SEMINAR REPORT

Digital technologies for transforming agriculture: prospects and challenges

By

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CERTIFICATE

This is to certify that the seminar report entitled **"Digital technologies for transforming agriculture: prospects and challenges"** has been solely prepared by **RASHIDA V. K. (2018-11-082)**, under my guidance and has not been copied from seminar reports of any seniors, juniors or fellow students.

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1. INTRODUCTION

The global population is expected to increase by almost 40 per cent to 9.8 billion by 2050. United Nations Food and Agriculture Organization (FAO) predicts that the agriculture sector will need to produce 70 per cent more food in order to feed this drastically increasing population. The digital agriculture revolution can provide the solutions to the problems of feeding the world (FAO, 2017). This will require an urgent transformation of the current agri-food system. Digital innovations and technologies may be part of the solution. We have been undergoing the 'Fourth Industrial Revolution' in several sectors by rapid transformation through 'disruptive' digital technologies such as Blockchain, Internet of Things, Artificial Intelligence and Immerse Reality. Mobile based applications are also helping farmers to make informed decisions (World Bank, 2019). In the agriculture and food sector, the spread of mobile technologies, remote-sensing services and distributed computing have already improved smallholders' access to information, inputs, market, finance and training. Digital technologies are creating new opportunities to integrate smallholders in a digitally driven agri-food system (USAID, 2018).

According to Mahaldar and Bhadra(2015) digitization is the 'Integration of digital technologies into everyday life by the digitization of everything that can be digitized'. A digital tool can be considered as software and platforms for teaching and learning that can be used with computers or mobile devices to work with text, images, audio, and video.

1.1 Major milestones in the History of digital transformation

1956 : First computer was invented by Charles Babbage

1992 : Creation of web

1994 : Beginning of online sales

1995 : Emergence of social networks

1999 : Development of the mobile web

2008 : Emergence of 3G technology

2010 : Cloud computing enter in to mainstream

2016 : Half of the world's population became connected

2. DIGITAL AGRICULTURE

Digital agriculture can be defined as Information and Communication Technology (ICT) and data ecosystems to support the development and delivery of timely, targeted information and services to make farming profitable and sustainable while delivering safe, nutritious and affordable food for all (Bergvinson, 2016). It can also be referred as the use of agriculture technology (AgTech) to integrate agricultural production from the paddock to the consumer. These technologies can provide the agricultural industry with the tools and information to make more informed decisions and improve productivity.

2.1 Expected output of digital agriculture by UN

- $15 billion digital agricultural market size in 2021
- Competitive advantage by 80 per cent of agricultural companies
- 60 per cent increase in food supply required to feed the predicted world population in 2050

2.2 Trends driving digital technology in agriculture

While demand is set to grow, farmers are facing the challenges of a changing climate. Increased temperatures, changes in rainfall patterns, more frequent extreme weather events, and reductions in water availability are already impacting the agriculture sector. In this environment, farmers must continue to innovate to maintain and improve productivity to meet demand.

Digital technologies have the potential to provide farmers with the information and ability to meet these challenges and seize opportunities for growth.

But it is not just about farmers. Consumers both at home and abroad are becoming more informed about the products they buy. They demand high quality and sustainably produced food and fiber, and want to know more about where their products come from. Digital technologies can enable improved traceability of agricultural products, providing peace of mind for consumers and increased value for farmers.

2.3 Basic conditions for digital transformation

- IT infrastructure and networks in rural areas

In the era of digitalization, ICTs becomes vital for humanity and their daily life activities. ICTs have revolutionized how people access knowledge and information, do business and receive various services. However, access to ICT benefits and opportunities is unequally distributed both across and within countries. Driven by wireless technologies and liberalization of telecommunication markets, the rapid adoption of mobile phones in some of the poorest countries in the world has far exceeded expectations.

- Educational attainment, digital literacy and employment in rural areas

At record speed, digital technologies are changing the way people live, work, learn and socialize everywhere. They are giving new possibilities to people to improve all areas of their lives, including access to information, knowledge management, networking, social services, industrial production and mode of work. However, those who lack access to digital technologies and the knowledge, skills and competencies required to navigate them, can end up marginalized in increasingly digitally driven societies. Literacy, introduction of digital tools in the educational systems and rural employment can navigate rural communities, especially youth and women being digitally native in the digitally driven society and drive the closure of the digital divide.

- Policies and programmes for enabling digital agriculture

Demand for digital transformation is partially being driven by government ICT strategies. Many countries are following processes such as benefit payments, tax filing and passport applications online, and efforts are being geared up to digitize education, health and public. The agricultural sector is still lagging behind in the process, but grassroots initiatives are already present. Governments typically emphasis their digitization efforts on four capabilities: services, processes, decisions and data sharing.

2.4 Enablers for digital agriculture transformation

The use of internet and mobile and social networks among farmers- Literacy and digital skills and the availability of technologies all affect the use of digital innovations.

However, the most critical component for unlocking the possibilities of use of digital technology is access to the internet. In LDCs, only one out of seven people uses the internet (ITU, 2016) and there are apparent disparities between rural and urban areas (although the patterns vary between countries).

Education and income levels are strong determinants of how people use the internet. Those with higher levels of education tend to use more advanced services, such as e-commerce and online financial and governmental services.

Countries that have ICT education programmes can have good access to the internet and develop better digital skills. Agricultural extension officers, rural population with high digital skills can operate digital tools.

A culture which encourages digital agri-preneurship and innovation is observed in some countries. Digital entrepreneurship involves the transformation of existing businesses through novel digital technologies and the creation of new innovative enterprises characterized by the use of digital technologies to improve business operations, the invention of new (digital) business models and engaging with customers and stakeholders through new (digital) channels. With its large farming sector and consumer market, Africa is anticipated to be a major testing ground for digital solutions by agri-tech groups.

2.5 Early platforms of digital technologies in agriculture

Digital technologies have emerged through ages. The early digital tools used in agriculture are Television, Telecenters, Village Resource Centers, Village Knowledge Centers, Akshaya e Centre ande –choupal.

Television

- Television combines all the advantages and utilities of other mass media such as radio, newspaper and film.

The major farm telecast programmes and their representative broadcasting channels in India are

DD Kisan - Durdarshankissan

KrishiDarshan- DD malayalam

KissanKrishideepam -Asianet

HarithaKeralam – Jeevan TV

HarithaBharatham –Amritha TV

Telecentres

- Telecentre make access to computers, the Internet, and other digital technologies
- Enable to gather information, create, learn, and communicate

Village Resource Centre

- VRCs was inaugurated in 2004 (ISRO, RRSSC)
- Users at one node interact with others through video and audio links
- It has two domains ie Government and Public

Village knowledge centre

- It was started at Villianur, Pondicherry in 1998. It is Funded by MSSRF
- VKC project uses a Hub & Spokes model
- The hub is a "Village Resource Centre" Which is typically connected to 20-30 VKCs spread over a 60Km radius.
- It is actually a single window delivery of need-based services for rural areas

Akshaya e- Centre

- Introduced in Malappuram district during 2002

Akshaya conceived was a landmark ICT project by the Kerala State Information Technology Mission (KSITM) to bridge the digital divide and to bring the benefits of ICT to the entire population of the State. Malappuram was declared 100 % e-literate in 2005. Akshaya in association with Dept. of Agriculture has registered over 17 lakhs farmers.

e - choupal

- ITC Limited kiosk with Internet access is run by a *sanchalak* who is a trained farmer

The computer is housed in the *sanchalak's*house and is linked to the Internet via phone connection. Each installation serves an average of 600 farmers in the surrounding ten villages within about a 5 km radius. The *sanchalak* bears some operating cost but in return earns a

service fee for the e-transactions done through his e-Choupal. Online accessibility enables farmers to obtain information on *mand*i prices, and good farming practices, and to place orders for agricultural inputs like seeds and fertilizers.

2.6 Modern digital platforms in agriculture

During the beginning of 21st century several drastic transformations are witnessed in the field of digital technology. Some of the major digital tools are as follows

Social media

Social media refer to the means of interactions among people in which they create, share, consume and exchange information and ideas in virtual communities and networks. Major social media include facebook, whatsapp, and you tube (Kietzmann, 2011).

According to Saravanan*et al.* (2015) the major advantages of social media are

- Instant information dissemination
- Highly cost effective
- Reaches large numbers of clients
- User-generated content and discussion
- Increases internet presence of extension organizations
- Brings all stakeholders into a single platform

Mobile agriculture

Mobile applications are used for agricultural information dissemination. Mobile applications for agricultural and rural development (m- ARD apps) could provide the most economic, practical and accessible routes to information, markets, governance and finance for millions of people who have been excluded from their use. India's internet users grew by 40 per cent while globally the growth was of 9 per cent, making the growth 4 times higher in India.

Some of the few important familiar mobile apps available in India are

- Karshika Vivara Sanketham -Dept. of Agriculture Development & Farmer's Welfare
- FEM@Mobile - KVK Malappuram

Plate 1. FEM@mobile

- Plantix -cooperates with international research institutes and inter-governmental organizations such as ICRISAT, CIMMYT and CABI (Centre for agriculture and bioscience international).
- IFFCO Kisan -IFFCO

Expert systems

An "Expert System" is an intelligent computer programme that uses knowledge and inference procedures to solve problems that are difficult enough and require human expertise for their solution.

Expert systems in Agriculture

- Rice-Crop Doctor , IRRI
- EXOWHEM, IASRI
- Maize Expert System, IASRI
- AMRAPALIKA -An expert system for the diagnosis of pests, diseases and disorders in Indian mango
- KAU Agri - Infotech Portal
- TNAU Agritech Portal

Cloud computing

Cloud Computing refers to manipulating, configuring, and accessing the applications online. It offers online data storage, infrastructure and application. Cloud computing provides

high capacity data stores and provides infrastructure to share the mutual information and experiences.

Cloud agro system is the cloud based computerized system used to monitor the overall information related to agriculture. It includes Land Record Automation, Farm Management, System Data Collection Tools, Weather Forecasting and Solution to Farming Queries.

2.7 Future of digital platforms in agriculture

Digital technologies are going beyond predictions. It is a fast growing field which is changing day by day.

Internet of Things (IoT)

Internet of things is an integration of several technologies such as sensors, actuators, embedded systems, networks, wireless communication and web technologies that connects physical and digital entities (Sharma *et al.,* 2016).It was introduced by Kevin Ashton in 1999.

It is leveraged to remotely monitor sensors that can detect soil moisture, crop growth and livestock feed levels, remotely manage and control their smart connected harvesters and irrigation equipment, and use AI based analytics to quickly analyze operational data combined with third party information, to provide new insights and helps to decision making that is crop selection crop output etc.

UAV -Drones - unmanned aerial vehicles (UAVs) or unmanned aircraft systems (UASs)

Remotely controlled or software-controlled flight plans in their embedded systems are working in conjunction with onboard sensors and GPS. Mainly used in Mapping/Surveying, Crop Dusting/Spraying Irrigation Management and Livestock Monitoring. India has recently unveiled its 'Drone Regulation 1.0' policy and these guidelines will foster technology and innovation in the development of drones .It has extensive applications ranging from disaster relief to agriculture.

Big data analytics

With the help of big data and data analytics, farmers can have real time insights to help performance optimization. Advanced analytics can show how farmers are utilizing their

inputs and what adaptations are required to take account of emerging weather events or disease outbreaks. NITI aayog signed an agreement with one of the big software firms to develop a model for crop yield predictions using Artificial Intelligence (AI) so that farmers can be provided real time advisories.

Robotics

A robot is a mechanical, artificial agent and is usually an electro mechanical system. It is a device that makes complicated tasks easy to perform by the use of software programming. Components of robots includes sensors which can give the robot controller information about its surroundings .The controller functions as the "brain" of the robot, Actuator is the “engine” of the robot and the end effectors means the last link (or end) of the robot. At this endpoint the tools are attached. In agriculture the major type of robots involved are weed control robot, forester and fruit picking robot. Advantages of use of robots in agriculture includes sustain domestic agriculture, 24/7 operations, improvements in safety, reduction in labor needs and chemical usage, work in harsh land and adverse weather conditions with automation.

Plate 2. Weed controller Robot

Block chain technology

It is the tracking of ownership records and tamper .It can be used to solve urgent issues such as food fraud, safety calls, supply chain efficiency and food traceability in the current food system. Blockchains’ unique decentralized structure ensures verified products and practices to create a market for premium products with transparency. Advantages include high level of security and the ability to spread data processing between many devices. It is like a new version of RFID tracking (Radio Frequency IDentification).

3D printing

It is the process of making three dimensional objects from a digital file. It produces complex shapes using low cost material and thereby helping local farmer to prototype their own tools.

Plate 3. 3d- printed pot

3. ROLE OF DIGITAL TOOLS IN AGRICULTURE

Digital revolution has marked the start of a new technological era in the world economy. India being the open economy has also adopted the digitalization process in all the sectors of the economy. Agriculture, the primary sector of our economy has also seen many changes due to the digital revolution. Digital technology will be a key to increase agriculture productivity by delivering tailored recommendations to farmers based on crop, planting date, variety sown, real time localised observed weather and projected market prices. The various application of these technologies can be better analysed by considering the following fields of agriculture.

- **Crop Production and protection**
- **Agricultural Research**
- **Transfer of Technology**
- **Marketing**

3.1 Crop Production and protection

Digital technologies help in protection of crop against pest and diseases by timely and accurate monitor systems and thereby increasing crop yield. Their area of action includes Forecasting of weather and disease out breaks, Diagnosing pest and diseases, Water management, Soil mapping and Monitoring soil properties. Precision agriculture utilizes many of these digital technologies which help farmers to maximize yields by controlling every variable of crop farming such as moisture levels, pest stress, soil conditions, and micro climate. It also aiming to bring efficiency to the farm in terms of cost. Precision agricultural

technologies ranging from robots, sensors, drones, satellite imagery, big data and internet of things (IOT).

As an example, Japan produced Lettuce with less than 80 per cent potassium through controlling growing condition which helped kidney patients who were not able to take lettuce due to its high potassium content. Another example is Pepsico which reduced water use in potatoes by locating waste water for re use, monitoring soil moisture, and weather forecast.

3.2 Platforms for agricultural research

Computer have been used to mechanization, automation and to develop decision support system for taking strategic decision on the agricultural production and protection research.

Data mining

A variety of software systems are available today that will handle the technical details so that people can focus on making the decision.

It is the process of data to information to knowledge and discovering potentially useful, interesting and previously unknown patterns from a large collection of data.

Remote sensing and geographic information system

Remote sensing: It is the process of gathering information about an object, at a distance, without touching the object itself. It helps gathering information about certain phenomenon which cannot be seen by normal eye.

Geographic Information System

GIS is a computer based information system that can acquire spatial data from a variety of sources, change the data into the useful formats, store the data, and retrieve and manipulate the data for analysis.

Expert systems

It is a specified kind of information system in which computer software serves the same function expected of an expert. The computer is programmed to mimic thought process of experts and provide the decision maker with suggestions as the best choice of action for a particular problem situation

Decision support systems (DSS)

Computer systems that provide users with support to analyze complex information and help to make decisions. It consists of a collection of people, procedures, software and data base with a purpose.

2.3 Platforms for transfer of technology

Major platforms include Television, Websites, Portals, Expert systems, E - Choupals, Mobile apps, and Social media.

It helps in timely dissemination of information, easy exchange of vital information between farmers and service providers, reaching the services to large number and receiving early feedback.

2.4 Marketing

Electronic markets in agriculture have been functional for at least the past three decades. Digital technologies make the marketing channel more transparent. The important digital technologies involved are websites, mobile apps, social media marketing and content marketing. A promising area encompassing the agri value through the application of internet and related technologies is e- agriculture while e – Agribusiness provides features like organized and centralized trading,widely dispersed buyers and sellers with remote access, merchandising based on product description, high trading volume and use of reliable grades and standards. The important commodity trading floor in India is E-NAM (National Agricultural Market). It is a pan-India electronic trading portal which networks the existing APMC mandis to create a unified national market for agricultural commodities. It includes commodity arrival and prices, buy and sell trade offers provision to respond to trade offers among other services. The other examples for e commerce in agriculture are TELCOT,electronic computerized egg exchange and electronic auction system.

4. CASE SUDIES

4.1 A MOBILE APP FOR MONITORING AND EARLY DETECTION OF THE DESERT LOCUST IN AFRICA AND ASIA

THE SITUATION

The Desert Locust is considered to be the most dangerous of all migratory pest species in the world due to its ability to reproduce rapidly, migrate long distances and devastate crops. This is because the pest has the ability to change its behaviour and physiology, in particular its appearance, in response to environmental conditions. It can transform itself from a harmless and solitary individual to part of a collective mass of insects that form a cohesive swarm, which can cross continents and seas, and quickly devour a farmer's field and his entire livelihood in a single morning.

THE DRIVERS

As part of the FAO work in emergencies, member countries and stakeholders have requested the Organization to establish a monitoring and early warning system for the Desert Locust in Africa and Asia to allow governments to manage this deadly pest effectively.

THE INNOVATION

FAO developed eLocust3, a rugged tablet used by national survey and control teams in 30 countries to record and transmit, via satellite, field data in real time from some of the remotest areas on Earth to decision-makers and forecasters so that action can be taken and alerts and warnings can be issued. Even without internet connection, it also guides teams to green vegetation, contains a digital library and camera, and works in three languages. The eLocust3 system has dramatically improved the management and analysis of data as well as forecasting and early warning to prevent devastating plagues. The eLocust3 system is an example of how the latest advances in digital tools, communication and satellite technologies can be packaged into a unified monitoring and early warning system for use in Africa and Asia. Data from the app provide valuable insights on how the insect populations change over time and its potential to migrate and invade other countries.

This allows FAO to provide countries with more timely and precise forecasts and warnings to better manage Desert Locusts.

THE CHALLENGES

Integrating the new technologies into the national and global Desert Locust monitoring and control programmes was a complicated endeavour that had to overcome harsh environmental operating conditions, including the low level of digital literacy rates coupled with a lack of Internet connectivity use and deployment of appropriate technologies or

technical support in the countries. Different languages and cultures, insecurity, lack of training and sustainability also complicated matters considerably.

THE IMPACT

eLocust3 has contributed significantly to a decline in the duration, severity and frequency of devastating Desert Locust plagues in Africa and Asia. As more outbreaks are detected earlier, allowing their successful control, this has led to improved plague prevention, better food security and protection of the environment.

Lessons learned from eLocust3 are currently being expanded to other transboundary plant pests monitoring and early warning systems, including the Fall Armyworm Monitoring and Early Warning System (FAMEWS) and the Red Palm Weevil mobile app, SusaHamra. Drone technology is also being considered to supplement monitoring and control of these pests (FAO, 2018).

4.2DIGITAL GREEN

Digital Agriculture will also leverage social media platforms to build human capacity. One of the best examples originating from India is Digital Green. Digital Green's early roots were formed as a Microsoft Research Project in Bangalore. Founded in 2006 by Rikin Gandhi, the project was part of an effort to test different ways of using technology for social development. More specifically, the project focused on testing the use of participatory videos as a means of agricultural extension. The approach was substantially more effective as a means of extension than existing conventional agricultural extension programmes. The use of video for agricultural extension was by no means a new approach and Digital Green was inspired by a number of different projects. These can be broadly categorized as information technology for agricultural development, video in agricultural extension and mediated instruction for effective training with video. Digital Green weaves together the best of these three strands into a novel system that maximize the impact of agriculture extension workers and adds the critical element of community engagement and participation throughout the process. Based on the success of the project, Digital Green was formally established as an NGO in 2008, with offices in Bangalore, Karnataka in India and Berkeley, California in the USA.

YouTube for the farms In Karnataka

In Karnataka, India, with the partnership of Digital green YouTube for the farms In Karnataka was introduced for providing localized knowledge through a farmer-centric peer-to-peer approach for helping to enhance uptake of improved farm management technologies. Short videos created by farmers in the local language on topics relevant to neighboring farmers are proving to be an effective dissemination strategy. A content gathering team decides the videos to be produced in consultation with the farmers. Field staff identify progressive farmers who have adopted the management practices to be disseminated. Farmer shares his/her experience about the technology on camera, with the farmer facilitator playing a supporting role as an interviewer. Videos are screened at small village gatherings (20-30 farmers) using battery operated portable projectors. After the screening farmer facilitator collects feedback from farmers. The feedback system also captures the adaptation rate of technologies screened earlier.

THE IMPACT

Result shows that around 48 per cent of the farmers have adopted the new technologies (ICRISAT, 2016).

5. DIGITAL AGRICULTURE: INDIAN SCENARIO

Throughout the world, information and communication technologies (ICT) continue to proliferate at incredible speed. Digitalization is one of the most fundamental periods of transformation we have ever witnessed. To diversify, small farmers need less costly and readier access to the financing, technology, and inputs, and fewer barriers to the sale, storage, and transport of those more perishable products. Digital innovations and government-issued soil health cards can offer that access. Credit can be extended to small farmers at lesser risk and cost through digital channels. Digital extension services can also provide real-time advice to help farmers transition to new crops. Mobile phones, especially through the use of WhatsApp, make it possible for farmers to determine the price and time at which to sell their crops and possibly to enter into sales contracts.

5.1. Opportunities for transforming Indian agriculture

The major opportunities includes as far as India is considered are

Digital India

Digital India is a flagship programme launched by the Prime Minister of India NarendraModi on 1 July 2015 with an objective of connecting rural areas with high-speed internet networks and improving digital literacy. The vision of this programme is to transform India into a digitally empowered society and knowledge economy. It is one of the biggest steps by government of India to motivate the citizen of the country and connect Indian economy to knowledge savvy world. Government interventions introduced as a part of digital India are

- BharatNet
- Wi-Fi Hotspots
- Next generation network
- National Agricultural Market Online Portal
- National e-Governance programme (NeGP) in agriculture as A-MMP
- Centre of Excellence on Internet of Things(IoT)

Availability of cheaper mobile handsets

As technology gets improved mobile handsets are available in low cost which helps the economically weaker sections of society. Cheaper mobile handsets, spread of wireless data networks and evolving consumer preferences will drive rural penetration and usage (IMRB, 2018).

Interested younger generations

Younger generation likes to try new things and is also keen in changing world. Here digital technologies can attract a section of new generation due to its novelty and provision for wide varieties of employment option.

Response shown by farmers towards adoption of technologies

Many of the farmers are showing positive response toward digital technologies like Drones, social media etc.

Market led production

Rather than finding markets for what has produced, now a day's trend is going towards producing what can be marketed. This necessitates a transfer of current agricultural sector.

Commitment of FAO to assist governments and partners

FAO currently provides technical assistance for sustainable farming, conducts study and projects in collaboration with orgnization and governments.

5.2. Challenges involved in transformation

More than a year has been passed since Digitalizing India has been announced but it is facing multiple challenges in successful implementation. Few of the challenges are

1.High level of digital illiteracy is the biggest challenge .Low digital literacy is key hindrance in adaptation of technologies . According to ASSOCHAM-Deloitte report on Digital India, (2016) around 950 million Indians are still not on internet.

2. Making Digital India scheme known and creating an awareness among common masses about its benefits is also a great challenge.

3.It is a mammoth task to have connectivity with each and every village , town and city. Connecting 250000 Gram Panchayats through National Optical Fiber is not an easy task. The biggest challenge is ensuring that each panchayat point of broad band is fixed up and functional.

4. A key component under this vision is high speed of internet as a core utility to facilitate online delivery of various services. India has low internet speed. According to third quarter 2016 Akamai report on internet speed, India is at the 105th position in the world in average internet speed. This rank is the lowest in entire Asia Pacific region.

5. According to ASSOCHOM- Deloitte report, the issue pertaining to taxation and regulatory guidelines have proved to road block in realizing the vision of Digital India. Some of the common policy hurdles include lack of clarity in FDI policies have impacted the growth of ecommerce.

6. Slow and delayed infrastructure development also provide hindrance to success of digitalization. India’s digital infrastructure is comprehensively inadequate to tackle growing increase in digital transactions. India needs over 80 lakh hotspots as against the availability of about 31000 hotspot at present to reach global level, according to ASSOCHOM-Deloitte report.

7. The private participation in government projects in India is poor because of long and complex regulatory processes.

8. Many request proposals issued by government are not picked up by competent private sector organizations since they are not commercially viable. Currently over 55000 villages remain deprived of mobile connectivity because providing mobile connectivity in such locations is not commercially viable for service providers, ASSOCHAM-Deloitte report pointed out.

9. There is a wide digital divide between urban and rural India. Till now funds have not been deployed effectively to meet the cost of infrastructure creation in rural areas.

10. India has 1600 languages and dialects. Non availability of digital services in local languages is a great barrier in digital literacy.

11. Fear of cyber crime and breach of privacy has been deterrent in adoption of digital technologies. Most of the technology including cyber security tools is imported. We do not have requisite skills to inspect these for hidden malwares. We have no top level experts for these high end jobs at present. According to NASSCOM, India needs 1 million trained cyber security professionals by 2025. The current estimated number is 62000 (Bergvinson, 2016).

6. CONCLUSION

Digital agriculture has the potential to deliver economic benefits through increased agricultural productivity, cost efficiency and market opportunities, social and cultural benefits through increased communication and inclusivity and environmental benefits through optimized resource use as well as adaptation to climate change. Market forecasts for the next decade suggest a 'digital agricultural revolution' will be the newest shift which could help ensure agriculture meets the needs of the global population into the future. In emerging economies, weak technological infrastructure, high cost of technology, low levels of e-literacy, weak regulatory framework and limited access to services contribute to major challenges for the digitalization process in rural areas (Dua, 2017). Digital agriculture is widely recognized as the third great revolution of modern agriculture. It has the potential to deliver economic benefits through increased agricultural productivity, cost efficiency and market opportunities. However, the transformation must be done carefully without widening the digital divide between the economies and sectors. This is also true between those with differing abilities to adopt new technologies.

7. DISCUSSION

Q1. Whether use of expert system is efficient in Kerala condition? Is there any study related to that?

In one of the studies conducted by Ravikishore et al about two of the expert systems available in Kerala that is **e- crop doctor** and **KAU Fertulator** among agricultural officers, frontline extension personnel and scientists it was found that percentage of innovators (10%) was actually greater that normal Rogers' standard for adopter categorization (2.5%).

Table 7.1 Adoptor categories of KAU expert system

	Agricultural officers (n=40)		**Frontline extension personnel (n=30)**		**Scientist (n=30)**		**Total**	
Category	No:	%	No:	%	No:	%	No:	%
Innovators	3	7.5	4	13.33	3	10	10	**10**
Early adopters	6	15	5	16.66	8	26.66	19	**19**
Early majority	11	27.5	11	36.66	10	33.33	32	**32**
Late majority	12	30	6	20	6	20	24	**24**
Laggards	8	20	4	13.33	3	13.33	15	**15**

Q2. How actually the digital divide is formed?

Developed nations are having more innovations in the field of digital technologies due to large sum of funds available and also better researches are taking place in their country. So they can introduce those to the respective fields and get the benefit. In contradictory, poor nations are not able to adopt many of the technologies and this creates a lag in the

transformation of their sectors. This difference can create a divide called digital divide in between the richer and poor countries.

Q3. How can we overcome the digital divide?

Digital divide can only be overcome by availing all those technologies in poor countries also. For that the governments of respective nations need to introduce more policies and programmes in favor to promote digital technologies. FAO is actually funding many of the poor countries for supporting their technology field.

Q4. How the e-NAM is working?

It is a pan-India electronic trading portal which networks the existing APMC *mandis* to create a unified national market for agricultural commodities. It includes commodity arrival and prices, buy and sell trade offers provision t respond to trade offers among other services.

Q5. How e- NAM is working in Kerala?

Kerala is not connected with e- NAM

Q6. How do you substantiate the progress of adopting digital technologies in countries like India?

India has come far in digital field. Rural penetration in India was about 9 per cent during 2015 and it was recorded as 25 per cent in 2018.this data is clearly showing the growth of internet in India. And also the per cent of rural penetration comparing to urban penetration is also increased considerably comparing to previous years. In India total internet penetration of 36 per cent is recorded in 2019 that is second to china in number of users. These all shows the possibilities of introducing digital technologies in India.

Q7. Whether any gender factors affect the adoption of these technologies? What about in Kerala?

In India women are lagging behind in education. So it also affects the technology adoption. But as far as Kerala is considered, condition is different. Here women are more educated and it is also reflected in the technology adoption.

8. REFERENCE

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9. ABSTRACT KERALA AGRICULTURAL UNIVERSITY

COLLEGE OF HORTICULTURE, VELLANIKKARA

Department of Agricultural Extension

EXTN 591: Master's Seminar

Name : Rashida V. K. **Venue** : Seminar Hall

Admission No : 2018-11-082 **Date** : 28-11-2019

Major Advisor: Dr. Mercykutty M. J. **Time** : 10.00 am

Digital technologies for transforming agriculture: Prospects and challenges

Abstract

The global population is expected to increase by almost 40 per cent to 9.8 billion by 2050. United Nations Food and Agriculture Organization (FAO) predict that the agriculture sector will need to produce 70 per cent more food in order to feed this drastically increasing population. The digital agriculture revolution can provide the solutions to the problem of feeding the world (FAO, 2017).

Digital agriculture can be defined as Information and Communications Technology (ICT) and data ecosystems to support the development and delivery of timely, targeted information and services to make farming profitable and sustainable while delivering safe, nutritious and affordable food for all(Bergvinson, 2016).Basic conditions for digital transformation include IT infrastructure and networks, educational attainment, digital literacy, employment opportunities in rural areas and policies and programmes for enabling digital agriculture (FAO,2019).

Digital technologies are used in various fields of agriculture like crop production, agricultural research, transfer of technology, and marketing.In agriculture, these technologies range from television to modern technologies like drones, 3-D printing and Internet of Things. Digital platforms such as socialmedia, mobileagriculture, expert system and cloud computing are extensively practised.e-NAM (e-National Agricultural Market) portal has been introduced from 2016 as a common platform for marketing agricultural products.

Mobile based applications are also helping farmers to make informed decisions (World Bank, 2019). Some of the important applications in agriculture that are widely used in Kerala are 'FEM@mobile', '*KarshikaVivaraSanketham' and 'Mannu'*. The number of

internet users in India has registered an annual growth of 18 per cent during 2018. Cheaper mobile handsets, spread of wireless data networks and evolving consumer preferences will drive rural penetration and usage (IMRB, 2018).

In emerging economies, weak technological infrastructure, high cost of technology, low levels of e-literacy, weak regulatory framework and limited access to services contribute to major challenges for the digitalization process in rural areas (Dua, 2017). Digital agriculture is widely recognized as the third great revolution of modern agriculture.It has the potential to deliver economic benefits through increased agricultural productivity, cost efficiency and market opportunities. However, the transformation must be done carefully without widening the digital divide between the economies and sectors. This is also true between those with differing abilities to adopt new technologies.

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