ICT in Agriculture: Developing Countries

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Abstract: World population is expected to surpass the 9 billion mark by 2050, and agricultural production will need to increase by 60 percent from its 2005/2007 levels to meet this additional food demand. ICT applications can make a significant contribution to meet this future global food needs. Information and Communication Technology can do so by collecting and sharing timely and accurate information on weather, inputs, markets, and prices; by feeding information into research and development initiatives; by disseminating knowledge to farmers; by connecting producers and consumers, and through many other avenues. Already, in the agricultural and food sectors of many countries, ICT companies, multinational farm input business, large machinery manufacturers, but also small and medium farm input suppliers provide a number of services to farmers through ICTs, including extension advice. Downstream, supermarket and agricultural product buyers also engage in the food value chain through ICTs, where the technology is also used by farmers' cooperatives, international organizations, the civil society and governments to effectively provide information on many aspects of farming, including regulation.

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INTRODUCTION

ICT in agriculture is increasingly becoming steady in developing countries and this could facilitate self-reliance for national growth. Agriculture plays a vital role in the social and economic development of most African countries and is the main contributor to economic growth and stability (Munyua and Adera, 2009; Bhalekar et. al, 2015). Electronic-agriculture describes an emerging field focused on the enhancement of agricultural and rural development through improved information and communication processes. The e-agriculture disseminates useful information through Decision Support System (DSS), Management Information System (MIS) and Expert System (ES) by infusing the User Interface and Knowledge Management System (Behera et al, 2015; Bhalekar et. al, 2015). An Enterprise Resource Planning (ERP) system is a standardized software package that combines functionality of multiple business functions into one integrated system (Verdouw et al., 2015). According to this study, the position of ERP with the precise features and requirements of a company is a critical encounter in order to exploit the benefits of ERP. Nevertheless, the authors disclose that it is likely to deal with this encounter and concluded that appropriate administration of the orientation, selection and implementation methods is important for acceptance of ERP. This indicates that ERP may contribute immensely to agricultural growth but requires more improvement. Despite the fact that ICT improves agricultural economic growth, there are issues and challenges attributed to it. Interestingly, this paper compiled a range of recent literature with the aim of revealing the challenges and opportunities regarding application of ICT in agriculture in developing countries. The paper was reviewed according to number of subtopics that consist of background of the review, ICT devices that support agricultural development, potential benefits of ICT in agricultural development, problems associated with the application of ICT in agriculture, conclusion and the way forward.

Background of the Review

In a work published by Oyewole et al. (2013), the role and contributions of ICT in the development of agriculture around Ibadan North West area council in Nigeria have been evaluated. The survey utilized well-structured questionnaires and 50 respondents were sampled, and frequency counts, percentages and Pearson Product Moment Correlation were used for data analyses. The result shows that about 58% of the respondents have used ICT for about 1-5 years. The finding also indicated that there is significant relationship between ICT and agricultural development. This assertion was supported by Büyükbay and Gündüz, (2013) their result shows that there was a solid association between computer and internet use and social and economic characteristics of the individuals. It was

recommended that internet facilities should be made accessible to the agricultural researchers to improve usage and contributions to agricultural development (Oyewole et al. 2013). The conclusion of Oyewole et al. (2013) that ICT has impacted on agriculture has been supported by the finding of Patel and Patel (2013) in a study conducted to evaluate the application of cloud computing in agricultural development of rural India. It has been argued that the cloud computing technology impacted positively on agriculture field and related services they provide for users. This conclusion is in agreement with Büyükbay and Gündüz, (2013), the authors concluded that in order for computer and internet technologies to be applied effectively in rural areas, extensive training for farmers and establishment of ICT infrastructure are highly required. Büyükbay and Gündüz, (2013) were able to figure out the significance of ICT application in agricultural development in rural areas of Tokat Province in Turkey. However, the major limitation of the study is that out of 184 questionnaires administered; only 30% were collected for the use of internet and computer which were in inadequate.

The study by Oyewole et al. (2013) established a clear relationship between ICT and agricultural development. However, it fails to indicate whether such relationship is positive or otherwise. Furthermore, the representative sample used in the study was not adequate to reflect what is actually on ground bearing in mind that substantial number of the population in the study location are farmers. Moreover, it is not clear whether the samples are actually members of the farming community or academia in agriculture or both. Therefore, the findings are not dependable as they require clarifications.

ICT Devices that Support Agricultural Development

Singh et al (2015) reported that Agriculture Information System (AIS) is a computer based information system which contains all the interrelated information which could really help farmers in managing information and policy decision making. The ICT devices that help facilitating farming activities encompassed applications like radio, television, cellular phones, computers, tablets and networking, hardware and software, satellite systems (Munyua and Adera 2009; Pande and Deshmukh 2015). In the same way, (Yimer, 2015; Munyua and Adera 2009) reports that radio is extensively used to inform users on agricultural topics, including new and upgraded farming techniques, production management, and market information. This shows that farmers may take advantage of using radio in the absence of technology especially rural farmers. The Internet and web-based applications are extensively used in sharing and dissemination of agricultural knowledge, marketing of goods and services. The study conducted by (Ramli et al, 2015) have shown evident that ICT is an effective solution to problems that militate against the development of agricultural industry, such as weak marketing linkages, poor information management, low productivity, low income and lack of diversity. Singh et al, (2015a) noted that the importance of ICT in agriculture by sharing agricultural information system to farmers at all level. But the major drawback of this research its references did not follow the format of the international standard.

Potential Benefits of ICT in Agricultural Development

Current researches establish possible benefits of ICT in the advancement of agricultural technology have been well documented. This is likely due to the fact that farmers are increasingly accepting new technological revolutions in farming system and thus paper presents several benefits of ICT in agricultural industry:

Enhancement of Operational Work Strength

The application of ICT could harmonize data between suppliers and clients and also enhance decision making process. Moreover, it could facilitate the exchange of supply and demand information between farmers and entrepreneurs (Kale et al, 2015; Ramli et al., 2015; Singh et al, 2015). This is consistent with Pande and Deshmukh, (2015) who argued that ICT help in finalizing decision making at the right time, to discover best solutions, and efficient systems for water management and irrigation to harvest maximum yields. Equally, in Verdouw et al., (2015), ERP system provide up-to-date management information, which enables immediate corrective and preventive actions. The above results agreed with Bhalekar et al. (2015) who suggested that ICT offers a network of agricultural sector globally and bring farmers, scientist/researchers and administrators together to achieve common goal and thus strengthening the development of farming activity.

Rise of Profit

Information and Communication Technology plays important role in enhancing the impact and performance of agricultural production and by extension, directly alleviate poverty through credit and financial services (Bhalekar et. al., 2015).

Entrepreneurs can increase production and sell more products to potentials buyers and enhances effective management of sales. Additionally, it minimizes direct and indirect prices, particularly advertisement cost and at the same time improve business process. This could be achieved using websites to provide farmers with ability to exchange information with other farmers and extension officers which are cheap compared to telephone operation. More so, farmers could access relevant information through ICT at any point in time, and this enables them to create jobs with development agencies and other farmers, and ultimately yield higher agricultural productivity (Ramli et al., 2015, Abdullah and Samah, 2013). These assertions were supported by Kale et al. (2015) that ICT provides timely information on what, when, where, why and how to produce and sell agricultural products. Furthermore, ICT-based market information systems have a proven track record for improving the rural livelihoods in middle income earners of developing countries where they have been introduced (ibid). These findings are consistent with De Silva and Ratnadiwakara, (2008) who found that there is likelihood of reductions in business cost with the use of ICT. Because it minimizes cost of information search and allows more farmers to contribute in commercial agriculture and sustain farming activity through alleviating poverty among farmers in developing countries. These results have been supported by Singh et al. (2015b) in their excellent review that aims to analyze the potential benefit of Indonesia cocoa farmers in the global value chain inclusion. It has been outlined that a mixture of worldwide value chain governance with reference to internet innovation in food supply chain network provide opportunity for the farmers to reap benefit on international value chain inclusion by lowering the degree of irregularity. De Silva and Ratnadiwakara (2008), were able to fetch out the relevance of ICT in agricultural growth but the research is limited to Sri Lanka hence there is need to substantiate the outcomes by assessing what is happening in other countries for dependability.

Strategize Market Activity

The use of ICT enables entrepreneurs to access relevant and recent business information. This provides likelihoods for younger generation-agro based entrepreneurs to established their own network and websites regardless of time and place (Bhalekar et. al., 2015; Pande and Deshmukh, 2015; Ramli et al, 2015; Singh et al, 2015a; Singh et al 2015b). Consequently, they could advertise their products both in national and international markets. Likewise, ICT solves issues such as traceability, process control, transparency in market information, reduction in transaction costs, and identification as well as tracking of consumer needs (Kale et al, 2015). This result is in accordance with Bhalekar et. al., (2015) that ICT could be used to secure food traceability and reliability that has been an emerging issue concerning farm product like chicken flu and other related diseases. Besides, new agricultural and rural business such as e-commerce, real estate business for satellite offices, rural tourism, and virtual cooperation of small scale farms are initiated. Similarly, Yimer (2015) indicates that ICT furnish up-to-date knowledge and information on agricultural technologies, best practices, markets, price trends, and weather conditions. The above arguments also agreed with Munyua and Adera (2009) that ICT help in providing capacity building, accessing markets and credit, restructuring of extension and scaling up inter-linkages of development interventions. Verdouw et al. (2015) further revealed that ERP supports multiple business processes, such as order management, financial administration, warehouse management, production planning, sales, purchasing as well as distribution of services.

Opportunity for Information Exchange

Through the use of ICT, entrepreneurs can create new opportunities by penetrating international market and get contact with new partners and exchange relevant information for their business sustainability. Moreover, entrepreneurs can establish public-private partnerships globally that lead to viable self-reliance (Kale et al., 2015; Pande and Deshmukh, 2015; Ramli et al, 2015; Singh et al., 2015). Equally, Munyua and Adera (2009) discovered that modern ICTs have the potential to improve agricultural productivity by communicating knowledge and information to rural agricultural communities. These have been confirmed by Bhalekar et al. (2015), ICT provides self-reliance for farm management, farming technologist, risk management and effective information for knowledge transfer. This argument corresponds with Verdouw et al. (2015), an ERP system data are automatically shared in the complete system directly after data entry. Primary data used by Munyua (2009) through field visits to institutions in Botswana, Ghana, Kenya and Uganda. Although, this data may be adequate, but the study is insufficient to be generalized for developing countries. Therefore, more research need be conducted in other developing countries in order to substantiate the argument.

It Improves Economic Growth

Information and Communication Technology tools could be adopted in the Agricultural sector to accelerate the development and may automatically lead to growth in national economy (Pande and Deshmukh, 2015). This implies that application of ICT in agriculture may enhance national economic growth by facilitating farming activities within required period. Likewise, the findings of Behera et al. (2015), showed that E-agriculture add value to the lives of farmers and end-users in a sustainable development through e-governance, knowledge management portals, e-kiosks and common service centers at grass root level. It also provides the basis for the international community to monitor development and validation of conceptual models and methodologies, to package and disseminate them once tested. The above findings were supported by Bhalekar et al. (2015) that ICT creates awareness among farmers and artisans through Geographical Information System (GIS) for proper planning and management of natural resources. The authors concluded that the role of Information Technology (IT) to develop e-agriculture and eminence of life in the rural area is well established. An average Indian farmer could get appropriate information regarding agro-inputs, crop production technologies, agro processing, market support, agrofinance and management of farm business through IT (ibid). The research of Pande and Deshmukh (2015) portrayed the relevance of ICT in agriculture but fail to address adequate research methodology.

Research in Agriculture

The significant of ICT in agricultural research is quite enormous. It supports policy and decision making with the use of GIS such as disaster management and agro environmental resource management. Furthermore, it could ease rural activities and provide effective and safe rural life such as provision of distance learning, telemedicine and remote public service (Bhalekar et al., 2015). Equally, Patel and Patel (2013) developed a model consisted of Cloud Agro System and e-Data Bank. It updates information on demand-supply, communication and communication devices, e-knowledge sharing and research. The e-Data Bank is primarily to disseminate information to farmers and comprised the crop related information, weather and soil information, growth progress monitoring, farmer's data and experts' consultation. The benefits of the developed model include data management and readiness, reduced rural-urban drift, motivation of both farmers and researchers to get involved in agriculture, improved security, reduced technical issues and improvement of the overall economy. These assertions conform with Behera et al. (2015), that E-agriculture provides an international framework to facilitate the processes of capturing, managing, and disseminating the lessons learned through national and regional activities, as well as the results and implications of multilateral processes related to the use of ICT in agriculture and rural development. Similarly, the application of web based system provides possibility of accessing relevant information online and has increased intensively leading to the development of meta-database (Kale et al., 2015; Munyua and Adera, 2009; Singh et al, 2015). Correspondingly, Kale et al. (2015) argue that ICTs provide learning material and curriculum support in agriculture. They further provide improvement for existing courses, offering new pedagogical methods and serve as a platform for rural distance education (ibid). Bhalekar et al., (2015) concluded that the Indian government should re-orient agricultural policies so that a complete strategy is formed to harness ICT's capacities for supporting overall agricultural growth. It further recommends that before ICT facilities are setup in an area, effort should be made to develop awareness among farmers at all levels with the intension to attain the goal of agricultural development.

Infrastructure

Inadequate, and unstable power supply, cost of hardware and software are high with respect of average rural dwellers (Kale et al., 2015). Similarly, Taragona and Gelb (2005) maintains that awareness, time, cost of technology, system integration, and software availability are the main constraints of ICT adoption in horticulture. This argument corresponds with Wyche and Steinfield (2015) who put forward that there is a mismatch between the design of MIS and smallholder farmers' perceptions of their mobile phones' communication capabilities. Nevertheless, the major drawback of these findings is the use short-term fieldwork and it is understood that longer-term ethnographic or case study research could yield more interesting findings that may probably deepen the understanding of the rural farmers' perceptions of their mobile phones. This weakness was acknowledged by at least one of the authors (Wyche and Steinfield, 2015). Bad mechanisms and infrastructure for sharing and exchanging agricultural knowledge generated from research nationwide and provincially led to data redundancy and duplication of work (Kale et al, 2015). This has been supported by Yimer (2015) in a research to determine the critical role of ICT for promoting

virtuous governance and agricultural growth in southern Ethiopia. The authors conclude that the major challenges impeding the use of ICT in broadcasting agricultural knowledge and information include insufficient of access to ICT infrastructures and services which need to be addressed. These conclusions further substantiate the existence of these challenges that hinder the application ICT in agriculture hence more research is required to mitigate these challenges.

Power Supply and Farmers Perception of ICT

Skills In 2015, Barakabitze et al. investigated the implementation of ICTs in Agricultural Research Institutes (ARIs) for the improvement of agricultural productivity in Tanzania. Results revealed that the use of agricultural journals is limited due to unreliability and poor connectivity of the internet, and regular power cuts. Findings also showed that the use of specialized ICT devices have not been adequately recognized in agricultural activities due to low investment of ICTs that can be used for teaching and learning modern production techniques in research institutes. Moreover, challenges hampering the use of ICTs in ARIs have been listed to include inadequate computers and the supporting technological infrastructure, and low coordination of agricultural stakeholders due to institutional diversity and department disintegration. These findings were supported by Singh et al. (2014). The research conducted by Barakabitze et al (2015) has been able to list a number of challenges of ICTs utilization in Agricultural Research Institutes (ARIs) in Tanzania. Although the findings of a case study research used in the study cannot be generalized, it has addressed a generally held view that in most developing countries, power and internet are epileptic and are parts of the major problem in using ICT. Taragola and Gelb (2005) reports that lack of ICT proficiency by end user is one of the factors militating against adopting ICT in horticulture. This is in line with Anoop and Ashok (2015) that irrelevancy of contents, lack of reliability and awareness in ICT, which lead to unwillingness of farmers to adopt ICT as an avenue to acquire information on improved farming techniques as well as data on soil, weather and other elements of climate. In view of the foregoing, it is clearly understood that inadequate basic ICT skills posed a serious challenge towards reaping the impact of ICT for agricultural growth.

Conclusion

Collectively, these studies outlined the critical roles of ICT in agricultural technology development in developing countries centering on opportunities and challenges. The review mainly focuses on potential benefits and problems associated with the application of ICT in agriculture. This review has identified that agricultural research, improvement of market activity, exchange of relevant information, profit gain; networking agricultural activities globally, conducting research and strategizing economic growth for self-reliance are among the possible benefits of ICT. However, lack of basic ICT skills, absence of political will, in adequate and fluctuation of power supply, poor internet infrastructure, insufficient personnel to handle ICT infrastructure, language and harmonization of knowledge continued to impede ICT implementation in agricultural growth. Relevant suggestions were given by various researchers to overcome challenges militating against successful implementation of ICT in agricultural technology advancement but were found to be insufficient. Therefore, further research should focus on these challenges to bring out more suitable solutions.

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