Does Innovation Enhance Youth Participation in Agriculture: A Review of Digitalization in Developing Country?

C.O. Farayola[1*], L.O. Adebisi[1], O. Akilapa[1] and F. Y. Gbadamosi[2]

[1]*General Management Division, Agricultural Development Management Department, Agricultural and Rural Management Training Institute (ARMTI) Ilorin, Nigeria*

[2]*Computer Training and Information Management Division, Agricultural Development Management Department, Agricultural and Rural Management Training Institute (ARMTI) Ilorin, Nigeria*

Corresponding Author: *C.O. Farayola, General Management Division, Agricultural Development Management Department, Agricultural and Rural Management Training Institute (ARMTI) Ilorin, Nigeria, Email: walecharless@gmail.com*

ABSTRACT

Given the high demand for food caused by the ever increasing world population, which has put pressure on agricultural production. At the same time, the inefficiency of tradition practice prevents farmers from having maximum returns from their farming enterprise. The concept of digitalization of agricultural sector has therefore become vital in achieving the goal of food security. The study provides a review of literature on the process of digitalization and agriculture in developed and developing countries. It further analyzes the usage of digitalization and youth's participation in Nigerian agricultural system. The study uses secondary literature. The results reveal that the application of digital agriculture is in the early developmental stage in Nigeria. The study therefore concludes that digital agriculture in Nigeria is yet to be fully utilized, as the practice is faced with many challenges. The study, recommends that government should provide support and adequate frame through policy to enhance full utilization of this innovation especially among the youths.

Keywords: *Agriculture, Digitalization, Innovation and Youth*

INTRODUCTION

Agriculture is considered as an ultimate option and fundamental instrument for spurring growth and sustainable development, poverty reduction, and enhancing food security in developing countries like Nigeria (Food and Agriculture Organization, 2011). With about 36.55% of Nigerian population engaging in agriculture for their livelihood (Trading Economics, 2018). Despite the huge reliance on earnings from oil export, it still accounted for over 40% of the GDP and 90% of non-oil exports. Agriculture is one of the most viable sectors particularly in terms of its employment potentials as more than 70% of the 182 million populations are employed directly or indirectly in agriculture (FMARD 2016; FAOSTAT 2015; Fuentes et al., 2012).

It is the foundation for the development of stable human communities, both in rural and urban communities. It provides environmental benefits such as, conservation, guaranteed sustainable management of renewable natural resources and preserved biodiversity (Preshstore, 2013).

A majority of the population in most nations are the youths, with Africa recording about 70 percent of its population as youths under the age of 30 years and Kenya recording a youth population of about 78.31 percent who are below the age of 34 years (Sitawa M. et al., 2016). An average age of agricultural practitioners ranges around the age of 57 years as at 2010 in china(paisley, 2014) to about 60 years in the United States of America and other developed nations(FAO, 2014).

Despite efforts by the governments and other organizations to make agriculture attractive to the youth and improving their participation, there is still a trend of many youths making decisions not to go into the agricultural sector and farming in particular (Leavy and Smith, 2010). The participation of youth in agriculture is still on the decline and most of the youths are still migrating to urban areas seeking a decent and well remunerating job (Njeru, 2017).

Agriculture in most parts of the world is viewed as an uninteresting subject, a last resort for under-achievers and a dirty job for urban students. This has inevitably affected the agricultural

aspirations of youths in a negative way (Brooks et al, 2012). Agriculture is not seen as a viable source of employment around the world. In some areas, ladies are not interested in getting married to farmers which has aided in driving the young men away from farming (World Bank, 2011),and in Asia the media promotes western and urban lifestyles and demonizes agriculture and rural areas. This also influences the youth's agricultural aspirations negatively (Noorami, 2015).

Njeru L.K., 2017 concluded that the perception of the youth towards agriculture directly affects their participation; hence the decline in participation is largely due to negative perceptions of Agriculture. As a result of all these, the potentials and prospects of Agricultural growth are being left as the responsibilities of the ageing rural population (Proctor and Lucchesi, 2012).

Unfortunately, Nigerian agricultural sector is bedeviled with several challenges such as lack of access to markets and credits, low level of technology, inadequate post-harvest infrastructure (storage, processing, transport), low uptake of research findings by stakeholders and inadequate availability of improved technological packages especially planting materials and certified seeds (Ministry of Agriculture, 2007). This has made agriculture unattractive and non-lucrative resulting in decline in the number of youth participation in agriculture, making farming population to be aging. It is practically impossible for this aged generation dominating agricultural sector to deliver the expected productivity to meet food needs of the ever growing population (Muhammad-lawal, Omotoesho and Falola, 2009).

Given the current and projected population of the world which is expected to reach 9.2 billion by the year 2050. The United Nations on Food and Agriculture Organization (FAO) foresees that farmers should produce 70% more to satisfy this demand. In order to achieve this, producers need to use new generation farming models instead of the traditional farming methods so as to sustain agricultural production. (Pihl, 2001)

Innovation is considered as an important way of achieving much more with fewer resources and effort (Avsar and Avsar, 2014). Juma (2015) states that enriching raw material by innovation in accordance with world's changing economic, political and ecological conditions, contributes to the processing, packaging, storage, distribution, and safety of food after the production.

Innovation is generally acknowledged to be principal means by which regions increase economic growth and development (Pihl, 2001). In recent years there has been tremendous economic growth owing to technological innovations especially in digitalization. Digital Revolution has gained much attraction, both in the academic sphere and among policy makers. This interest has been sparked by the emergence of new technologies, such as different types of automation, robotization, Artificial Intelligence and Big Data Analysis.(Lutkenhorst, 2018)

However, there are different schools of thought on this concept. First, is the claim that digital technologies will provide the solution to most contemporary economic and social problem. On the other hand, the fear that digital technology will replace human labour, resulting in high level of unemployment with negative economic and social consequences. Up until today, most of the new literature on the impact of digitalization has focused largely on the developed countries, while the impacts on developing countries are under-researched and the few ones available are not empirically proven. However, a study on the impact of digitalization in developing countries is necessary especially as it affects the agricultural sector of the economy.

Although many literatures have dealt with the effects of ICTs (Information and Communication Technologies) but studies on the impacts of digitalization on development and its implications on youths involvement in agriculture is scanty and research in this direction is still at early stage.

Therefore, this paper reviews and explores the process of digitalization and its implication on youth's participation and agriculture in developing country.

MATERIAL AND METHODS

The analysis presented in this paper is based on secondary literatures. Secondary data used in this study come from published documentation obtained from journals, conference proceedings, annual reports of international organizations, the figures and drafts retrieved from archive of Communications and Information Technology Commission (CITC) and Organization for Economic Co-operation and Development (OECD).Background documentation includes a wide range of grey literature, policy documents and a smaller set of published research.

DISCUSSION

This section presents the findings based on the scientific papers and agricultural digitalization draft that were reviewed.

Evolution of Digitization in Developed and Developing Countries

The proliferation of digital technologies over the past two decades has been substantial, marking one of history's most rapid rates of adoption of new technologies. First, is the number of personal computers (PCs) in use worldwide which increased from 100 million in 1990 to 1.4 billion by 2010. Also, there were 10 million mobile phone users in the world in 1990; today there are more than 5 billion. Moreover, the number of Internet users has also grown at an even more rapid rate over the same decades, from 3 million to 2 billion. (Kamel, 2009)

To put that into context, only two decades ago, there were as many Internet users in the world as people in the city of Madrid; today, there are as many people online as are living in all of Asia. This surge in ICT use has not been restricted to the developed world alone. (Kamel, 2009)

In Africa, more than half a billion people today connect to mobile networks. The explosive growth of ICT services which has given rise to an advanced stage of digitalization in many developed and developing countries is often determined by some factors. (Kamel, 2009).These factors are responsible for the varied level of digitalization across various countries. They include;

- Ubiquity: the extent to which consumers and enterprises have universal access to digital services and applications.

- Affordability: the extent to which digital services are priced in a range that makes them available to as many people as possible.

- Reliability: the quality of available digital services.

- Speed: the extent to which digital services can be accessed in real time.

- Usability: the ease of use of digital services and the ability of local ecosystems to boost adoption of these services.

- Skill: the ability of users to incorporate digital services into their lives and businesses.

However, the resultant effect of these factors when computed together has been used to classify various countries into stages and levels of digitalization. An analyses of countries based on their stages of digitalization provide measures of digitalization for a sample of 150 countries on a scale of 0 to 100, with 100 being the most advanced and vice visa. Four distinct stages of digital development were isolated, namely: constrained, emerging, transitional, and advanced stage of digitalization. These groupings will allow policymakers of each country to recognize their nation's current level of digitalization and provide proper perspective on how progress could be made.
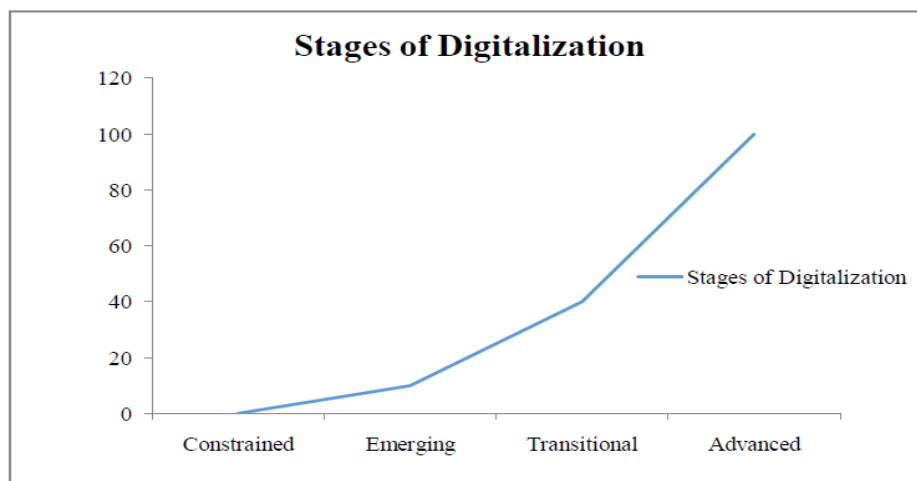

Figure1. *Stages of Digitalization*

Source: *International Telecommunication Union, 2012*

From figure 1 and table 1, it can be seen that most of the developing countries, of which Nigeria is one, are at the constrained stage of digitalization. Constrained economies are those

with a digitalization score of below 25 and they face challenges in realizing basic digitalization building blocks such as wide spread access and affordability.

In these nations, services remain expensive and limited in reach. The result in this figure gives a major concern and need for development and policy.

Table1. *Stages of Digitalization among Sampled 150 Countries*

CONSTRAINED	EMERGING	TRANSITIONAL	ADVANCED
Egypt	Albania	Argentina	Australia
Ethiopia	Armenia	Bahrain	Austria
Cuba	Azerbaijan	Barbados	Belarus
Benin	Georgia	Bulgaria	Belgium
Aruba	Venezuela	Uruguay	Canada
Benin	Trinidad	Ukraine	Czech Republic
Bhutan	Macedonia	Turkey	Denmark
Belize	Saint Lucia	Seychelles	Finland
Lesotho	Peru	Serbia	France
Krgstan	Panama	Saudi Arabia	Germany
Kenya	Mongolia	Qatar	Greece
Angola	Lebanon	Philippine	Hong Kong
Algeria	Ecuador	Oman	Hungary
Afghanistan	Costa Rica	Montenegro	Iceland
Kazakhstan	Brazil	Mexico	Ireland
Iraq	China	Mauritius	Israel
Indonesia		Malta	Italy
India		Malaysia	Japan
Honduras		Macao	South Korea
Guyana		Latvia	Lithuania
Guatemala		Kuwait	Luxembourg
Ghana		Jordan	Netherlands
Gabon		Iran	New Zealand
Fiji		Estonia	Norway
El Salvador		Cyprus	Poland
Cote d'Ivoire		Croatia	Portugal
Cameroon		Colombia	Romania
Honduras		Chile	Russia
Kenya			Singapore
Lesotho			Slovak Republic
Mali			Slovenia
Morocco			Spain
Namibia			Sweden
Pakistan			Spain
Rwanda			Switzerland
South Africa			Taiwan
Swaziland			United Arab Emirates
Thailand			United Kingdom
Togo			United State
Vanuatu			
Uganda			
Tunisia			

Source: *International Telecommunication Union, 2012*

Digitalization in Agriculture

Agricultural sector like every other sector has been changing and progressing towards becoming a knowledge-intensive enterprise, this is as a result of new innovation and technology incorporated in the economy. With this change, traditional production systems have been

transforming into modern, productive and innovative systems (Andrade 2010).

Recently, farmers have embarked on a lot of managerial activities as well as turning new paradigms besides production and this situation require more interaction with environmental factors (Sørensenet al., 2010). The concept of

agriculture in recent times and in the future entails good irrigation practice, precision, high-quality, high-efficiency and non-polluting agricultural practice. Digital agriculture is the most effective approach to realizing all these transformations (Yane 2010).

Digital agriculture means the using of computer and communication technologies to increase profitability and sustainability in agriculture. Digital agriculture brings together new opportunities, along with the widespread use of advanced, related, and data-intensive computer technologies, popularly called 4.0 revolution technology, to the agriculture sector. The digital agricultural tools, which are used in cropping and livestock systems makes optimization, high precision, real-time and customized information usage, for management of resources become possible. This creates leverage effect in agricultural planning and implementations (Van et al. 2016; Deichman et al. 2016).

However, the report given by GIFS (2015) states that less than 20% of agricultural lands of the whole world are managed using digital agricultural technologies. Therefore, computerized systems and communication technologies need to be fully utilized to realize digital agriculture which will consequently transform the economy.

In the recent years, there have been huge benefits obtained from the use of various forms of digitalization in Agriculture in many developing economies. The opportunities were as a result of the utilization of some forms of digitalization which includes; cloud computing, robotic technologies, drones and big data analysis (van et al., 2016).

Big Data

Big data technologies play a vital role in the digital agriculture revolution. Hashem et.al (2015) defines big data as complements of techniques that require integration forms to distinguish unrecognized values from large scale, various and complex data sets. Big data enables farmers to view all production parameters of real-time operations and improve decision-making processes (IDEAGRO 2015). Data from internal sources have a leverage effect when integrated with data from external big data sources such as market data or competitors (Sun et al., 2013; Wolfert et al., 2017). Data used in agriculture includes activities of an enterprise, its customers, and of its operations, data derived from the internet of

machines or objects, obtained from many sensors and intelligent machines used to record and measure agricultural activities which may range from simple sensor records to complex computer logs (Hashem 2015).

More accessible agricultural information makes it compulsory to collect more data and allows deeper insight. This cycle has come through the accumulation of more data and the development of more intensive agricultural knowledge. In recent years, analytic possibilities of agricultural data and sensor data have expanded with the use of multivariate statistical methods and "machine learning" artificial intelligence (Weltzien 2016).

Cloud Computing

Cloud computing is the basic infrastructure that enables intelligent farming implementations such as scalable calculations, software, data access and storage services. Through cloud computing, large-scale data can be stored with low investment cost and instant access to this data becomes possible (Chavali 2014). Cloud monitoring provides the following opportunities

- **Real-time monitoring and guidance in agricultural production:** Through cloud computing, agricultural production processes can be instantaneously viewed, controlled, and intervened immediately in the production process if required.

- **Farm management system:** Cloud-based farm management systems enable farmers to enter data into the system time and space independently which enables managerial decisions to be up to date all time.

- **Data flow from external sources:** Cloud computing enables instantaneous acquisition of information for weather and other climatic conditions that may be needed during the agricultural activities and can be used directly in decision-making through interrelated devices (Goraya & Kaur 2015).

Internet and Drones in Agriculture

The advent of smart and connected devices will enable companies to face the new competitive opportunities and threats by changing nature of the industry and the nature of competition. According to Halloran and Kvochko (2015), internet and drones has dramatically change sectors such as production, energy, agriculture, transportation and other industrial sectors that generate two-thirds of global GDP, when considered together.

Use of Internet and Drones in agriculture will in the nearest future improve the functionality of existing tools by making the physical world a part of the information system through advanced networked innovative systems. Bringing together information from different sensors and RFID tags, drones has unlimited potential application areas from monitoring of greenhouses to animals and agricultural machinery (Kaloxylos et al. 2012).

Through sensor networks, agriculture can be established regardless of geographical differences between scientists, farmers, and crops by linking to the Internet. The technology enables efficient use of resources by allowing producers to make timely and appropriate decisions with real-time and accurate data (Savale et al., 2015; Balamurugan et al., 2016).

It supports agricultural enterprises with enough data to calculate how much output can be produced in a specific area given the amount of seed, fertilizer, water, soil chemistry and weather. Agricultural enterprises can prepare sensitive production mixes to increase harvest yields

through interconnected intelligent machines and cloud computing-based on big data analysis software (Halloran and Kvochko 2015).

Within the framework of sensitive agricultural implementations, satellites and air vehicles are used to provide information about agricultural areas for a long time. As a result of developments in drone technology, the use of these tools for agricultural purposes has become widespread and it has become possible for farmers to access the images they need instantly or by remote control of activities such as pesticide applications at low cost. Drones that are specially developed for agricultural applications, has sensitive sensors and imaging systems to detect pests and plant diseases (Doyle et al.2015).

Prospects of Youth Participation in Digitalize Agriculture

Digital agriculture has presented the youth with the opportunity to engage efficiently in the agricultural sector. The youth can now fit into all ICT driven aspect of agriculture in various capacities as explained in the figure below;
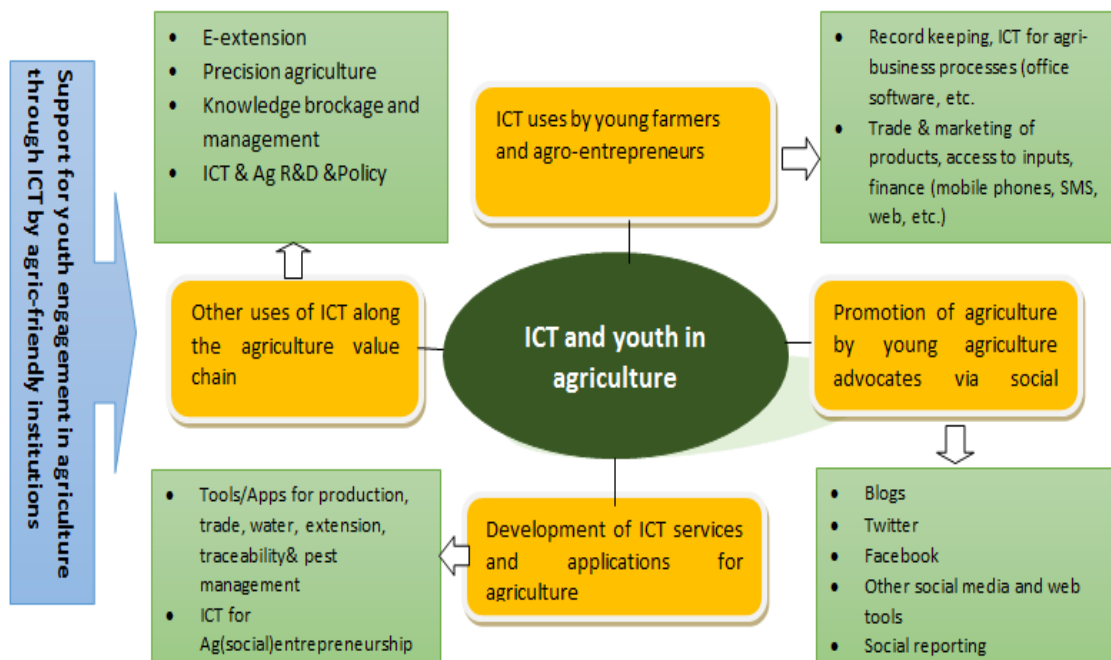
Source: *Lohento and Ajilore 2015*

Youths can now launch various digital based agricultural investments (ITU, 2004). ICTs have also enabled key connections to markets, training opportunities, and capital and provide an effective gateway to entrepreneurship and improved livelihoods (UNDESA, 2013).

Several case studies have shown different and wide application and prospects of digitalization

in Agriculture by youths, such as; use of ICT by IITA youth Agripreneurs (IYA), use of ICT by Savanna Young Farmers Network, Ghana, Mkulima Young: Face book farmer with 52,000 likes.(Lohento K. and Ajilore , 2015).

Other prospects includes but not limited to the following; extension and ICT-enabled agricultural research, agricultural knowledge management,

precision agriculture, increased awareness of ICT opportunities among agricultural organizations, increased ICT penetration and affordability, increased support for youth engaged in ICT for agricultural related activities, stronger interests in ICT application development in the agriculture sector, emergence and growing role of ICT innovation centers ICT hubs (Lohento and Ajilore, 2015)

Problems of Digitalized Agriculture in Encouraging Youth Participation

There several problems affecting youth participation in digitalized agriculture in developing economies like Nigeria. These challenges include the following; high cost of digital devices and internet access, poor connectivity, low digital literacy level, weak awareness of digital potential and applications in agriculture, social factors (gender, marital status, land ownership culture and traditions), absence of effective public ICT access spaces in rural areas, lack of ICT adoption and connectivity in agricultural institutes, lack of ICT training in agricultural education, poor power supply, unfavorable government policies and regulations that limit investment in digitalization, tax imposed by government and high cost of mobile services(Lohento and Ajilore , 2015)

CONCLUSION AND RECOMMENDATIONS

The study concludes that digitalization has beneficiary effects on agriculture in Nigeria especially among young people. However, the digital agriculture is faced by several constraints that hamper full utilization of the innovation.

The study therefore recommends that government should provide a platform through policy to enhance awareness and full utilization of digital agriculture.

REFERENCES

[1] Andrade-Sanchez, P., &Heun, J. T. (2010), Understanding Technical Terms and Acronyms Used in Precision Agriculture, the University of Arizona, Arizona Cooperative Extension Bulletin AZ1534.

[2] Avsar, D. & Avsar, G. (2014), YeniTarımDüzenininTarımsalÜretimÜzerindekiEtkileriveTürkiye'dekiUygulamalar, Akademik Platform, 379-385.

[3] Chavali, L. N. (2014), Cloud Computing in Agriculture. In Agricultural Bioinformatics, 189-213, Springer India.

[4] Dong, X., Vuran, M. C., & Irmak, S. (2013), Autonomous Precision Agriculture Through İntegration of Wireless Underground Sensor Networks with Center Pivot Irrigation Systems, Ad Hoc Networks, 11(7), 1975-1987.

[5] FAOSTAT (Food and Agricultural Organization) 2015. Data Extract from World Development Indicator

[6] FMARD (Federal Ministry of Agriculture and Rural Development) 2016.*The Agriculture Promotion Policy (2016 – 2020)*. Abuja, Nigeria: FMARD.

[7] Food and Agriculture Organization-FAO, (2011). The State of Food and Agriculture 2010-11**.** Women in agriculture: Closing the gender gap for development.FAO, Rome, Italy.

[8] Fuentes P.A., B. Bumb and M. Johnson 2012. Fertilizer Markets in West Africa: The Fertilizer Supply Chain in Nigeria. International Fertilizer Development Center (IFDC) and International Food Policy Research Institute (IFPRI) Paper Series IFDC – P-42

[9] GIFS, Global Institute for Food Security (2015), Digital and Computational Agriculture, 2014-2015 Annual Report, http://gifs.ca/wp-content/uploads/2015/08/GIFS-2014-15-Annual-Report-final.pdf, Accessed: 11.02.2017.

[10] Hashem, I. A. T., Yaqoob, I., Anuar, N. B., Mokhtar, S., Gani, A., & Khan, S. U. (2015), TheRise of "Big Data" on Cloud Computing: Review and Open Research Issues, Information Systems, 47, 98-115

[11] Hashem, I. A. T., Yaqoob, I., Anuar, N. B., Mokhtar, S., Gani, A., & Khan, S. U. (2015), the of "Big Data" on Cloud Computing: Review and Open Research Issues, Information Systems, 47, 98-115.

[12] IDEAGRO (2015), The Era of Digital Agriculture, http://www.ideagro.es/index.php /noticias/89-the-era-of-digital-agriculture, Accessed: 11.02.2017.

[13] ITU (International Telecommunication Union). 2012. *Broadband Korea: Internet Case Study*, March. Geneva: International Telecommunication Union. Available at http://www.itu.int/ITU-D/ict/ cs/korea/material/CS_KOR.pdf.

[14] Juma, C. (2015), the New Harvest: Agricultural Innovation in Africa. Oxford University Press.

[15] Kaloxylos, A., Eigenmann, R., Teye, F., Politopoulou, Z., Wolfert, S., Shrank, C., Dilinger, M., Lampropoulou, I., Antoniou E., Pesonen, L. & Nicole, H. (2012), Farm Management Systems and The Future Internet Era, Computers and Electronics in Agriculture, 89, 130-144.

[16] Kamel, S. 2009. "The Evolution of the ICT Sector in Egypt: Partnership4Development."

Communications of the IBIMA 10 (2009): 39–49. Available at http://www.ibima publishing .com/ journals/CIBIMA/ volume10/v10n7.pdf

[17] Lutkenhorst, Wilfried (2018): Creating wealth without labour? Emerging contours of a new Ministry of Agriculture (2007).National Agricultural Extension Policy Implementation Framework. Nairobi, FAO.

[18] Muhammad–Lawal, A., Omotosho, O. A. and Falola, A. (2009). Technical efficiency of youth participation in agriculture: A case study of youth – in – Agriculture Programme in Ondo State, south western Nigeria. *Nigeria Journal of Agriculture, food and Environment,* 5(1): Pp. 20- 26

[19] Pihl, T. 2001. "Analysis of Estonian IT Sector Innovation System," October.Archimedes Foundation. Available at http://ev2.ioc.ee/ useful/evikings-analysis-cluster-state.pdf

[20] Preshstore (2013). Improving Agricultural Production through Agricultural Cooperatives. Retrieved from https://preshstore/status/.com on 27th July 2015

[21] Sørensen, C. G., Fountas, S., Nash, E., Pesonen, L., Bochtis, D., Pedersen, S. M., Basso, B. & Blackmore, S. B. (2010), Conceptual Model of a Future Farm Management Information System, Computers and Electronics in Agriculture, 72(1), 37-47.

[22] Sun, Z. F., Du, K. M., & Zhang, F. X. (2013), Perspectives of Research and Application of Big Data on Smart Agriculture. J. Agric. Sci. Technol, 15(6), 63-71.\techno-economic landscape. German Development Institute Discussion Paper 11/2018

[23] Trading Economics (2018). www.tradingeconomics.com/Nigeria

[24] Van es, H.M., J.D. Woodard, M. Glos, L.V. Chiu, T. Dutta, and A. Ristow. 2016. Digital Agriculture in New York State: Report and Recommendations. Cornell University, Ithaca, NY.

[25] Weltzien C., (2016), Digital Agriculture or Why Agriculture 4.0 Still Offers Only Modest Returns, Landtechnik, 71(2), 66–68.

[26] Wolfert, S., Ge, L., Verdouw, C., &Bogaardt, M. J. (2017), Big Data in Smart Farming–A Review, Agricultural Systems, 153, 69-80.

[27] Yane, D. (2010, October), Research and Analysis about System of Digital Agriculture Based on a Network Platform, In International Conference on Computer and Computing Technologies in Agriculture (pp. 274-282). Springer Berlin Heidelberg.