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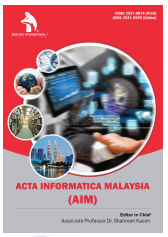

RESEARCH ARTICLE

ROLE OF ICT IN THE DISSEMINATION AND ACCESS OF AGRICULTURAL INFORMATION BY SMALLHOLDER FARMERS IN SOUTH EASTERN KENYA

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ABSTRACT

The agricultural sector has been described as the engine for economic growth and improved livelihoods in Africa. However, the sector has been in decline over many years and poor farmers have largely remained poor with 73 percent of the people living in rural areas subsisting on less than a dollar a day. The efforts to ensure global food security face an ever-expanding list of challenges such as climate change, reduced biodiversity, increasingly frequent natural disasters, food price volatility and inefficient supply chains. The inaccessibility of technological and market information has been cited as the major reason for the low productivity in African agriculture knowledge and information have become the major drivers of social and economic transformation in the world. The objective of the paper was to demonstrate the role of ICT in the dissemination and access of agricultural information by smallholder farmers in South Eastern Kenya. The researcher used mixed research method because it had the ability to explore both quantitative and qualitative research methods hence the researcher had the opportunity to use a wide variety of techniques that aided the research process. This study was carried out in Machakos, Makueni and Kitui Counties of Kenya. The local community were mostly smallholder farmers that relied on rain fed agriculture for crop farming of maize, beans, cow pea, pigeon pea and green grams. The study captured in detail the information needs of the farmers by addressing what they required in the course of normal agricultural activities. It was found out that farmers required information on soil management, pest management, use of fertilizer, weather forecast and financial management tips for mainly improving their productivity. The study concluded that there were positive outcome whenever accurate and timely information was disseminated to the farmer which led to higher quality of production and increased productivity.

KEYWORDS

ICT, Agricultural Information, Smallholder Farmers & South Eastern Kenya.

1. INTRODUCTION

As the world's present population grows from 6.7 to 9.1 billion by 2050, food production will need to double over this same period (FAO, 2019). Thus, more effective extension services are needed to address agricultural challenges including meeting the information needs of poor smallholder farmers in developing countries. In response, agricultural extension experts and institutions around the world are promoting the use of Information and Communication Technology (ICT) by agricultural extension and education agents. ICTs can expedite the process of agricultural technology transfer from research and development institutions to farmers. ICTs improve adoption of agricultural technology by supporting farmer learning, problem solving, and accessibility to profitable markets for their crops (World Bank, 2017)

Technology and digital tools have become increasingly affordable and accessible to farmers. Technological developments in such as aerial imagery from drones or satellites, weather forecasts and soil sensors and mobile applications are making it easier for farmers to manage their crops in real time. Technological advancements in agriculture provide vast potential for farmers, entrepreneurs and investors to improve the productivity and efficiency of agriculture at a time when numerous factors, such as population growth and climate change, threaten food security (KARLO, 2017).

Unfortunately, the rural areas in low-income countries such as Kenya have the largest concentration of poverty and food insecurity. One of the causes of poverty in rural areas is the low productivity of agriculture (Bendre, Thool & Thool, 2015). Absence of technological and market information on agriculture has been cited as the major reason for the low productivity in African agriculture. The economy of Kenya depends mainly on agriculture where smallholder farming has a significant role as it employs 65 percent of the work force and contributes 32 percent of Kenya's GDP. However, the agricultural industry in Kenya is currently facing difficulties in low productivity. The rural areas have the largest concentration of poverty and food insecurity. Majority of the farming activities in Kenya are on small scale and the problems of these farmers are multifaceted including sub-divisions and small farm sizes, leading to diseconomies of scale and low productivity.

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A number of approaches have been taken to provide farmers required information to support their farming operations such as traditional public-sector extension services and use of variety extension programmes to overcome barriers to technological adoption without much success. In this context, the agriculture and rural development sector urgently needs solutions, and modern information and communication technologies (ICTs) that offer enormous potential benefits. ICT input can contribute to poverty reduction, if it is tailored to the needs of the poor and boost agricultural productivity.

The goal of this research was to demonstrate the role of ICT in the dissemination and access of agricultural information by smallholder farmers in South Eastern Kenya. The contributions of this paper were to;

i. Investigate the challenges encountered in the dissemination and access of agricultural information by smallholder farmers and how to meet them in attempt to improve agricultural productivity in South Eastern Kenya

ii. Establish the influence of ICT in improving agricultural productivity in South Eastern Kenya.

2. Literature Review

2.1 Theory of Knowledge

Foucault (1977) draws a close link between knowledge and power. The scholar maintains that human experience is based on communication, with structures arising from the rules of the communication. Further, knowledge gives way to power that generates further knowledge through the process of surveillance and new discourse. It is assumed that whoever has knowledge or information is empowered and whoever lacks it, is incapacitated. In the case of the current study, the agricultural information provided by an ICT service to farmers was to lead to improved agricultural productivity this was because of more knowledge on carrying out various farming activities.

The use of Foucault theory was because of the link between knowledge and power. In the study of ICT on agriculture by smallholder farmers, the power could be labelled as improved agricultural productivity. The theory was empirically tested and validated in the same settings. For instance, Kaddu (2011) using the Foucault's theory to study rural women adoption of ICT on agricultural information in Uganda. The scholar found evidence that agricultural information empowered rural women.

2.2 The Role of ICTs in the Agricultural Sector

Increasing agricultural production is critical in reducing poverty as it can boost farmers' income especially smallholder farmers who have limited resources to leverage in growing and marketing their produce. This could be achieved if there exists an efficient value chain, which entails engaging many stakeholders ranging from farmers growing the crops and raising cattle, to input suppliers and distributors. However, the existence of efficient value chains depends on the efficient and systematic flow of relevant information, which in turn depends on the existence of an efficient and reliable ICT infrastructure and the associated services to connect to a diverse range of stakeholders along the agricultural value chain (Halewood & Surya, 2012). In this regard, ICTs could provide a unique opportunity to facilitate agricultural related technological adoption and access, provision of information on markets and market prices, weather, transport and agricultural techniques. The ICT sector had a significant impact in developing countries, as they are being utilized in the agricultural sector through ICT-enabled solutions for food and agricultural production.

ICTs improve access to financial services of which a large body of theoretical and empirical literature suggests could have significant impacts on economic growth and poverty reduction in developing countries (Burgess & Pande, 2015; Levine, 2015). An example is the use of mobile money through M-Pesa in Kenya, where studies have shown that households with access to mobile money are better able to manage negative livelihood shocks such as job losses, death of livestock, or problems with harvests (Aker & Mbiti, 2010; Sen & Choudhary, 2011). Insurance, credit and savings services are also being developed based on the mature mobile money systems in Africa. For example, Kilimo Salama is a microinsurance product that uses M-Pesa to provide payouts to smallholder farmers where crops fail. In the second year of its operation in 2011, 12,000 farmers were insured, and 10% of these received payouts of up to 50% of their insured inputs (Sen & Choudhary, 2011), hence having an impact on agricultural growth and people's livelihoods.

ICTs help extension workers and researchers to adopt improved agricultural practices and disseminate them to farmers. They provide agricultural information that is relevant to farmers such as agricultural techniques, commodity prices, and weather forecasts to farmers (Aker & Mbiti, 2010). The utilization of ICTs, especially mobile technologies, helps agricultural producers, who are often unaware of commodity prices in adjacent markets and rely on information from traders in determining when, where, or for how much to sell their produce, to have relevant and timely information to this regard. Delays in obtaining this information or its misinterpretation by middle traders has serious consequences for agricultural producers, leading to charging low prices or high/low produce supply in the markets. In addition, relying on traders or agents creates rent seeking opportunities, adding to the agricultural workers' cost of doing business. As a result of mobile technological developments, especially mobile phones have had some dramatic effects, particularly in rural Africa, for example the utilization of e-Soko in Rwanda. Farmers can compare market prices for the grain they produce and fishermen are able to sell their catch every day and reduce spoilage and waste by locating customers (Aker & Mbiti, 2010; Chavula, 2012).

Studies have shown that the benefits of using ICTs in promoting access to price information in Africa have led to increases of up to 36% of farmers' income, and up to 36% of traders' income in countries such as Kenya, Ghana, Uganda and Morocco (Halewood & Surya, 2012). This is because ICTs facilitate information flow and enhance communication between buyers and sellers leading to lower communication costs, thereby allowing individuals and firms to send and acquire information quickly and cheaper (Aker & Mbiti, 2010). This makes markets operate more efficiently, hence increase the overall production in the agricultural sector and growth of the economy as a whole.

ICTs play also an important role in facilitating agricultural growth because they increase the efficiency of market interactions and provide access to real time information mainly by enhancing farmers' access to markets and their pricing power through the use of trading platforms over the Internet through web/mobile applications (Driouchi et al., 2010). They allow people to obtain information immediately on a regular basis as compared to other information channels. It is argued that the utilization of ICTs, especially by using mobile technologies greatly reduces search costs, as stipulated by the search theory. It is also argued that in markets where traders have local monopoly, increased access to information could improve consumer welfare by disrupting this monopoly power, although it also reduces traders' welfare (Aker & Mbiti, 2010). Also, despite their high initial fixed costs, mobile technologies and their variable costs associated with their use are significantly lower than equivalent travel costs and other opportunity costs.

In their study in Niger, Aker and Mbiti (2010), observed that an average trip to a market located 65 km away can take 2 to 4 h roundtrip, compared to a two-minute phone call. E-soko, a mobile and web-enabled repository of current market prices and a platform through which buyers and sellers interact in Ghana, managed to increase farmers' revenue by 10% since they started using the platform in northern Ghana (Halewood & Surya, 2012). These real time market dynamics help farmers deal with external demand directly, hence capturing more of the products' value. In their study Muto and Yamano (2019) found that mobile phone coverage was associated with a 10% increase in farmers' probability of market participation for bananas, but not maize, in this case suggesting that mobile phones were more useful for perishable goods. Supporting the notion that technology-driven agricultural services have the ability to improve crop yield, expand access to markets, and boost revenue for farmers – thus improving livelihoods and boosting the broader economy. Especially through connecting farmers with expertise and information on everything from weather, crop selection, and pest control to management and finance. For example, the Ethiopian Commodity Exchange (ECX) provides a virtual market place, accessible online, by phone or SMS, which provides transparency on supply, demand and prices, and increases farmers' share of revenue (McKinsey, 2019).

In terms of technological developments, increases in agricultural

production will depend on the technological capacity to innovate, develop and the diffusion of new technologies and technological techniques which are specifically adapted and utilized based on the existing factor endowments and prices in a particular region or country (Hayami & Ruttani, 2011). One such factor is the level of education which entails the capacity of a country required to engage in the necessary agricultural research, development and extension as well as the ability to acquire, adopt and utilize existing agricultural knowledge and new agricultural related technologies. To enhance the diffusion and utilization of agricultural knowledge and acquisition of the necessary technological skills, there is need to have a diverse range of agricultural skills, by making more investment in education, skills development and life-long learning (Juma, 2016).

Advanced skills and higher education play a complementary role to technological advances in this knowledge revolution. New technologies cannot be adopted in agricultural production without a sufficient education and trained workforce who should be equipped with the necessary skills and knowledge, and also to be able to impart the knowledge and skills acquired to the masses especially, if it involves the less educated especially in the rural areas (Muto & Yamano, 2019). Hence agricultural related technological developments may not take place without an educated and therefore demanding customers and consumers, in this case the agricultural population. Even those who do not go into careers that require advanced education in agricultural science and engineering will need basic scientific and technological literacy to function as effective citizens in this environment. This being the case education and skills development affect both the supply and demand side of the agricultural-based knowledge driven economy. Theoretically, higher education allows workers to use existing physical capital more efficiently, it drives the development and diffusion of new knowledge and technologies and also improves the capacity to imitate and adopt new knowledge and technologies (Dahlan, 2017), as well as impart that knowledge to a greater part of the local population. This implies that developing countries need to expand not only primary education, but also secondary and tertiary education in order to enhance the diffusion and utilization of knowledge for agricultural as well as economic development as a whole.

While primary and secondary education have been at the centre of donor community attention for decades, higher education and research have been viewed as essential to development in recent years in Africa. Higher technical education is increasingly recognized as a critical aspect of the development process, especially with the growing awareness of the role of science, technology and innovation (Juma, 2016). Increasing higher education will lead to a rapid development and dissemination of agricultural knowledge, which will lead to more advances in technological innovation as it is becoming a more critical element for the countries' competitiveness and development.

2.3 Selected ICT Cases on Agricultural Information in Developing Countries

The researcher reviewed ICT applications on agricultural information in 5 developing countries in terms of; technology used, the model of business and the description. The aim was to show that the developing countries had set up ICT services to bridge the gap of the problems the farmers were facing and how ICT solved them.

2.3.1 ICT Application case in Tanzania

2.3.1.1 TigoKilimo

Technology used: Mobile phone

Model of business: Subscription base (consumers pay)

Description: this agricultural value-added service (Agri VAS) in Tanzania provided relevant, timely and actionable information on farm inputs and market intelligence. Farmers could use Unstructured Supplementary Service Data (USSD), Interactive Voice Response (IVR) and helpline to access Content (Chung, 2015). Moreover, as a result, respondents (88 percent) reported that they were making changes thanks to TigoKilimo information. These changes occur in realizing for farmers higher yield that was auctioned by more access and use of farming practices (37percent), and current, relevant weather (23 percent) (Chung, 2015). Some farmers gave their testimonial on this ICT. For instance, '*previously I used to weed the field, remove all grasses, and take them away from the field. However, through TigoKilimo, I obtained knowledge that I should not collect the weeds away from the field but to leave them there to decompose as manure.so, now I do as they advised me.*' (Chung, 2015).

Agricultural input information: farm input prices, weather forecasts, agronomy advice

2.3.1.2 Z-Kilimo

Technology used: Mobile phones

Model of business: Subscription based (consumers pay)

Description: Z-Kilimo is an SMS-based application in Tanzania, utilizing mobile phone capability and ubiquity to provide access to comprehensive farming methods operated by Zantel (a network provider in Tanzania).

Agricultural information: daily weather forecast, details on soil management, pest control methods and information on livestock knowledge and bird flu (Zantel, 2013).

2.3.2 ICT application case in China

2.3.2.1 NOVA

Technology used: Mobile phones, web portal

Model of Business: Subscription based (consumers pay)

Description: The agricultural information dissemination is done by NOVA (agriculture and production information system (CICC, 2003). It is a web-based agricultural service. Some farmers achieved significant productivity thanks to the use of information on agricultural products including farm inputs. Some farmers even claimed that they could no longer work without the system. Farmers on site, proving that it gives the assistance required, generally accept the system. In particular, the system of installing a help Centre, which provided the same services on the telephone as online in environments without PC access was highly assessed, as was the function of achieving immediate results of exploring new sales channels to farmers (CICC, 2003).

The agricultural information accessed by the farmers was weather forecasts, best practices, farm inputs prices, where to buy inputs (seeds, fertilizers)

2.3.2.2 SOUNOUNG

Technology used: Mobile phones, web portal

Model of business: Subscription based (consumers pay)

Description: SOUNOUNG disseminates agricultural input in China. Harrod and Jamsen (2010) argued that the project provided an aggregated information from a search engine to farmers. They further reported that in 2009, 1276 households were using the website and by 2010, that figure doubled indicating an indisputable success for the project. The project worked with farmers' organizations as partners that were well structured and functional. Farmer organizations' members could access information from the service using their computers, mobile phones and personal digital assistants (PDAs). Farmers could access agricultural information according to their farm characteristics. Farmers of the organization who did not have computers, mobile phones or PDAs, the farmers' organization (cooperative) could also print information and recommended actions (Harrod & Jamsen, 2010). The cell phone was found to be the most ICT service used in China because of its timeliness and convenience (Harrod & Jamsen, 2010). The project assisted the farmers to access agricultural information such as weather forecasts, best practices, farm inputs prices, where to buy inputs (seeds, fertilizers).

2.3.3 ICT application case in India

2.3.3.1 E-choupal

Technology used: Mobile Phone, Personal Computer, information systems

Model: Subscription based (consumers pay)

Description: The ITC (Indian Tobacco Company) Limited's e-choupal project is an ICT-based project, which aims at building effective farmer-agribusiness linkages. The model has been designed to tackle the problems of fragmented farms, weak infrastructure and a large number of intermediaries in the Indian farming sector (Dangi & Singh, 2010). The system permits the delivery of current and appropriate information that help farmers to ameliorate their decision-making on farm inputs and hence better productivity and aggregation of demand at the village level for accessing higher quality inputs and knowledge at lower costs. Farmers benefited from the following agricultural information weather information, advice on the activities in the farming life cycle, agricultural best practices organized by crop type, buying inputs such as seeds, fertilizer and pesticides in local languages (Dangi & Singh, 2010).

2.3.3.2 IFFCO Airtel

Technology used: Mobile Phone (Siraj, 2010)

Model: Subscription based (consumers pay)

Description: Indian Farmers Fertilizer Cooperative Limited (IFFCO) and Airtel3 launched a service for Indian farmers on agricultural information in 2008 (Singh et al., 2016). Farmers can buy a mobile phone that is already registered for the initiative and look for agricultural input information through SMS (Short Message Service) or a call Centre. IFFCO Airtel provides the best time to plan, the weather information, prices of farm inputs (fertilizers and seeds) as agricultural information to farmers in all local languages (Singh et al., 2016).

2.3.4 ICT application case in Indonesia

2.3.4.1 Nokia life

Technology used: Nokia Mobile Phones

Model of business: Subscription based (consumers pay)

Description: Nokia life suite is an information service through mobile phone (Nokia) launched in India in 2009 and scaled the same year in Indonesia, and currently used in Nigeria and China. In the four countries, the service is cheaper in Indonesia than the others. In a report on Nokia Life, Pshenichnaya and Clause (2013) found that the service cost is: 5 Chinese Yuan (0.76 US$) in China per month, 60 Indian Rupee (0.88 US$) in India per month, 500 Indonesian Rupiah (0.03 US$) in Indonesia per month and 250 Nigerian Naira (1.25 US$) in Nigeria per month. In Indonesia, Nokia heads the ranking as reported by Ueno and Yoshida (2012). The Indonesian experience on this service is therefore different from the three other countries in terms of cost of the service. Thus, we have chosen to review Indonesian experience of that ICT service. Nokia Life delivers Education, Health, Agriculture and infotainment services to address the information gap and enable consumers in emerging societies to be better informed and to improve their livelihoods (Pshenichnaya & Clause, 2013). The service delivers information on agricultural inputs via SMS.

Agricultural information: crop tips, agriculture news, market prices, weather information and advisory.

2.3.5 ICT Application case in Pakistan

In the recent years, Pakistan made tremendous strides in improving ICT services for masses (Siraj, 2010). In the field of agricultural input information dissemination, some ICT services have been set up in the country.

2.3.5.1 Ukisaan

Technology used: Mobile phones, web portal

Model of Business: Subscription based (consumers pay)

Description: Ukisaan is an agricultural value-added service launched by Ufone4 towards farmers. It provides information on a call made by the peasants. It is only available for the users of this telecom operator.

Agricultural input information: agricultural crops, livestock farming, non-conventional crops, poultry and fruit farming, weather alerts, in regional languages.

Summary of the Reviewed ICT Application Cases

The experience from the developing countries was that ICT services had assisted in adopting agricultural information to farmers. For instance, the Chinese experience was a success in achieving a transformation of the agricultural activities according to Siyao (2012). The researcher concluded from the Chinese application case that the timeliness, the relevancy and the appropriateness of the information, which were information quality characteristics, were the key factors for the success of the ICT service. It was also found that the use of Personal Digital Assistant (PDA) and computer were the most ICT means used to get agricultural information.

The question to ask then was that could we implement the Chinese experience in developing countries? In most of the developing countries, the ICT Skills and Illiteracy were barriers to the use of PDAs or computers. The cost of such devices is another factor to take into account for farmers. The answer to that question is therefore that the Chinese experience could not be applied in most of developing countries. On the other hand, in China, giving the agricultural information in a printed form was an appropriate manner of presenting the information to the farmers who did not have the ICT Skills. Nevertheless, they had to read it, which was re-challenged by the illiteracy in most of the developing countries. The fact that farmers' organization help farmers to access and use agricultural information could be helpful for most of the developing countries. However, it supposed that the farmers had to travel from their farm to get the information. That was a waste of time for the farmers. Therefore, again, the ICT models from the Chinese experience on agricultural input information could not be applied to most of the developing countries. The main conclusion was that three issues came up: 1) farmers were still facing lack of agricultural information; 2) This lack of information was restrained by the low usage of ICT on agricultural information and 3) that low use was due to certain challenges.

2.4 The role of Smallholder farming in Kenya

African agriculture is largely traditional and practiced by smallholder farmers and pastoralists. It is predominantly rain-fed and low yielding, with these farmers ever trapped in a cycle of poverty and food insecurity for decades (World Bank, 2017. However, agriculture remains a very important player in the economic sector, in Africa it contributes significantly to African nations GDP for instance, in Kenya it contributes 32 % to the GDP. In addition, it also creates employment. Thus, Smallholder agriculture provide livelihoods to over 70% of the Africa's population (Gollin, Lagakos & Waugh, 2014).

Kenya's agriculture is predominantly smallholder farming and is carried out on farms averaging 0.2–3ha, mostly on a subsistence basis. These Smallholder operations account for over 70% of agricultural production and meet about 75% of the national food demand (World Bank, 2017). Therefore, it is important to support and promote smallholder farming as it plays a critical role in achieving food security and ensuring source of income.

2.4.2 Challenges facing the smallholder farmers in the use of ICT on agricultural information

2.4.2.1 Cost

The high' cost is a barrier to the use of ICT on agricultural information in developing countries. For instance, in Tanzania, the cost was an obstacle to the uptake of ICT on agricultural information by farmers (Barakabitze et al., 2015). Therefore, this study identified the high cost as a barrier to the use ICT in the context of agricultural information. The high cost of ICT services constitutes a factor to its use on agricultural information. For instance, in Bangladesh, the high cost was one of the factors that could dilute the advantages of accessing information through mobile phone (Dey, Prendergast & Newman, 2008). This finding was confirmed by many other studies (Wulystan and Andrew, 2013; Haug and Tumbo, 2016; Kilima, Sife and Sang, 2016) in Tanzania. In Mali, 95% of SENEKELA users find that the cost is prohibitive (Palmer, 2014). In India, a case study on e-choupal by Sukhpal (2004) argues that low cost leads to use of ICT by farmers. In Bangladesh, Dey, Prendergast and Newman (2008) noted that high costs are one of the factors that can dilute the advantages of having access to information through ICT.

2.4.2.2 Information Quality

Farmers question the effectiveness of the provided information for use. For example, in India, studying the ICT in Agriculture development Meera et al. (2004) argued that information on agricultural (availability and prices) was sensed as inappropriate by farmers. This finding was similar to another study on an agricultural value-added service (VAS) conducted in Mali by Palmer (2014) who found that the information provided was incomplete. Also, Wang and Peng (2008) report that the information content (quality) was a problem in China. Moreover, Lwoga (2010) reports that relevant and local content were barriers to the use of telecentres in Tanzania by farmers. Therefore, the provided information quality constituted a challenge for farmers in the use of ICT on agricultural information.

There are some characteristics related to the agricultural information quality affecting its use. For instance, in Uganda, Kaddu (2011) argues that the value of information depends upon many factors including accessibility, relevance, accuracy and currency. In addition, in a study on ICT services for development in developing countries, Beardon (2005) argues that the participants said that for information to be useful or valuable, it should be well-timed and comprehensible. Agricultural information completeness meant that all the data necessary to meet the current need for farm information was provided by the ICT services (Siyao, 2012). The accuracy meant that the information on agricultural inputs was correct for the farmers' need for information on agricultural inputs. Siyao (2012) argues that accuracy implies that information is free from bias. Timeliness meant that the farmers should have been be able to get the agricultural information when they needed it. Relevant meant that the information was suitable for the current information needed of farm inputs. Appropriateness

2.4.2.3 Illiteracy and ICT Skills

It is important to know how to access and to have the skills to use ICT to adopt information. Dutta et al. (2004) argued that an educated and ICT aware population is the condition for any community to participate in the networked world fully. In addition, Sanga, Kalungwizi and Msuya (2013) reported that illiteracy remained a challenge for farmers in their use of ICT on agricultural information. The same observation was made by (Kaddu, 2011). Therefore, Illiteracy was a major concern (a challenge for farmers in their use of ICT on agricultural input information. The low ICT Skills also constituted a challenge to the use of ICT on agricultural information. For instance, the GSMA (2015) reported that illiteracy and low technical skills were a major barrier to uptake. In addition, the USSD channel of TigoKilimo in Tanzania necessitates farmers to navigate through a comprehended interface menu text-based information.

Msoffe and Ngulube (2016) also argued that low levels of literacy were a barrier to access to information. Another study conducted in India, Mittal and Mehar (2012) found that farmers in Bihar and Punjab States, farmers having access to information on farm inputs (seed, best cultivation practices, protection from weather-related damage and handling plant diseases) had seen a yield increase of respectively 63.82% and 76.64%. Further, they argued that Bihar had a literacy rate of 21.1% and Punjab a literacy rate of 49.2%. Therefore, the use of ICT on agricultural information was higher in Punjab where the illiteracy was lower than Bihar where the illiteracy was high. However, Glendenning and Ficarelli (2012) argued that the appropriateness, usability, relevancy of information was mediated by the users (farmers) capacity (literacy and skills). Therefore, ICT Skills and Literacy moderate information quality effect on the use of ICT on agricultural information. Another study in India on the use of ICT services in agriculture conducted by Meera et al. (2004) reported that frequent use of the internet services was positively associated with education. In Serbia, Simin and Janković (2014) argued that the level of education had a positive effect on Innovations' adoption in agriculture. In Saudi Arabia, Al-Ghaith et al. (2010) also argued that the adopter of new technology had the appropriate level of education and that several metrics could be used to measure the educational achievements. These were illiteracy and the percentage of the population that had a second-degree education (Garcia-Murillo, 2003). Singh et al. (2016) emphasized that the use of ICT such as mobile phone required basic literacy.

2.4.3 Other Challenges facing the smallholder farmers

Agricultural sector in Kenya is characterized by the existence of both large scale and smallholder farmers. There are currently more than 5 million smallholder farmers who account for about 75% of the total agricultural production in the country (World Bank, 2017). Smallholder agricultural production is largely characterized by growing of staple food like maize and beans, which are primarily targeted for own consumption with little marketable surplus. In Kenya, land holdings have become smaller due to population pressure, hence farmers have transformed from staple crop production to highly market-oriented crops. More than 25% of food produced is lost in the entire post-harvest chain before reaching the consumer. These losses particularly during harvesting, drying, shelling, winnowing, sorting/packaging, storage and transportation and also in-market storage. With the right equipment, knowledge, local and national government support small holder farmers would contribute to reducing post-harvest losses leading to more quantity of food supply as well as agricultural income (De Janvry, Macours & Sadoulet, 2017).

Extension services play a key role in disseminating knowledge and are critical in transforming subsistence farming to modern and economically viable agricultural ventures. However, there is limited access to extension services in most parts of the country with the national extension staff to farmer ratio standing at 1:1000. This situation has hindered most farmers from keeping pace with technological advances. There is a need to recruit more extension staff to increase access to extension services to farmers (Kanui, Kauti & Mwobobia, 2016).

Although Kenya has an established agricultural research system with research scientists, research and discussion on the use of modern science and technology to support smallholder farmers in the country has not been exhaustively explored and pushed to the public as a national agenda. This constrains efforts to increase agricultural productivity these farmers continue to use outdated and ineffective farming methods, techniques and technologies. However, this would not be the case if research to farmer and farmer to research linkages, for instance through a robust extension service support was available. This is because such a service would provide a platform for farmers to learn new farming methods, techniques, technologies through the extension service providers on the research-farmer linkage. Besides, this approach would deliver on-demand access to services to improve farm productivity towards meeting the ever-increasing demand for food in the country and for export (Kanui, Kauti & Mwobobia, 2016).

Smallholder farmers faced a challenge of the size of the land which was in a decline due to population growth and the pressure this poses on land and water resources; the subdivision of land where it is custom to divide land among children; private investment and national development projects.

Improving food security depends on removing the socioeconomic and political barriers faced by smallholder farmers in expanding their productive capacity. Amongst other things, these include making agricultural extension services available, providing access to information on financial and marketing services, providing access information on land leases, information on improving farming infrastructure, continue learning programs for farmers, and information to other services such as access to health care etc. (Gollin, Lagakos & Waugh, 2014). It then follows that policies be put in place to protect and promote projects and grassroots that are successfully addressing the needs of the farmers. Only some smallholder farmers use innovative technologies. The rest, either they have no access to them or they perceive them as risky. For many, even decisions on educating their children can shape their choices on when to sell their produce. And they sell when prices are at their lowest level – just after harvest which coincides with the beginning of the school year – in order to meet the cost of schooling (FAO, 2015)

Trust and transparency were another challenge that faced the smallholder farmers. Use of mobile phone technology to access farming information was barely trusted as the information source. Therefore, the content was not accepted or adapted for practical use. This was partly attributed to by low transparency from information sources and reliability of service providers. A study by Tisselli (2015) recognized mistrust between farmers themselves, while David-West (2010) and Schalkwyk et al. (2017) identified mistrust between farmers and project organizations (Esoko).

Building trust and transparency among crop farming stakeholders creates confidence to use the available information to support decision-making appropriately. Consequently, trust and transparency could be improved by formalizing information sources, so that when a problem arises, responsible people can be held accountable for it.

The use of a foreign language such as English for communication that scarcely considered the cultural context was another burden facing smallholder farmers when using mobile phone technology to access farming information. The foreign language is not easy to interpret (Asenso-Okyere & Mekonnen, 2012). This might have led to the possible misuse of the available information (Schalkwyk et al., 2017). Other obstacles included technophobia, that is fear of technology among smallholder farmers (Ifeoma & Mthitwa, 2015), no consideration of ethical and language issues in designing mobile phone applications and content (Anjum, 2015), a design that did not consider existing psychological and social barriers among the community (Anjum, 2015), the existing negative attitude of smallholder farmers on technology (Darko & Koranteng, 2015), and poor information sharing culture among farmers (Asenso-Okyere & Mekonnen, 2012).

Therefore, in future, it was important to consider using local languages that would be appropriate to the cultural context when developing an artefact, targeting smooth information flow to a community, and encouraging the adoption and scalability of mobile phone use in the crop farming value chain. This would ultimately increase the confidence of smallholder farmers in decision-making during farming. The low level of education and training among farmers was an additional weakness that faced smallholder farmers when using mobile phones to access farming information.

Conclusion: On the basis of the reviewed literature of this study, there were many challenges that faced the smallholder farmers such as Cost, information quality, illiteracy and ICT skills, trust and transparency among others, Considering the bottlenecks and obstacles mentioned, it could be affirmed that one way to overcome them would have been to involve all stakeholders, the participation of stakeholders in a project calls for diffused sustainability, collaboration, learning from each other, and sharing experiences of modern technology (McCormick, Anderberg, Coenen, & Neij, 2013). Thus, both donors and governments needed to aggregate farmers' needs and involve stakeholders during the invention process so to take the cultural context into account and create a sense of ownership.

2.5 Barriers to Agricultural Information Dissemination in the Case of Small Holder Farmers in Kenya

Information needs differ significantly between countries and within countries for farmers producing different products. Farmers differ in their perceptions of the information they require and, in their priorities, when they come to access information. The primary message underlying these disparities appears to be that farmers require a package of information and that their needs and priorities change throughout the production cycle. There is need to identify and involve all the agricultural stakeholders when considering incorporating ICT-in-agriculture.

The ability of farmers to make informed decisions is limited by the deficiencies which have been observed in the quality and applicability of the information available to them. These deficiencies are compounded by the lack of consistent data formatting or standards for the integration of data. Frameworks have been applied in the data mining and bioinformatics research disciplines as a means of facilitating integration of data. An eAgriculture framework need to take information needed by farmers and utilizes processes that deliver this critical information in a format usable by the farmer. A series of steps which include data capture, analysis and data processing precede the delivery of integrated information to the farmer.

Effective design and consistent, transparent implementation of appropriate policies and regulations guiding a country's investment in and provision of ICT infrastructure, tools and services are keys to enabling ICT interventions. In creating a supportive environment for ICT innovation and service provision, effective policies and regulations in a number of other key areas are equally important, such as public and private financing of infrastructure, the business environment, support for innovation, and intellectual property (Dlodlo & Kalezhi, 2015). ICT-in-agriculture interventions require a strong, but flexible, regulatory environment; the policy environment is further strengthened by incentives for the private sector to make investments.

The agricultural barriers may be resolved by employing ICT tools to provide an information bridge between agricultural experts and farmers. For example, communication via mobile phones can reach farmers in distant areas where landline phones are limited. Video conference or voice over IP (VoIP) may be used to transfer information between an expert and groups of farmers in several areas. Such an approach could reduce the need for travelling to remote areas, the costs of travelling and the time spent with those farmers (Tantisantison, 2011).

While the use of ICTs in extension services provides several key benefits in relation to traditional media, ICT projects come with a range of challenges including: technological dependence; lack of accessible telecommunication infrastructure in many rural and remote areas; capital cost of technologies, high cost of on-going access and support; inherent need for capacity building; integration issues with existing media and local communication methods and tradition and lack of involvement of all stakeholders in planning (UNDP, 2012). From the aforementioned review, the following major barriers are cited;

A combination of unfamiliarity with technology and lack of self-efficacy intimidates many people lacking technology-operation skills from direct usage. The effort of acquiring the skills required to operate the device is also perceived as high. The easiest alternative, then, is to find a technologically skilled person. Non-literacy limits the ability of some users to understand the features, functions, and outputs of technologies (Gwada, Bett & Sibiko, 2019).

Numeracy is an essential skill in number-based operations, such as dialing phone numbers and operating menus. This is further compounded by the skills required to operate technologies. For example, a user who is non-literate but numerate, and could read the time from a wall clock but not set the alarm. Pre-existing habits of dependency, not always regarding technology, transfer to device interactions (Njeru, 2016). Factors such as age, lack of self-esteem, social order gave rise to dependencies on other community members. Local experts acted as enablers of information and communication access, through existing relationships. The cost of ownership of a device was sometimes prohibitive, not just in terms of initial purchase, but also in maintenance, subscriptions, updating, or repairs. Security is paramount, it calls for secure storage systems, all sensitive data for farmers be well protected, unauthorized access should be eliminated and maintain a good data confidentiality (FAO, 2018).

2.6 Challenges in ICT Adoption in Agriculture

ICT represents an enormous opportunity to introduce significant and lasting positive change across the developing world. However, this new potential and opportunity is accompanied by significant challenges and possible threats. Some of them include sustainability, lack of knowledge, and pace of change, funding and changing roles and norms (Gollin, Lagakos & Waugh, 2014). Anyan and Frempong (2018) investigated the barriers that hinder the effective use of ICT in farming by smallholder farmers. The study revealed that majority of the smallholder farmers have some level of education. The study also identified radio and mobile phones as the most common ICT tools used by smallholder farmers. Three main barriers that hinders the effective usage of ICT namely attitudinal, accessibility and technical were identified by the study.

Sustainability and scale of ICT adoption in smallholder farming has been one of the challenges. The use of ICT in development programs has, to date, been relatively ad hoc, with many examples of small initiatives or pilots but very few large-scale, sustainable, ICT-supported programs (Gakuru, Winters & Stepman, 2015). To unleash the full potential of ICT in development programs, a new level of collaboration, both internally and with other organizations, and a new approach to scaling solutions to achieve a material impact are needed. This will necessitate significant coordination between INGOs, technology companies, private sector organizations, universities, and government entities (central and local), as well as with traditional development partners (FAO, 2017).

It is observed in Tiamiyu, *et al*., and (2012) that one of the key factors affecting use of ICT in agriculture is inappropriate ICT policies, especially those targeting rural communities and rural development, language

barriers, poor information sharing culture, and the fact that not all people in rural areas have even the low-end ICT such as radio and television. The rural farmers and agriculture sector are not well equipped internally to support and nurture the effective exploitation of ICT to benefit development. They simply do not have the knowledge, expertise, or organizational capacity needed. The use of information technology is often seen as a thorny, problematic issue relating to back office systems. Although there have been various attempts to introduce ICT to smallholder farmers in Africa to provide effective communication and information services, these efforts have been mostly through uncoordinated project.

Another challenge is that network coverage in rural areas remains limited. Despite 4G becoming the most common mobile connection globally and 90% of being able to access the internet through 3G or higher quality network, only around a third of rural populations in Least Developed Countries (LDCs) receive coverage by 3G networks (GSMA, 2019). Smartphones have become a major way for consumers to access internet. Falling handset prices and innovations such as pay-as-you-go plans mean that mobile devices are increasingly affordable and accessible, including for rural communities (Hahn & Kibora, 2018). Among the world's poorest households, 7 out of 10 have a mobile phone and more households in LDCs (ITU, 2018). However, these are not always web-enabled smartphones.

Effective design and consistent, transparent implementation of appropriate policies and regulations guiding a country's investment in and provision of ICT infrastructure, tools and services are keys to enabling ICT interventions. In creating a supportive environment for ICT innovation and service provision, effective policies and regulations in a number of other key areas are equally important, such as public and private financing of infrastructure, the business environment, support for innovation, and intellectual property (Dlodlo & Kalezhi, 2015). ICT-in-agriculture interventions require a strong, but flexible, regulatory environment; the policy environment is further strengthened by incentives for the private sector to make investments.

Furthermore, ICT often has a questionable reputation as a result of previous unsuccessful or costly initiatives. Under Pace of change, government current structures, staffing, and ways of operating have a strong momentum that is not easy to halt or redirect (Kanui, Kauti & Mwobobia, 2016). It is relatively easy to utilize ICT to sustain and improve current organizational constructs and approaches, making useful but incremental progress. It is incredibly difficult to conceive of new ways of working with organizational constructs that are fundamentally different from the status quo and require a shift in terms of strategy, competence, skills, and organizational structure (Kieti, Kauti & Kisangau, 2016).

Access to web-enabled smartphones and fast 3G or 4G internet connections remains particularly limited in rural areas. There will need to be work to address this disparity and to facilitate smartphone ownership and use in areas where it is currently lacking. Both literacy and education levels also remain particularly low for rural populations in developing countries and LDCs which presents a barrier to the use of digital technologies. Youth unemployment rates are often higher than the country average and this is especially the case in rural areas. Increasingly, employers want employees who are adept at using technology. A lack of e-literacy and digital skills in rural areas means these populations will fall behind in the modern labour market. There is a need for school curricula to incorporate digital subjects, for improved knowledge and skills among teachers and for increased availability of digital technologies in classrooms.

3. Methodology

The researcher used mixed research method because it had the ability to explore both quantitative and qualitative research methods hence the researcher had the opportunity to use a wide variety of techniques that aided the research process. Mixed research method was used to determine the characteristics of the subjects, including their traits, behaviour and opinion. It is preferred to the other mixed methods designs for its suitability and strengths in collecting, analysing and integrating quantitative and qualitative research simultaneously in a single study as advanced by Creswell, (2014). For example, by investigate the challenges encountered in the dissemination of agricultural information for smallholder farmers and establishing the influence of ICT in improving agricultural productivity in South Eastern Kenya, the government policymakers would make informed decisions regarding implementing policies that speeded up the use of ICT on agricultural information in the region.

The research philosophy for this study was positivism. Positivism thus derives a quantitative perspective, which holds that there is an objective reality that can be expressed numerically, with explanatory and predictive power. This study was carried out in Machakos, Makueni and Kitui Counties of Kenya. The study area is located in the arid and semi-arid regions of the country. The area lies between latitude 00 ◦ 030 and 03 ◦ 000 and longitudes 36 ◦ 450 degrees 39 ◦ 120. The area received rains twice a year, with the main rains season occurring in October to December and the lesser rains season occurring in March to May. The annual rainfall ranged from 500 mm in the low land areas to 1500 mm in the sub-humid hilltops. The seasonal rainfall is highly variable, erratic and unreliable. The local community are mostly smallholder farmers that rely on rain fed agriculture for crop farming of maize, beans, millet and vegetables.

All the questionnaires received were prepared in readiness for analysis through editing, cleaning the data and coded to facilitate data entry and keyed into SPSS for analysis. Descriptive statistics was used because they enabled the researcher to meaningfully describe distribution of scores or measurements using few indices. The qualitative data was analyzed using thematic content where key themes were used to beef up the quantitative results.

4. Results and Findings

The study administered 1,150 questionnaires and from the 1,150 questionnaires, 1047 questionnaires were filled and returned to the researcher representing a 91% response rate.

4.1 Challenges Encountered in Dissemination and Access of Agricultural Information by Smallholder Farmers

4.1.1 ICT Channels for Information Dissemination

The smallholder farmers were asked to indicate ICTs tools used in the course of their work. The results were presented in the Figure 1.

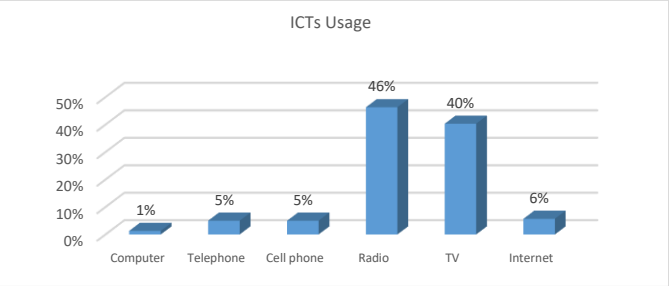

Figure 1: ICTs used

From the findings, most of the smallholder farmers indicated that they used radio 46 percent and television at 40 percent to acquire agricultural information. Other means such as internet 6 percent, cell phones 5 percent and computers 5 percent were not common and limited as they had less representation of below 10 percent. When interviewed, the county agricultural extension officer responded that;

> "Radio is considered useful in improving the sharing of agricultural information by remote rural farming communities as it supports agriculture extension through the use of local language and rural radio to communicate directly with farmers and listener groups."

In addition, Radio and TV programmes on agriculture are run in most vernacular stations that serve agricultural communities. This showed that while radio is quite popular as a source of agricultural information, the internet is still an emerging technology with only 6 percent of farmers reporting its and the key reasons for not being used were costs and lack of smart phones.

On the factors limiting the use of ICT by farmers, the first county agricultural extension officers mentioned that;

> "Most of the smallholders concentrate on subsistence farming, with low yields and relatively low excess production volumes available for large-scale trading. Smallholder farmers lack access to critical information, market facilitation, and financial intermediation services."

Another county agricultural extension officer responded that;

> "The ability of farmers to make informed decisions is limited by the deficiencies which have been observed in the quality and applicability of the information available to them. These deficiencies are compounded by the lack of consistent data formatting or standards for the integration of data."

Further, a county agricultural extension officers responded that;

> "A combination of unfamiliarity with technology and lack of self-efficacy intimidates many people lacking technology-operation skills from direct usage. The effort of acquiring the skills required to operate the device is also perceived as high. In addition, the cost of ownership of a device was sometimes prohibitive, not just in terms of initial purchase, but also in maintenance, subscriptions, updating or repairs."

It was also found that some farmers used mobile phones not as a source of agricultural information but for MPesa services. Therefore, farmers were encouraged to join farmer groups as a key pipeline for improving awareness and use of other m-services for access of agricultural information.

4.1.2 Preferred format for Information Dissemination

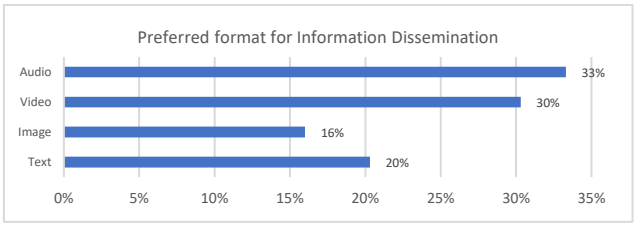

Figure 2: Preferred format for Information Dissemination

In improving agricultural productivity among the smallholder farmers, preferred mode for information dissemination was sought and the findings indicated that most of them preferred to use audio 33 percent and video 30 percent. Other means such as images 16 percent and texts 20 percent were not common and limited due to their level of education, this was concurred by (Gollin, Lagakos & Waugh, 2014) that text-based media were not popular among farmers because of their limited reading and writing skills. These audio and video formats also incorporated radio and television since they could disseminate agricultural information in their vernacular language.

The availability of personalized agro-advice was limited where a majority of 71 percent could not be able to retrieve any personalized agricultural information.

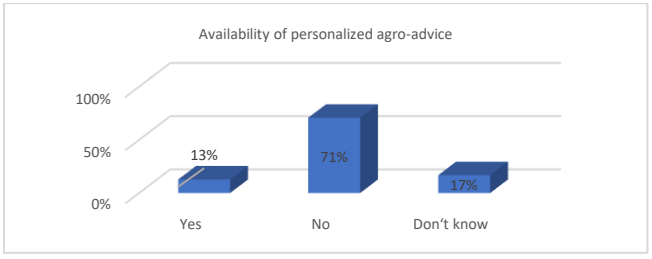

Figure 3: Availability of personalized agro-advice

Radio and cell phones were most preferred ICT tools for disseminating information to farmers. It could be deduced from the findings that of all the respondents in this study, 48 percent preferred cell phones and 25.5 percent radio as most suitable tools of disseminating agricultural information. However, agricultural information delivered by these tools could not be repeatedly played and rewinded by the farmers to satisfy themselves with the details of what they listened to; therefore, it was concluded that the use of radio and cell phones as communication tools in this research could not be suitable on their own.

It was also found out that preference for the use of computers, as an ICT tool for disseminating agricultural information was considerably low. Agricultural information dissemination through computers may be a suitable option to be considered in combination with other tools since farmers can save the information for future references. Although ICT tools, such as computers, mobile phones and the internet are commonly used around the world, their appropriateness within specific situations and the readiness of potential users to use them posed a lot of challenges in the dissemination of information amongst farmers. A number of challenges were cited. The absence of a robust feedback mechanism and ICT policy or guideline to streamline the flow of information was a setback in smallholder farmers. At least 34.3 percent of the respondents are not accustomed to using computers to access agricultural and 76.5 percent of the respondents access it occasionally. From the study, extension officers, government officers and the internet were the main sources. The small holder farmers also noted the declining presence of the extension work officers. A small holder farmer noted that;

> "……. agriculture extension services provide farmers with important information, such as patterns in season planning, new seeds varieties, management practices with respect to crop cultivation and marketing, and training in new technologies. However, the declining effectiveness of the extension service is being identified as a major factor hampering ICT adoption by the small holder farmers."

From the findings, the sources of agricultural information were critical to the delivery of information to smallholder farmers and other farmers in general.

4.1.3 Accuracy of Agricultural Data

Table 1: Accuracy of Agricultural Data

Category	Not Accurate	Moderate	Very Accurate
Extension workers	15.0%	44.3%	40.7%
Government officers	19.3%	44.0%	36.7%
Websites	18.0%	42.7%	39.3%
Sales agents	17.7%	48.3%	34.0%
Neighbors	64.0%	20.0%	16.0%

The researcher assessed the quality of data received by smallholder farmers by focusing on their accuracy. Accuracy consisted of two components, reliability and validity (ISO 1994). The reliability of a method was its ability to produce repeated, consistent results. Validity referred to the closeness of a result or the mean of a large group of results to the actual value or accepted standard. The combined information about reliability and validity allowed discussion of the accuracy of a method. The accuracy of information received by the smallholder farmers on weather forecast and extensional services was assessed and the results were depicted in Table 1. The accuracy of agricultural data received from the extension workers 44.3 percent, government officer's 44.0 percent, websites 42.7 percent and the sales agent's 48.3 percent was of highly of moderate accuracy. However, the neighbors provided the least accuracy at 64 percent. That was concurred by the (World Bank ,2016) that the agricultural extension service was one of the critical change agents required to transform subsistence farming to modern and commercial agriculture and it was the link between agricultural research and farming communities for technology transfer in support of agricultural development poverty (Republic of Kenya, NASEP, 2016).

4.3.4 Information need by smallholder farmers

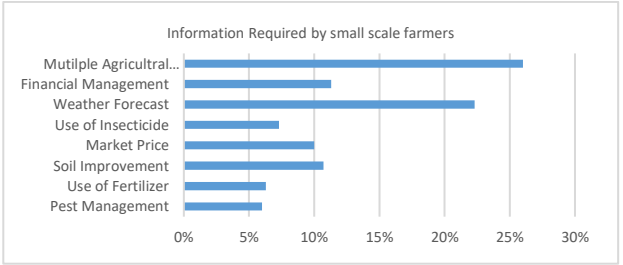

Figure 4: Information Needs

Most of the smallholder farmers posited that the type of information they sought in order to improve on productivity was a combination of multiple agricultural information of 26 percent. This involved a combination of pest management, use of fertilizer, soil improvement, market price, use of insecticide, weather forecast and financial management. Individually, information on weather forecast was also highly sought with 22 percent and financial information at 11percent.

The findings revealed that the information needs of smallholder farmers were closely linked with their day-to-day activities of farming. The farmers needed information on where and how to access regular support services relating to unusual problems that were difficult to diagnose during routine plant health control. They also required information on how to access agricultural inputs such as quality seeds, fertilizers or pesticides. The study also revealed that the farmers needed information on markets and prices for their produce. The other needs expressed by farmers included information on soil and weather conditions. The county agricultural extension officers responded that;

> "Lack of accessible telecommunication infrastructure in many rural and remote areas; capital cost of technologies, high cost of on-going access and support; inherent need for capacity building; integration issues with existing media and local communication methods and tradition and lack of involvement of all stakeholders in planning."

The smallholder farmers could only use the available information at their disposal which was dependent on provision and access. According to the theory of knowledge, it said that further knowledge gives way to power that generates further knowledge through the process of surveillance and new discourse. It is assumed that whoever has knowledge or information is empowered and whoever lacks it, is incapacitated. This was evidenced by (Kaddu, 2011) who used the Foucault's theory to study rural women adoption of ICT on agricultural information. However, the interest on ICT usage also hampered the adaptability of solutions for small scale holders and this was noted a by an extension officer that;

> "…….. the rural farmers assume that they have no need for information and prefer to continue their agricultural practices in their conventional mode. This visible low level of interest in utilizing agricultural information affect the extent to which rural information needs can be satisfied through ICT solutions."

The availability of personalized agro-advice was limited since majority with 71 percent could not receive agricultural information according to their personalized needs.

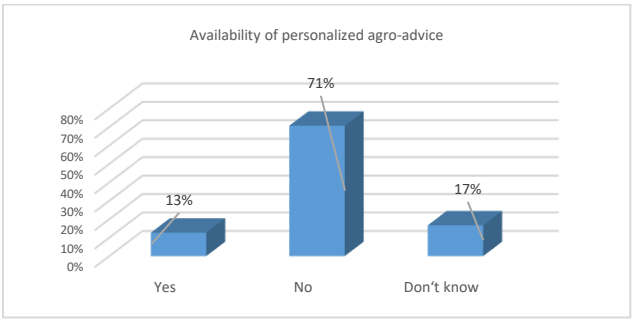

Figure 5: Availability of personalized agro-advice

Numerous challenges that frustrated farmers in accessing and utilizing agricultural information were established. These included, lack ICT skills (Computer illiteracy), inadequate ICT infrastructure such as power and telephones, lack of suitable content at the appropriate level and in a language, they comprehended and operated with.

The findings showed that there were inadequate ICT infrastructures through which internet-based service could be provided and accessed. Meeting information needs rural farmers in developing countries through internet-based information system was mostly hampered by lack of ICT infrastructures. Without ICT infrastructures like strong connectivity, it was difficult to connect the rural farmers and provide them with internet-based information services. Information service that could have been provided through websites, online forums, social media was hardly provided when the infrastructures were not in place.

The findings indicated a low level of interest in utilizing agricultural information among rural farmers: It had been acknowledged over time, that there was a connection between the level of interest in anything and extent of use same thing. Most rural farmers assumed that they had no need for information and preferred to continue with their agricultural practices in their conventional mode. This visible low level of interest in utilizing agricultural information affected the extent to which rural information needs could be satisfied through internet-based services.

The findings showed that there was inadequate knowledge of rural farmers' agricultural information needs. This was one of the major factors that affected the provision of internet-based services to rural farmers. Even when there were structures and facilities in place, it was pertinent that the information needs of rural famers were understood properly. Adequate understanding of rural famers information need was essential in providing internet-based information service, because it helped in determining the best approach and form of internet information system to adopt and use, this was because, while some information needs where personalized others could have been generic. One approach could not suit for both.

The low level of ICT literacy among rural farmers, especially in small scale was low. This was a major limitation as far as meeting the information needs of rural farmers was concerned. Lamptey, Sambo and Hassan (2016) revealed that lack of technological expertise was one of the major challenges of dissemination of information. As noted by Letshela (2019), rural farmers in most instances were faced with the same challenges that confronted the local population.

With proper ICT devices in place, farmers need shall be met due to good access and utilization of disseminated agricultural information. This could lead to increased efficiency in extension services since databases of relevant information could be kept and new research findings and discoveries relayed to farmers as soon as they were generated. Trainings and demonstrations could also be conducted easily through videos. The choice of delivery systems of ICT knowledge should have been based on what was efficient, effective and not expensive as people should use their resources carefully to derive maximum utility.

4.2 The Influence of ICT in improving agricultural productivity

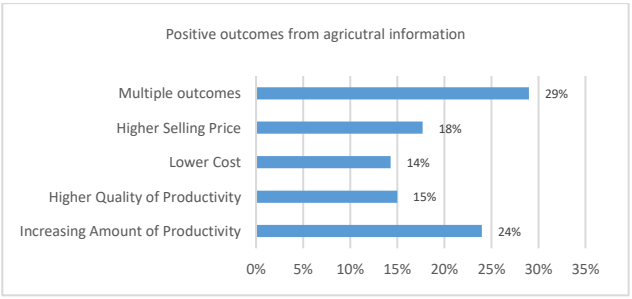

Figure 6: Positive outcomes from agricultural information

The study paper to establish the influence of ICT in improving agricultural productivity. The smallholder farmers indicated that the positive outcomes derived from the agricultural information from these providers resulted into a combined effect on increasing amount of productivity, higher quality of productivity, lower cost and higher selling price with 29 percent. Individually, the information led to increasing amount of productivity by 24 percent.

From the findings, most of the smallholder farmers indicated that they used radio 46 percent and television at 40 percent to acquire agricultural information. Other means such as internet 6 percent, cell phones 5 percent and computers 5 percent were not common and limited as they had less representation of below 10 percent. This showed that while radio is quite popular as a source of agricultural information, the internet is still an emerging technology with only 6 percent of farmers reporting its use. It was also found that some farmers used phones not as a source of agricultural information but for MPesa. That confirmed the previous study that mobile payments and mobile saving solutions was a successful ICT application in Kenya (Baumüller, 2018), mobile payments were used to receive remittances, a valuable source of money for many developing countries.

On the advantages for farmers using ICT: today and in the near future; the extension officer responded that;

> "The small holder farming is realizing several potential benefits of ICT. For example, the Radios and Televisions provides access to timely information (such as weather forecasts or market prices). Farms can also reduce costs by buying in bulk inputs or purchasing inputs that are not available in their villages. New markets are made available to farmers through collective communication and some farmers are selling their products profitably."

The positive outcomes were a reflection of the available accurate agricultural information found to be useful to some smallholder farmers in satisfying their information needs though in a low level. The potentials of agricultural information to farmers have been reported by Vidanapathirana (2012) for him, agricultural information within the hands of the farmers means empowerment through control over their resources and decision-making processes. This assertion makes it very clear that when farmers are bestowed with information, they become empowered and are able to make positive changes in their farming activities. Indeed, Vidanapathrina (2012) notes that an effective and efficient delivery system of essential information and technology services to farmers facilitates their critical role in decision-making towards improved agricultural production, processing, trading and marketing.

4.3 Discussions

Despite the existence of many information sources, a relatively small proportion of farmers were accessing agricultural information. From the findings, most of the smallholder farmers indicated that they used radio 46 percent and television at 40 percent to acquire agricultural information. Other means such as internet 6 percent, cell phones 5 percent and computers 5 percent were not common and limited as they had less representation of below 10 percent. This showed that while radio is quite popular as a source of agricultural information, the internet was still an emerging technology with only 6 percent of farmers reporting its use.

This was a key constraint to improving production considering a large number of farmers that required extension information. In terms of information sources, the results showed five sources of agricultural information; extension service, Government officers, websites, sale agents and neighbors. However, farmers' preference for any of the sources is significantly influenced by a number of socioeconomic characteristics like age. In addition, Extension service providers still remained the most utilized source of information by majority of smallholder farmers. Gender differential in access to agricultural extension is evident, yet the role of women in agriculture cannot be undermined. In order to increase productivity. Effective dissemination of new and existing technologies requires a combination of various appropriate dissemination channels that are gender sensitive. Integration of ICT, especially the use of mobile phones in extension is a potential disseminating channel which when effectively used, can create a significant impact. Other ICT platforms like internet can also be used to improve delivery of agricultural information. However, adoption of such technologies requires adequate capacity building for both extension staff and the end users (farmers).

Pertaining to farmers' information needs, the study established the following needs; availability of agricultural inputs, pest management and control and the results of soil testing, pricing and pricing techniques, modern ways of farming, weather forecasts, marketing of products and services, preservation and conservation of products. Challenges that frustrated farmers in accessing and utilizing agricultural information were established; lack ICT skills (Computer illiteracy), The level of education that lead to lack of suitable content at the appropriate level and in a language, they could comprehend and operate with. With proper ICT devices in place, farmers' needs shall be met due to good access and utilization of disseminated agricultural information. The study concluded that there was an urgent need to bring all technological development, available information, market sources, government policies and actions, research work, international efforts and other stakeholder to one table with a view to formulate policies for agriculture.

5. Conclusions and Recommendations

The study captured in detail the information needs of the farmers by addressing what they required in the course of normal agricultural activities. It was found out that farmers required information on soil management, pest management, use of fertilizer, weather forecast and financial management tips for mainly improving their productivity. The study concluded that there were positive outcome whenever accurate and timely information was disseminated to the farmer which led to higher quality of production and increased productivity

The study concluded that one of the biggest challenges faced Kenya and other developing nations which needed to be addressed urgently was agricultural technology, innovations and other research findings that did not get to the farmers who needed it most. Therefore, to exploit the contribution of ICT in sustainable agricultural development, the governments needed to empower poor farmers with information and communication assets and services that increased their productivity and income as well as protect the food security and livelihoods, and; to harness ICT effectively to compete in complex, ever rapidly changing global markets. The study illustrated the contribution of ICT to food security and sustainability of agriculture in developing countries.

The study concluded that there was an urgent need to bring all technological development, available information, market sources, government policies and actions, research work, international efforts and other stakeholder to one table with a view to formulate policies for agriculture. In order to exploit the contribution of ICT in sustainable agricultural development, the governments needed to empower poor farmers with information and communication assets and services that increases their productivity and incomes as well as protect the food security and livelihoods, and; to harness ICT effectively to compete in complex, ever rapidly changing global markets.

The government and information providers should come up with measures to overcome the existing challenges facing farmers in accessing agriculture information. There is need to scale up the use of ICTs in access to agricultural information especially radio since it was the most preferred and accessible media by farmers. There is need for the government to educate smallholder farmers on ICTs through extension officers to enable them to acquire agricultural information that could develop skills to improve and hence increase their crop production. These could be done through organizing workshops and short courses for the farmers. The government can also work towards ensuring that there is power connection in all the rural areas in order to encourage the use of ICT channels.

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