40%	15.40%	26.90%	0.00%	2.269	1.282
Extension officers supplies me with the necessary inputs and services to support my agricultural production.	50.00%	23.10%	11.50%	7.70%	7.70%	2.000	1.296
Extension services ensures I have access to improved crop varieties.	42.30%	19.20%	11.50%	19.20%	7.70%	2.308	1.408
Extension services ensures I have access to better livestock control	50.00%	15.40%	15.40%	11.50%	7.70%	2.115	1.366
Through agricultural extension services I acquire improved water management skills.	46.20%	19.20%	7.70%	15.40%	11.50%	2.269	1.485
Agricultural extensional services ensures I have better control of weeds, pests and diseases, hence improved yields	46.20%	23.10%	11.50%	11.50%	7.70%	2.115	1.336
Agricultural extension services ensures that my efforts towards increasing agricultural productivity are sustainable.	26.90%	34.60%	23.10%	15.40%	0.00%	2.269	1.041
Development and dissemination of improved agricultural technologies to these smallholder farmers in the rural areas helps in improving productivity.	38.50%	11.50%	15.40%	15.40%	19.20%	2.654	1.599
Extension services ensures improvement in my managerial and technical skills through training, facilitation and coaching, among others which leads to improved production.	46.20%	15.40%	11.50%	15.40%	11.50%	2.308	1.490

The results in Table 2 show that most (84.6%) denied getting agricultural extension service regularly, 57.7% of the farmers also indicated that agricultural extension service was offering no technical advice on agriculture to farmers, and 73.1% of them denied being supplied with necessary inputs and services to support their agricultural production by extension officers.

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Additionally, majority of the farmers (61.5%) disagreed that extension services were ensuring they had access to improved crop varieties. In a similar vein, 65.4% of the respondents indicated that extension services was not at all ensuring they had access to better livestock control.

Moreover, it is evident that most of the respondents (65.4%) did not agree with the statement that through agricultural extension services they were acquiring improved water management skills, 69.3% of the farmers disagreed with the fact that agricultural extensional services was ensuring they had better control of weeds, pests and diseases, hence improved yields, while 61.5% of the farmers were convinced that agricultural extension services was never at all ensuring their efforts towards increasing agricultural productivity were sustainable. Similarly, a half of the farmers disagreed with the statement that development and dissemination of improved agricultural technologies to these smallholder farmers in the rural areas helps in improving productivity. Finally, it is evident from the findings that most (61.6%) of the farmers were never convinced that extension services was able to ensure improvement in their managerial and technical skills through training, facilitation and coaching, among others which leads to improved production. Table 3 shows descriptive analysis results on the agricultural production in Kenya.

Table 3: Descriptive Analysis on the agricultural production in Kenya

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	Std. Dev.
Farmers are embracing technology in their farms	3.80%	11.50%	0.00%	38.50%	46.20%	4.115	1.143
There is improved crop yields.	0.00%	19.20%	19.20%	46.20%	15.40%	3.577	0.987
There is improved livestock products.	7.70%	11.50%	7.70%	61.50%	11.50%	3.577	1.102
There is improved income from agriculture.	7.70%	11.50%	11.50%	50.00%	19.20%	3.615	1.169
Better technology adoption benchmarks have been set up	3.80%	26.90%	19.20%	34.60%	15.40%	3.308	1.158
There is enhancement of extension service delivery	0.00%	30.80%	19.20%	34.60%	15.40%	3.346	1.093
Agricultural productivity has improved generally	0.00%	15.40%	30.80%	30.80%	23.10%	3.615	1.023
Acreage under agriculture has increased across the country over the years.	0.00%	23.10%	23.10%	30.80%	23.10%	3.538	1.104

A majority (84.7%) of the farmers according to the results in Table 3 agreed that farmers were embracing technology in their farms, 61.6% agreed that they had registered improved crop yields, with 73% of them indicating that there had been improvement in livestock products. It is moreover clear that most of the farmers (69.2%) were positive that there was improved income from agriculture, a half of them cited better technology adoption benchmarks having been set up, while another half indicated that there was enhancement of extension service delivery. Similarly, majority (53.9%) of the farmers agreed that agricultural productivity had improved generally and another 53.9% of the farmers were positive that acreage under agriculture had increased across the country over the years. The results imply that generally there had been improved agricultural

production in Kenya which is attributable to availability and accessibility of agricultural extension services by the farmers.

4.2 Inferential Statistics

The study conducted a simple linear regression analysis to determine the relationship between agricultural extension services and agricultural production in Kenya. The model summary findings are presented in Table 4.

Table 4: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.565a	0.319	0.291	0.49272

a. Predictors: (Constant), Agricultural Extension Services

Source: Field Data, 2022

The results show that the coefficient of determination (R squared) was 0.319 implying that agricultural extension services explains 31.9 % of the variation in agricultural production in Kenya. The adjusted R square of 0.291 depicts that agricultural extension services in exclusion of the constant variable explained the variation in agricultural production in Kenya by 29.1% the remaining percentage can be explained by other factors excluded from the model. Table 5 shows the analysis of variance results.

Table 5: ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.732	1	2.732	11.254	.003[b]
	Residual	5.827	24	0.243		
	Total	8.559	25			

a. Dependent Variable: Agricultural Production
b. Predictors: (Constant), Agricultural Extension Services

Source: Field Data, 2022

The ANOVA results in Table 5 show that the model used was statistically significant in explaining the influence agricultural extension services have on agricultural production in Kenya and it is indicated by a p-value of 0.003<0.05. Regression coefficient results are presented in Table 6.

Table 6: Regression Coefficient

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.526	0.624		2.446	0.022
	Agricultural Extension Services	1.561	0.465	0.565	3.355	0.003
a. Dependent Variable: Agricultural Production						

Source: Field Data, 2022

Y= 1.526+ 1.561X

Where

Y= Dependent Variable (Agricultural Production)

X= Agricultural Extension Services

The regression coefficient results in Table 6 show that there is a positive and statistically significant relationship between agricultural extension services and agricultural production in Kenya (β=1.561, p=.003<.05). This implies that a unit increase in the adoption and utilization of agricultural extension services leads to an improvement in agricultural production by 1.561 units. This is in agreement with the findings of Wang, Wang, Zhang and Wang (2021) who evaluated agricultural extension services for sustainable agricultural development and found that the evaluation system of Agricultural Economics Society for sustainable agricultural development was an effective way of realizing sustainable agricultural development. The study indicated that agricultural extension service is an effective tool to promote sustainable agricultural development by analyzing the main factors affecting sustainable agricultural development, putting forward improvement measures, improving the efficiency of AES, reducing the obstacles of sustainable agricultural development, and improving the decision-making of the agricultural sustainable system.

5.0 Conclusion

Based on the findings, this study concludes that there are a number of factors impacting agricultural production in Kenya, key among them are; use of modern technology in farming which is literally revolutionizing agriculture in the country, climate change, pests and diseases, change in soil fertility, agricultural extensions services, information on firm inputs, population density which results in subdivision of land, over cultivation, and state of the infrastructure such as roads to facilitate transportation of the produce to the market. Also, agricultural extension services have significant positive effect on agricultural production in Kenya. This study concludes that agricultural extension services play a significant role in improving agricultural production in Kenya because agricultural extension services offers technical advice on agriculture to farmers, and also supplies them with the necessary inputs and services to support their agricultural production.

Moreover agricultural extension services provide information to farmers and passes to the farmers' new ideas developed by agricultural research stations. This study further concludes that extension uses democratic methods in educating the farmers, helps in adoption of innovations, helps in studying and solving the rural problems, increases farm yields and improve the standard of living of farmers, makes good communities better and progressive, and also contributes to national development programmes.

6.0 Recommendation

Based on the findings and the conclusions arrived at, thus study recommends that the government of Kenya should formulate policies that will ensure positive impacts to the farmers are realized as far as agricultural productivity is concerned and guide the agricultural extension officers in coming up with better ways to disseminate agricultural information to farmers in their quest to improve agricultural production. Additionally, agricultural extension service delivery should be boosted through timely recruitment, periodic training of agents and provision of adequate logistics to the farmers.

Moreover, the national government, county governments and development partners should commit more human, financial and logistical resources to agricultural extension delivery in the country to boost agricultural productivity, farm incomes and total household income. Also, access to agricultural credit and formation of farmer groups such as farmer-based organizations should be promoted for agricultural extension service delivery to realize its full impact. The government has a role of providing the technical expertise on agricultural issues and as thus should be available when called upon by other providers. It should serve as the final reference or arbitrator of conflicting extension information.

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