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## ICT INTEGRATION IN HORTICULTURAL AGRICULTURAL SECTOR FOR SUSTAINABLE TECHNOLOGY TRANSFER IN NIGERIA: THE CHALLENGES

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### Abstract

*The strategic application of Information and communication technologies (ICT) to the agricultural sector, offers a greater opportunity for economic growth and poverty alleviation. This paper reviewed ICT devices applications and barriers to the horticultural sector of Nigeria. The review showed that Phyto-monitoring technique, e-Data Bank, Plant-Plus DSS, Computer-Aided Design (CAD) software, List Servers, Geographic Information System (GIS) were ICT devices that supported horticultural development for economic sustainability. Likewise, the review identified inadequate and unstable power supply, high cost of hardware and software, lack of financial assistance, inadequate databases, poor infrastructure and inadequate training on ICT devices impeded ICT integration in the horticultural sector of the country. It was concluded that the government should improve the horticultural sector through consistent policies and implementation, holistic adaptation strategy and proper funding.*

**Keywords:** Agriculture, Horticulture, ICT Integration, Sustainable Technology

### INTRODUCTION

The application of information and communication technologies (ICT) are increasing day by day among different communities for obtaining the information about related issues, problems and their solutions (Chhachhar *et al.*, 2014). ICT, as described by Food and Agricultural Organization cited in Lawal-Adebowale, (2017) refers to the technologies that facilitate collection, gathering, processing, storage, retrieval, dissemination, and implementation of data and information using microelectronics, optics, and telecommunication computers. Other devices include radios, telephone (mobile or fixed), video, television, DVD, audio players etc. (Maigoro, 2013; Lawal-Adebowale, 2017). As averred by Singh, (2002) horticulture is the branch of agriculture concerned with intensely cultured plants directly used by people for food, medicinal purposes or for aesthetic gratification. A more precise definition can be given as "the cultivation, processing and sale of fruits, nuts, vegetables, ornamental plants, and flowers as well as many additional

services" (Acquaah, 2009; Rahman, 2018). It also includes plant conservation, landscape restoration, soil management, landscape and garden design, construction and maintenance.

According to Chhachhar *et al* (2014) and Sheyin *et al* (2017) effective distribution of ICT can increase agricultural attractiveness by production, transaction costs, raising production, efficiencies and farmers' incomes, by providing more information and value to stakeholders. ICT can be used for distance learning programs and help the farmer for learning new approaches and technologies for the use of agriculture development in developing countries. Such kind of technologies can provide information on weather, prices, and profitable income. The application of ICT in agriculture development had been widely studied by individual researchers and corporate bodies (Sideridis, Koukouli, & Antonopoulou, 2010; Fawole & Olajide, 2012; Okasha & Okasha, 2013; Chhachhar *et al.*, 2014; Saidu *et al.*, 2017; Rahman, 2018; Taragola, Van Lierde & Gelb, 2009). For instance, Chhachhar *et al.* (2014) research in remote areas of developing countries yielded positive results when they discovered that mobile phones, radio and television used by farmers reduced communication gap with buyers of market goods. While Saidu *et al.* (2017) observed that despite the potential benefits of ICT in agricultural technology development in developing countries there are challenges that hinder the successful implementation. Recommendations such as good and affordable internet connectivity, good ICT infrastructure, and adequate ICT skills, were made.

Communication devices enable people around the world to contact one another to use information instantly, and to communicate from remote areas. There are lots of difficulties facing horticulturist which can be solved by providing them with adequate access to quality information which many researchers have generated (Taiwo & Amoo, 2021). ICT play important roles in addressing these challenges and enhancing the standard of living of the rural farmers. Improved agricultural production is the major weapon in the fight against world hunger, improving rural livelihood and increasing economic growth. The world development report of the World Bank (2008) argued that the growth in the agricultural sector contributes proportionally more to poverty reduction than growth in any other economic sector.

However, there are little or no known studies to assess ICT application and barriers in the horticultural sector of Nigeria. This review therefore intends to identify the gap that exists in the usage of ICT devices and the barriers in the horticultural sector. The objective of this review is to examine various linkages of Information technologies to the horticultural sector in order to achieve maximum productivity by the horticulturist.

## **METHODOLOGY**

The methodology used in this review involves collection of data from secondary sources. It is a literature review study with the main sources of data and information from documented sources such as books, journals, bulletins, official documents, reports, conference proceedings/workshop

papers etc. The data from these sources are discussed to bring out a clear picture of the issue in focus. The opinions and conclusions formed from this systematic process can be accepted as reliable and valid.

## **RESULTS AND DISCUSSIONS**

### **ICT Devices that support Horticultural Development**

ICT devices that support horticultural development as enumerated by many researchers such as Nokoe (2001), Van der Waals *et al.*, (2003), Gurovich, Ton and Vergara, (2006), Taragola, Van Lierde and Gelb (2009), Okasha and Okasha (2013), Musale and Swami (2013), and GIS geography (2019), can be categorized under the following headings.

- i. **Computer-Aided Design (CAD) software:** These programs aid designers in developing the urban design of sites particularly without affecting the other aspects of the design. Clients can choose or describe their requirements while the computer based model may be used to fine tune such requirements. The programs are Land CAD, Real time Landscaping Pro, Landscape deck patio designer 12, 3D Home Architect & Landscape Design Deluxe, 3D Landscape Design for Everyone, Earth capes, and 3D garden composer etc. The benefits of (CAD) are: saves time, increases productivity, improves accuracy, better quality and ease of understanding
- ii. **The Phyto-monitoring Technique:** was developed for early and objective detection of crop stress such as water stress. Phyto-monitoring was originally developed by Russian and Israeli scientists and combine modern microelectronics, computer and data transmission technologies. This technology enables real-time plant water status assessment in a nondestructive way. It is a combination of hardware (plant growth-related and environmental sensors, data loggers and data transmission units), software and application techniques (measurement protocols and data interpretation).The system is capable of warning the farmer of upcoming problems and can be used effectively to reduce crop damage in severe climatic conditions. The benefits of Phyto-monitoring system are introduced as follows: Reduced inspection outage frequency, reduced forced outage frequency, reduced spillage of water, reduced maintenance hours and reduced man power and High yield.
- iii. **The PLANT-Plus system:** was developed in the Netherlands as a DSS for the control of late blight on potatoes in Europe. The framework has since been expanded and modified to include DSS for various diseases on potatoes, carrots and other crops. The system requires information input on the spread and size of the fungus and environmental data. The system assists growers in deciding the most appropriate time to apply fungicides in a cost effective and environmentally acceptable manner. An

alternative model that has also been used is the *ADVANTAGE DSV* for the control of the same fungus in carrots.

- iv. **Geographic Information System (GIS):** is a computer system/tool for mapping and analyzing things that exist and evens happening on earth. The components of a GIS are the hardware (computers, digitizers, plotters etc.).Software (data input tools, database management system, query tools, graphical user interface), and possibly the Data. Data include maps (base maps, environmental maps, reference maps). An example of GIS for decision making may be given for tomato production, and indicating suitable areas (based on soil, rainfall etc.) for evaluation in Nigeria. The benefits include: Cost savings resulting from greater efficiency, better decision making, improved communication, better geographic information record keeping and managing geographically.
- v. **Internet, List Servers:** The exchange of information is much easier due to internet accessibility. Once an individual subscribes to a 'listserv', he/she is immediately accessible in some way to a wide array of professionals and experts who are in the group. The Internet has several listservs covering a variety of topics and disciplines. Example HORTI-NET caters for those interested in horticulture research related issues, development and issues specific to India. The Horticultural Research Institute of Nigeria and the Horticultural Society can take lead role in this aspect. The benefits of List Servers include: Relationship building & authentic, remote community, expertise on-demand, knowledge archiving and building a shared history / consciousness.
- vi. **Databases:** a database is an organized collection of data stored and accessed electronically from a computer system i.e. a place where the data is stored. The major components of the Database are: **Hardware** (I/O devices, storage devices), **Software** (DBMS software, application programs), **Data, Procedure, and Database Access Language** (It is used to access the data to and from the database).
- vii. **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.

According to Singh, Sankhwar, and Pandey (2015) Agriculture Information System (AIS) is a computer based information system which contains all the interrelated information which could

really help Horticulturists (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 & Adera 2009; Pande & Deshmukh, 2015). In the same way, Yimer (2015), as well as Munyua and Adera (2009) reported that radio is extensively used to inform users on agricultural topics, including new and upgraded farming techniques, production management, market information and many more. 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 mobile phone has reduced the gap among traders and farmers and same time farmers directly communicate with buyers and customers to find the good price of their product. Farmers before going to market simply contact one of the best buyers who purchase production in good price. According to Grameen Bank (2007), the uses of mobile phones among farmers have played positive impact in their income and productivity because before travel communicate with buyers and sell their product in good price. The development about agriculture in developing countries mostly depends on the use of information and communication technologies which can connect the different communities of people. The radio and television have played a very important role in enhancing the capacity of farmers by broadcasting different agricultural related programs. Similarly Television disseminates scientific and agricultural knowledge among farmers and provides latest information with the discussion of agriculture experts (Chhachhar *et al.*, 2014).

### **Barriers to the use of ICT in Horticulture**

ICT is extremely dynamic, changing dramatically with time and little political input. The presence of specific barriers can create difficulties that prevent farmers from reaping the benefits of the systems

- i. **Inadequate Training and ICT Support Facilities:** Access to the internet and telecommunications are mostly limited to urban areas in many developing countries while the rural areas remain beyond the ambit of new technology. It was further argued by Saidu *et al.*, (2017) that poor implementation in support of ICT is among the key impediments to wider usage by small-scale and rural farmers. In addition, lack of customized ICT applications, increase of sophisticated software with enhanced human capital requirements, lack of harmonization with production, market and essential ongoing end-user extension training that will enhance farmers and lack of basic skills of using ICT facilities in agriculture. “Lack of training” is important in most countries, regardless of the level of development (Taragola & Gelb, 2005). Singh, Sankhwar, and Pandey (2014) reported some existing issues to include inadequate accessibility of ICT services to rural farmers, lack of basic skills of using ICT facilities in agriculture, inability of government to deliver adequate ICT

knowledge to farmers. On the other hand, a study by Agu (2013), specifically focuses on the problems faced by women in agriculture like access to land, access/weak extension services, access to credit, lack of supportive policies, access/no adoption of new agricultural technologies, and restricted access to training and education. These issues continue to persist because information that could help the farmers adjust and minimize their problems were either absent or not sufficient (Abdulrahman et al., 2017).

- ii. **Inadequate Database:** As posited by Saidu *et al.*, (2017) the harmonization of the basic and scientific research knowledge database and farmers' knowledge database adopted biologically and socially over a period of time. This would aid faster dissemination of agricultural information and knowledge among the various stakeholders in the sector. In addition, outdated curriculum of agriculture is still being used in Nigerian educational institution which is not in conformity with global trends. There is need to in-cooperate agricultural curriculum into schools and to create massive awareness via mass media, especially Nollywood industry. It was revealed that the key challenges to ICT implementation were lack of customized ICT applications, increase of sophisticated software with enhanced human capital requirements, lack of harmonization with production, market and essential ongoing end-user extension training that will enhance farmers. The authors were able to analyzed impediments of ICT adoption in agriculture. The shortcoming of this review is the use of old data which could not reflect the present situation. The results would have been useful if current data are used, thus findings are not reliable as they fail to represent the contemporary situation. Owing to the fact that ICT is extremely dynamic, changing dramatically with time and little political input.
- iii. **Low Power Supply:** Inadequate and unstable power supply, cost of hardware and software are high with respect of average rural dwellers in most developing countries. In addition, Saidu *et al.* (2017) reports that lack of ICT proficiency by end user is one of the factors militating against adopting ICT in horticulture.
- iv. **Lack of Financial Support:** is a major stumbling block for many farmers to expand production or diversify into new high value enterprises.
- v. **Poor infrastructure and marketing facilities:** poor communications and unavailability of facilities from major suppliers hinders farmers' access to ICT devices. This argument corresponds with findings of Lawal-Adebawale, (2017) and Saidu *et al.* (2017) who put forward that these are also main constraints of ICT adoption in horticulture. 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. Most of the horticultural growers use the PC for business administration (Word, Excel, etc.).

## CONCLUSION

The review has demonstrated that ICT devices which support horticultural development for economic sustainability include the use of Phyto-monitoring, e-Data Bank, PLANT-PlusDSS, Computer-Aided Design (CAD) software, List Servers etc. for improved productivity and High yield. Collectively, the study outlined the critical roles of ICT integration in the horticultural sector of Nigeria centering on sustainable technology transfer. The review mainly focuses on integration of ICT devices in horticultural sector, benefits and some specific barriers. This review has identified the use of Phyto-monitoring technique, e-Data Bank, PLANT-PlusDSS, Computer-Aided Design (CAD) software, List Servers, Geographic Information System (GIS) as ICT devices that support horticultural development for economic sustainability. However, Inadequate, and unstable power supply, high cost of hardware and software, lack of financial assistance, inadequate databases, poor infrastructure and inadequate training on ICT devices impede ICT integration in the horticultural sector of the country. Relevant suggestions were given by various researchers to overcome challenges militating against successful implementation of ICT in horticultural sector but were found to be insufficient. The Government of Nigeria should therefore advance the horticultural sector through consistent policy making and implementation, holistic adaptation strategy and proper funding.

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