#7889 APPLICATION OF INFORMATION & COMMUNICATION TECHNOLOGIES (ICTS) INTO PRECISION FARMING ECOSYSTEM IN ETHIOPIAN DIGITAL AGRICULTURE DEVELOPMENT PERSPECTIVE PLAN

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ABSTRACT

Information and Communication Technologies (ICTs) in agriculture is an emerging field focusing on the enhancement of agriculture and digital technologies for precision farming are now replacing the traditional farming system. The Ethiopian government recognized the importance ICTs for the country's development and ICT in Agriculture is also expected to be a key catalyst for the transformation of Agriculture so as to contribute for the economic prosperity in the country. The endorsed and currently enforced ICT policy and the recent Digital Ethiopia strategy 2025 are the demonstration of its commitment to the development of ICTs in Agriculture and an enabler of socioeconomic transformation. Ethiopian Institute of Agricultural Research (EIAR) is a federal government organ, with a network of 20 research centers and more than 55 sub centers representing various agro-ecological settings. In EIAR, integrating ICTs into agriculture research, aiming at generation of context specific evidences to measure values of digital technologies in precision farming, compared to the analogue method, is considered as a major catalyst for modernizing the research system. However, there exist major challenges of building ICT infrastructure for sharing and exchanging agricultural knowledge generated from research at national and regional levels and there is a huge gap between the agricultural researchers, extension officers and farmers related to sharing, exchanging and disseminating agricultural knowledge and technologies. This paper presents the result of a survey on the use of ICTs in agricultural research, challenges, lessons and future needs in EIAR and discusses progresses on the application of precision farming technologies mainly on the use of unmanned aerial vehicles (UAVs for soil moisture nutrient and disease detection at crop critical growth stages, aiming at spot based and immediate response. The findings of the survey revealed that the use of ICT for agricultural research is still at its initial stage and lack of ICT policy and awareness about ICT for agriculture (e-Agriculture) by researchers and administrative staff is the main challenge. The poor ICT infrastructure, lack of centralized agricultural research information system, access and dissemination of the resources currently available in EIAR are also critical challenges which limits the full integration of Digital Agriculture practices. However, the recent initiatives on use of UAVs for precision agriculture and digitization of the Wheat rust diseases monitoring and early warning processes are believed to help breaking the old thinking and revolutionize the traditional way of data collection, analysis and interpretation. The possible integration of soil-crop-disease diagnoses tools, the remote sensing; including the current 13.75m resolution ETRSS-1 satellite imageries is a good initiative and so far, the preliminary results showed that precision agriculture practices are very critical for modernizing the research activities in EIAR and transforming smallholders to smart farmers through large scale demonstration farming approach.

Keywords: ICT, digital agriculture, precision farming, UAVs, wheat rust surveillance

INTRODUCTION

Information and Communication Technologies (ICTs) in agriculture is an emerging field focusing on the enhancement of agriculture and the advancement in ICT can be utilized for providing accurate, timely, relevant information and services to the farmers, extension agents and researchers. ICTs are used to digitalize agricultural processes and precision farming are now replacing the traditional farming system.

Agriculture is an important sector with the majority of the rural population in developing countries depend on it. In Ethiopia, agriculture influence the overall economic performance and poverty reduction and it accounts for nearly 40% of GDP and over 70% of employment. Accordingly, the Ethiopian government gives special attention to the sector and like in other sectors the government recognized the importance of ICT for modernizing the agricultural practices and developments. ICT in Agriculture is expected to be a key catalyst for the transformation of Agriculture so as to contribute for the economic prosperity in the country. The endorsed and currently enforced ICT policy and the recent Digital Ethiopia strategy 2025 are the demonstration of its commitment to the development of ICTs in Agriculture and an enabler of socioeconomic transformation. Projects such as 8028 IVRS/SMS toll-free hotline for farmers, Market Information System (MIS), Wheat Rust Surveillance Information System, Livestock tracking system and e-extension services which are implemented by the Ministry of Agriculture (MoA), Ethiopian Institute of Agriculture (EIAR), Agricultural Transformation Agency (ATA) and other partners shows some of the efforts that the government commitment to the sector on using ICT for agriculture so as to digitizing the agricultural processes across the value chain. However, the sector faces major challenges in enhancing production and to sustain and improve the livelihood of small holder farmers and despite these and other initiatives, there exist major challenges of building ICT infrastructure for sharing and exchanging agricultural knowledge generated from research at national and regional levels and there is a huge gap between the agricultural researchers, extension officers and farmers related to sharing, exchanging and disseminating agricultural knowledge and technologies. In general, the digitization of agriculture in Ethiopia is still far behind most other countries [1] and Precision Agriculture (PA) practices are very limited and most of the small holder farmers still use traditional farming system.

Therefore, ICT technologies play an important role in addressing these challenges and uplifting the livelihoods of the rural people. This paper reports the result of a survey on the use of ICTs in agricultural research in EIAR, which was conducted using an online questionnaire and interviews, and discusses current digital agriculture initiatives and progresses on the application of precision farming technologies mainly on the application of unmanned aerial vehicles (UAVs) and Wheat Rust Early Warning & Advisory System.

Application of ICTs in EIAR

The Ethiopian Agricultural Research System (EARS) consists of Ethiopian Institute of Agricultural Research (EIAR), seven Regional Agricultural Research Institutes (RARIs), which are administered by the regional state governments, and Higher Learning Institutions (HLIs). EIAR is a federal research institutes which coordinates research within the EARS, by taking a leading role in influencing agricultural policy development and conducts research at its federal research centers. EIAR is one of the oldest and largest agricultural research systems in Africa that comprises of 20 research centers and many sub centers located across various ecological zones in the nation. This section presents the results on a survey conducted to assess the current status on the use of ICTs for agricultural research in EIAR HQs and across 17 research centers.

METHODOLOGY

The survey was collected from researchers in HQs and 17 agricultural research centers through online questioners via http://www.qualtrics.com/ and interviews by personally visiting the research centers. Among the 17 research centers, 12 research centers & HQs participated in the survey and in total 43 researchers responded the questioners.

The following were some of the major questions presented via online:

1. What are the benefits of using ICT in Agriculture?
2. What data types do you use or generate? Where do you store your data?
3. Estimate the amount of research data you currently maintain (both
4. active and inactive data stored for long term)
5. What are the main challenges you encounter within your work on Data Management and open research data? (more than one answer possible)
6. In your opinion, what do you consider to be the most significant obstacles preventing greater use of ICTs in Agricultural research in EIAR?

Survey Analysis

From responses received as to the most significant obstacles preventing greater use of ICTs in Agricultural research, an overwhelming amount of respondents, (84%), indicated that their research center is not equipped the necessary ICT infrastructure and systems for delivering digital agriculture services while 16% of respondents indicated they have the necessary equipment/ICT infrastructure system and manpower for delivering ICT services. And most of the researchers responded that the main challenges they encountered in the research systems are the difficulty of accessing data and lack of data management system (see Figure 1).

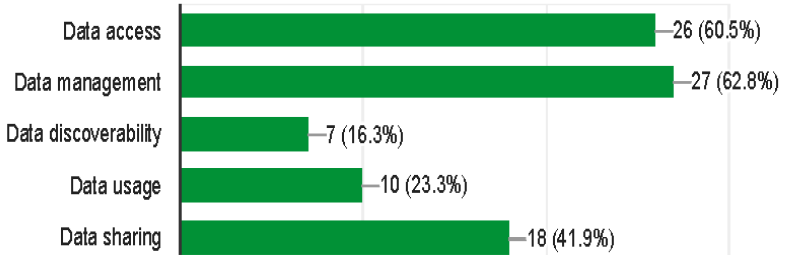

Figure 1. Responses for question no. 6 "What are the main challenges you encounter within your work on data Management and open research data? (More than one answer possible)"

DISCUSSION

The application/integration of ICTs in agricultural research in EIAR has shown significant progress over the last years and mainly internet connectivity were improved and EIAR Agri-Net which connects 17 agricultural research centers were fully implemented. And recently, some digital agriculture practices has been started. However, there exist major challenges of building ICT infrastructure for sharing and exchanging agricultural knowledge generated from research and there is a huge gap between the agricultural researchers, extension officers and farmers related to sharing, exchanging and disseminating agricultural knowledge and technologies. The research systems face various challenges and mainly the poor ICT infrastructure, lack of centralized agricultural research information system, access and dissemination of the resources currently available in EIAR are critical challenges which limits the full integration of Digital Agriculture practices. Therefore, the ICT infrastructure in all

research centers should be upgraded, integrated application platforms needs to be implemented, awareness should be created and e-Agriculture policy and strategy should be crafted at institutional level.

Precision Agriculture Practices in EIAR

Digital Agriculture (DA) practice is a gateway to Precision Agriculture (PA) and the much-dreamed transformation of Ethiopian Agriculture research systems. PA is an approach to farm management that uses information technology (IT) to ensure that crops and soil receive exactly what they need for optimum health and productivity [2]. In EIAR, DA practices is not new except that efforts are scattered here and there. For instance, agro-climate advisory services dissemination using a tool/platform called Ethiopian Digital Agro Climate Advisory Platform (EDACaP) has already been under piloting, while the Wheat Rust Surveillance and Early Warning platform and the Breeding Management System (BMS) in major crops, making an attractive example of the already incubated digital technologies in the agricultural research system. Accordingly, EIAR has already started to see important signs of progress, as well as notable areas for further improvement. The following systems and platforms are implemented in EIAR and greatly supports the initiatives towards ICT-based precision agriculture services.

Wheat Rust Surveillance Information System (WRSIS)

Wheat rust diseases pose one of the greatest threats to global food security, including subsistence farmers in Ethiopia. The Wheat Rust Early Warning and Advisory System or Wheat Rust Surveillance Information System (WRSIS) integrates a web portal and mobile app and it aims to collect real time data from field, report incidences in advance and provide integrated wheat rust disease related information for wheat rust disease protection community via SMS and Interactive Voice Response System (IVRS) and decision makers at the MoA. The framework represents one of the first advanced crop disease Early Warning Systems (EWSs) implemented in a developing country and EIAR manages the system at national level (www.WRSIS.gov.et).

Remote Sensing Applications-Drones for Precision Agriculture

EIAR recently acquired two Parrot Bluegrass drones donated by Technical Centre for Agricultural and Rural Cooperation (CTA) which are designed for end-to-end agricultural solutions. Currently the drones are used mainly for crops monitoring, wheat rust disease identification, water stress and nutrient deficiency applications at crop critical growth stages, aiming at spot based and immediate response for early warning and advisory services for researchers, farmers and extension agents.

CONCLUSIONS AND RECOMMENDATIONS

The findings of the survey revealed that the poor ICT infrastructure, lack of centralized agricultural research information system, access and dissemination of the resources currently available in EIAR are critical challenges which limits the full integration of DA practices. However, the recent initiatives on use of Drones or Unmanned Aerial Vehicles (UAVs) for PA and digitization of the Wheat rust diseases monitoring and early warning processes are believed to help breaking the old thinking and revolutionize the traditional way of data collection, analysis and interpretation. The possible integration of soil-crop-disease diagnoses tools and the remote sensing are a good initiative and so far, the preliminary results showed that precision agriculture practices are very critical for modernizing the research activities in EIAR.

As a frontrunner in the agriculture sector, EIAR must take maximum advantage of the opportunities presented by technological explosion (capturing the late comer advantage) and

from the new national digital strategy. DA should be considered as a major catalyst for modernizing the research system and technologies including Artificial Intelligence (AI), Machine learning (ML), Robotics, Internet-of-Things (IoT), Sensors and satellite-based communications needs to be integrated in the existing systems/platforms and so that early warning and advisory services can be provided to farmers and development agents via expert systems and different channels.

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