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The Place of Internet of Things and Information and Communication Technology in the Development of Rural Agriculture in Nigeria

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Abstract Agricultural practices in the rural areas of Nigeria is still traditional hence, the use of Internet of Things (IoT) and Information and Communication Technology (ICT) is at the formative stage. However, IoT and ICT can be used as tools for transforming agriculture to modern-day standard. The present study discussed the importance of IoT and ICT in rural agriculture. In livestock and crop production, the roles of IoT and ICT in terms of weather forecasting, irrigation of crops, monitoring of pests and diseases, animal tracking, health, marketing and transportation of farm produce to market were elucidated. In conclusion, these tools can aid and transform rural agriculture thereby lifting the face of agriculture.

Keywords: • Animal Tracking • IoT in Agriculture • ICT in Agriculture • Smart Phone•

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1 Introduction

The livestock sector typically contributes between 30 and 40% of agricultural gross domestic product in developing countries, and in Africa it provides livelihoods for some 200 million small-scale livestock producers. It is a source of food and nutritional security for producers and consumers for some, livestock are a mobile bank providing security in times of drought or disaster (ILRI, 2013). Nigerian agriculture is largely dominated by poor rural farmers. The farmers are characterized by low level of information on improved production practices.

Information and Communication Technology (ICT) was the largest contributor to growth and development within capital services for both Canada and United States (Harchaoui, 2002). Similar trend has been observed with the economic development of China, Korea, Taiwan, India, South Africa and other emerging economic powers (Fuss and Waverman, 2005).

The Internet of Things (IoT) is the network of physical objects, devices, vehicles, buildings and other items which are embedded with electronics, software, sensors and network connectivity which enables these objects to collect and exchange data (GSI, 2015). Internet of Things (IoT) is transforming the agriculture industry and enabling farmers to contend with the enormous challenges they face (Bamigboye and Ademola, 2016) resulting in improved efficiency, accuracy and economic benefit. There is growing interest in the potential of internet of things technologies (IoT) to support poverty alleviation and the upliftment of the living standards of people in rural areas.

The potential benefits of ICT to farmers and farm processes call for need to understand factors that might influence the use of the technologies by farmers. However, interactions with agricultural extension workers and agro-based entrepreneurs as well as literature sources (Agwu and Uche-Mba, 2010) depicted cost of the technology, lack of training, trust level in ICT, lack of ICT proficiency, lack of technological infrastructure and non-awareness and unwillingness to use new technologies could influence the use of ICT by farmers in many Nigerian communities.

The widespread use of ICT and IoT in rural areas for agricultural production is influenced by awareness, language barrier, accessibility of network and internet, technical-know-how of operation, affordability and small farmland/herd size. However, the use of mobile phones in Nigeria at the rural level for agricultural production is gradually improving. This is due to the fact that it is relatively affordable, serves as means of communication, relatively easy to operate by illiterates. The roles of IoT and ICT in improved agricultural production at the rural level for national development were discussed in the present paper.

2 Relevance of of IoT and ICT in rural livestock production

In rural areas in Nigeria, farm animals roam about, fend for and defend themselves as well as their young ones.

Animal tracking:

The habit of roaming about exposes animals to various dangers (theft, accident, unable to trace its way back) this makes monitoring of their movement a inevitability. Radio Frequency Identification (RFID) in animal-tracking applications tells about the implementation of tagging of domestic animals by various countries which helps them in tracking those animals. The tracking is done using RFID chip which is associated with the tag. This tag can be attached to animals (like cow, goat, etc.) by clamping on the ear or implanted inside the animal. Insertion can be done in various places depending on animal. These tags are embedded with sensor for mobile tracking with GPS (Global positioning system) that gives the exact position of the animal. In India, it was reported that animal situation was tracked technologies like RFID that identifies animals based on the information from the tag attached to their body, sensor nodes that sense body temperature of animals and GPS (Global Positioning System) that locates the animal (Wankhede and Pednekar, 2017).

To prevent stock theft, animals are fitted with radio frequency identifiers (RFIDs) that enable tracking of the animal. The position of the animal can be visualised on a map in a control centre through data remitted wirelessly. In rural areas where there is communal grazing, animals tend to get lost. Livestock can be fitted with radio-frequency identifiers (RFID) chips and RFID readers are placed at various monitoring spots to transmit information to (Dlodlo and Kalezhi, 2015) the farmer. Interestingly, work in India has shown that even in developing nations, RFID technology can help small scale rural farmers (Samad *et al.*, 2010).

In rural areas, the use of mobile phone is very common now in Nigeria. It can be used for tracing and tracking lost animals. The picture of the lost animal can be circulated to friends and neighbors in the village and adjoining villages to alert them. When such animal is seen around, they inform the owner and such animal is found.

Animal Health

The use of livestock or crop smart health cards which store information related to affected livestock or crops can be beneficial to both veterinary or agriculture officer and the farmer. This can lead to efficient and effective diagnosis and prescription of medicine since the officer has access to all the historic information of the affected livestock or crop. With the introduction of mobile internet and low-cost sensors (Mizunuma *et al.*, 2003) livestock health condition can be monitored by rural farmers.

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Mobile phone can be used by poor resource farmer to consult an extension agent attached to his/her area on animal health issues. The picture of the sick animals can be sent, diagnosed and drugs prescribed to the farmer. If the agent is not informed on the health issue, further consultation can be made from a veterinarian. Government can make special arrangement with such veterinarians to be available and accessible to extension officers.

Marketing of Animals

Satellite transmission can also enable farmers in rural areas obtain information on markets for their products and prices, government services that they can access, and their rights. The systems can also connect to government departments and local and international markets. With the introduction of the mobile internet and low-cost sensors, farmers could interact directly with consumers and cutting off middlemen who usually exploit them. This is beneficial to farmers because they can make better profits on their products (Mizunuma *et al.*, 2003).

Through the aid of mobile phones, prevailing market prices in various locations for livestock can be compared. This will help the farmers to boycott the middlemen and sell their animals at better prices. Farmers' groups on social platforms where livestock for sale can be advertised can also serve this purpose. Internet/mobile banking can be enabled on phones for both farmers and buyers to encourage cashless transactions.

Mobile phones enable farmers to compare prices more efficiently and to link up with other buyers who were not previously easily accessible. Mobile phone helps to improve the links between farmers and traders, creating opportunities for small-scale producers to sell to new markets, thereby increasing their incomes and helping to reduce poverty. Farmers could also easily use the mobile phones and other ICT to inform customers about the availability of products or discuss and negotiate prices (Nwagwu and Soremi, 2015).

ICT could help farmers in Nigeria to efficiently access current information and also provide information to buyers and consumers alike through innovative avenues like joining online communities of farmers, advertising in local farmers' markets that might host a neighborhood website and joining social network sites such as Facebook to build community interest around the farmer's activities (Jones 1997).

3 Relevance of of IoT and ICT in Rural Crop Production

In the recent times, climate change is seriously influencing a host of practices in crop production. Hence, weather forecasting is inevitable to mitigate agricultural risks and disasters.

Irrigation of crops

For agricultural purposes and in an environment where the advent of climate change results in unpredictable rainfall patterns, automated drip irrigation can be adopted. Drip irrigation is the crop watering technique that waters only the soil closest to the plant's roots. Linking data on temperature, radiation, humidity and soil water content collected by various sensors, controls not only where water is released but how much is needed. Since the rural areas are endowed with renewable energy and there is little or no access to the electricity grid, these renewable energy technologies such as solar and wind can feed energy into water pumps which in turn pump water from underground into tanks. This water is used to irrigate crops (Dlodlo and Kalezhi 2015).

Soil condition, Weather forecasting and disease/pest monitoring in crop

Temperature, humidity, light intensity, and soil moisture can be monitored through various sensors. These can then be linked to systems to trigger alerts or automate processes such as water and air control. They can also be set up to look for early signs of pests or disease (Huang, 2014).

ZigBee is a low-cost, low-power, wireless mesh networking standard. The ZigBee nodes can obtain the temperature, humidity and illumination information in real time, and then transfer to a remote monitoring center. The ZigBee technologies allow the identification of pests in the crops, drought or increased moisture. Having such information at a real-time interval, automated actuation devices can be used to control irrigation, fertilization and pest control in order to offset the adverse conditions (Zigbee, 2010).

All crop production activities (land preparation, sowing, harvesting and post-harvesting processes) are weather dependent, hence, the import of weather forecasting. Development and expansion of IoT technology for weather forecasting will deliver vital weather prediction to farmers and accordingly farmers may use the intelligence to improve their crop fertility and cost along with taking essential steps to diversify weather hazards. Timely and accurate delivery of weather forecast will ensure bumper harvest and lower the risk of weather hazard (Mahendra, 2016).

The farmer can get solution to crop pest infestation and diseases by sending the pictures of infested/diseased crop to the extension agent or putting a call through to explain observable effects. The extension agent then, fortifies the farmer with necessary information on what to do and how to go about it. In the recent times, smart phones possess applications for checking weather forecast. This can also be of immense help to farmers in predicting actions to be taken at a given time on agricultural production.

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In the recent times, smart phones with internet access can be used to obtain information on the name of disease affecting the plant and recommended medication prescribed. This is achieved through the use of search webs e.g. google search; description of disease presentation (signs/symptoms) is the tool for searching out the name and cure.

4 The place of IoT and ICT in Transportation of agricultural produce and livestock from production area to market outlets

The rural set-up is sparsely distributed and transportation needs with time differs. Hence, there is need for the transporter to be fortified with information on transportation needs of the producers and attend to it accordingly.

Social platforms on smart phones can be explored by transporters and farmers for sharing their transportation needs and availability. The farmers within a locality as well as the transporters covering the locality can link up on this platform and discuss modalities for transporting the farm produce to the market. The picture of produce to be transported can be sent to the transporter ahead for price bargaining and better pricing.

IoT technologies can empower the transporters by providing them with information of farmers who require transport. Therefore transporters do not need to wait until they have a full truck load of farm products to start off, they can leave any time provided they are aware that there are farmers waiting for transport ahead (Dlodlo and Kalezhi, 2015).

5 Conclusion and Recommendation

The judicious use of Information Communication Technology at the rural level by farmers makes them better informed on evolving technologies for improved performance on their farms. Internet of Things is the tool used in many areas of agriculture for increased production. It is recommended that training on the use of ICT media for obtaining information on agriculture production should be organized for farmers. Trainings on IoT; its importance and usage in agriculture should be demonstrated to the farmers.

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