International Journal of Agriculture Sciences
ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 12, Issue 14, 2020, pp.-10088-10091.
Available online at https://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Review Article

DIGITAL TECHNOLOGY: TRANSFORMING THE AGRICULTURAL SECTOR

SOLO V.* AND SINGH A.P.
Department of Agronomy, School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema, 797106, Nagaland, India
*Corresponding Author: Email - virosolo74@gmail.com

Received: July 01, 2020; Revised: July 27, 2020; Accepted: July 28, 2020; Published: July 30, 2020

Abstract: India is a land of contradictions which produces about 11 percent of total global agriculture and, at the same time, is host to the world's largest number of malnourished people. Our country perhaps has the world's largest agricultural community consisting of 60% of the population engaged in some kind of agricultural related activity and basically the use of digital technology to integrate agricultural production from the field to the consumer. These technologies provide the agricultural industry with instruments and data to make more informed decisions and improve productivity and yield. Thus, diversification of agricultural sectors has been enhanced by livelihood opportunities, strengthened resilience and led to considerable increase in infrastructure, knowledge and preparing for the future. In this paper, a review of the technologies is provided with tools that are applicable in real-time decisions from data.

Keywords: *Agriculture, Digital, Farming, Precision*

Citation: Solo V. and Singh A.P. (2020) Digital Technology: Transforming the Agricultural Sector. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 12, Issue 14, pp.- 10088-10091.

Academic Editor / Reviewer: Dr J. R. Talaviya, Er Prabhat Kumar Dhara

Introduction

Agriculture has been a backbone to the people of India since time in memorial, and has engaged more than 50% of the population in various activities related directly or indirectly to agriculture sector. However, there seems to be a demand for new ideas and innovations in this sector as with the growing population, there has been immense demand for food and which the traditional practises and methods are unable to reach the growing demand, so there is a wail for new innovation and ideas as to meet the challenges of the people.

Digital technology alongside other inventions in the modern era has proved to be a major advantage for humans and proper use of these appliances may change our lives as we know it. The transformation must be done carefully in order to avoid an increase of a 'digital divide' between economy and sectors and between those with differing abilities to adopt new technologies. With the rise of high-speed internet connections and web-enabled smart-phones, mobile apps, social media and digital engagement platforms have significant potential to improve access to information and services for those in rural areas [1,2].

Present scenario of Indian agriculture

The agriculture and food sector are facing multiple challenges; While the world population projected to grow from 7.6 billion in 2018 (UN DESA, 2019) to over 9.6 billion in 2050 there has been significant increase in the demand for food as per investigation [3,4]. At the same time, the availability of natural resources such as fresh water and productive arable land is becoming short. However, production is not the only concern; although agricultural output is currently enough to feed the world, 821 million people still suffer from hunger (FAO, 2018).

The Indian Agricultural sector provides employment to about 65% of the labour force, accounts for 27% of GDP, contributes 21% of total exports, and raw materials to several industries. While a food scarcity may sound like a faraway problem right now, it's a reality that India could be facing in as little as 15 years. India's growth has been largely jobless, with only 15 million jobs created during the last 10 years.

An Outline of The Challenges

There are several issues several challenges and issues arising in every field, none the less, traditional systems and non-fulfilment to adopt new strategies and modern techniques seems to be a major setback in the country. One major ultimatum is the issue of price over the technologies along with the technical experts which small scale farmers are unable to afford them. Poor internet connectivity and unavailability of adequate software disrupts the functioning of the flow of information to the required farmers. Keeping aside the technical issues, with unreliable weather and climatic conditions and lack of communication between the office and the farmers, ignorant and reluctant behaviour of the farmers this becomes a gap in adopting new ideas and learn new technologies. A SWOT Analysis was undertaken by Moni and Sharma, 2017, drawing on various stakeholders (farmers at block level, NGOs, academic & research institutions, public sector and private sector, etc.). During the last 22 years, agricultural sector has been witnessing ICT growth in a very systematic manner. As the connectivity over BharatNet / RailTel / Cable TV etc., systems strength then in reach, they will also require to be sharp ended with specialised content [5].

Digital Agriculture

In 2015, India had reported that about 720 million mobile phone users, out of which 320 million were rural mobile phone users concluding that these technologies have been spreading rapidly. Even among the poorest 20% in developing countries, 70% have access to cell phones [6] , while more than 40% of the global population has internet access and there are major initiatives underway to connect those still unconnected—the great majority of them in rural areas in developing countries. There are basic conditions that exist for the use of digital technologies and therefore for transforming of the agriculture and food sector digital introduction should be done in India, including infrastructure and connectivity (mobile subscriptions, network coverage, internet access, and electricity supply), affordability, educational attainment and institutional support.

Preventing losses through early warning systems have also been of growing interest, including climate models that raise public awareness of drought warnings, pest outbreaks, forest fire detection, and flood alerts, and thus give stakeholders enough time to react to emerging threats. Disease and meteorological information are required by farmers on a frequent basis, without such data, for example farmers are notable to use timely measures to stem losses from climate shocks. Digital tools have been serving as the backbone for early warning systems to mitigate these risks and safeguard incomes for a long time, for example, desert locust outbreak systems determine rainfall and vegetation cover from satellite images, after which the results are used to send survey teams to areas where the probability of a desert locust outbreak is most likely [7].

A range of climatic parameters can be obtained from satellite tech, and although the accuracy of satellite data is not always at the level of measurement stations, however they provide almost real-time data on rainfall, temperature, evaporation, vegetation and land cover that are especially efficient in remote areas where other measurement infrastructure is lacking. Introduction of the new technologies and ideas are looked forward and expected to bring change into the agricultural sector and sustain the environment in which we live in. In this way, it provides plan of action that deals with smart systems and digital tools that help to collect, analyse and gets integrated into the system where the outcome data is analysed in simple way which can be of use to the farmer and easily implemented in the field. Modern agriculture has several complex issues that need to be dealt with modern solutions.

Over the years, there has been a growing demand for food grains on the country and major steps and decisions are to be taken to meet the needs of the people. Year by year, India is facing pressure with tremendous demand in par with growing population, unavailability of land and a number of other defects with which come into view on the course of food and grain production. Digital technology includes the integration of several inputs which serve a s a solution to the modern problems and these technologies have been evolving over the years, with proper planning, processing and resulting to improve and upgrade the agricultural sector in all possible ways. The radical change in land use. By 2017, food-grains sector has increased by 5 times, horticultural crops by 9.5 times, fish by 12.5 times, milk 7.8 times and eggs 39 times since 1951.

The new technologies of micro-irrigation now include drip/trickle systems, surface and subsurface drip tapes, micro-sprinklers, sprayers, micro- jets, spinners, rotors, bubblers, etc. Maharashtra is the leading state under micro-irrigation followed by Karnataka, Andhra Pradesh and Tamil Nadu. Micro irrigation is popularly practised in about 30 crops, and is more popular in horticultural crops which allow relatively wide spacing. India produced 275.11 million MT of food grains during 2016-2017 breaking all earlier records.

Precision Agriculture

Precision agriculture can be known as 'the application of modern information technologies to provide, process and analyse multisource data of high spatial and temporal resolution for decision making and operations in the management of crop production'' (National Research Council,1997). Instead of applying equal amount of fertilisers over an entire field, precision agriculture involves measuring the within-field soil variations and adapting the fertiliser strategy accordingly. This would lead to optimised fertiliser usage, saving costs and reducing the environmental impact [8]. It is a kind of approach where inputs are utilised in precise amounts to get increased average yields, compared to traditional cultivation techniques. Studies have concluded that in India, one major problem is the small field size [9]. More than 58% of operational holdings in the country have size less than one ha.

Global positioning system (GPS)

GPS is a navigation system related to a network of satellites that helps the users to record positional information (latitude, longitude and elevation) with an accuracy of between 100 and 0.01 m [10]. It allows farmers to locate the exact position of field information, such as soil type, pest occurrence, weed invasion, water holes, boundaries and obstructions [11]. There is also an automatic controlling system, with light or sound guiding panel (DGPS), antenna and receiver. GPS satellites broadcast signals that allow its receivers to calculate their position [12]. With the introduction, of GPS in agriculture, it acts as a tremendous aid in helping farmers to have close observation on crops and related practises along with detection of crop requirements from afar, also provides location for soil nutrient mapping.

Geographic information system (GIS)

It is usually a set of computer tools and is a unique platform that allows one to work with multiple data that are tied to a spatially mapped location or area on earth. Advanced computer technology can now support provision of query based information and allow for the rapid computer analysis, for use at individual farms and across large territories. GIS tools and analytics can accurately depict the collection of data on, crop acreage, production, crop health, disease and also maintain geo-database of farmers [13]. It is a kind of computerized map, but its real role is using statistics and spatial methods to analyse characters and geography; it can also be used to evaluate present and manipulating data layers to produce an analysis of management scenarios [14].

Soil and plant sensors

These technologies provide data and help in processing to determine optimum yield and crop production at the same time minimising soil loss and sustaining the environment condition, Various technologies such as electromagnetic, conductivity, photo electricity and ultra sound are used to measure humidity, vegetation, temperature, texture, structure, physical character, humidity, nutrient level, vapour, air etc. Remote sensing data are used to distinguish crop species, locate stress conditions, identify pests and weeds, and monitor drought, soil and plant conditions. Sensors enable the collection of immense quantities of data without laboratory analysis [15].

Crop health monitoring

To understand the crop condition at early stages in the growing period is more important than acquiring the exact production after harvest time. Research and advanced technologies in the field of remote sensing have enhanced the ability to detect and quantify physical and biological stresses that affect the productivity of agricultural crops. The district-wise crop health condition assessment is possible for major crops, viz, cotton, groundnut, paddy, wheat, potato, rapeseed, gram, tobacco, cumin, jowar, etc., using vegetation index computed from multi-date atmospherically corrected high-resolution satellite data [16, 17]. Hence, crop vegetation indices values can also be used to detect and flag stressed crop.

Yield monitor

Yield monitors typically include several different sensors and other components, including a data storage device, user interface (display and key pad), and a task computer located in the combine cab, which controls the integration and interaction of these components. These components are mounted on harvesters or harvesting machines that have the system for s collecting data of specific location along with yield integrated into a system and provide necessary information to the farmers through yield mapping

The advent of drones

Aerial devices that are remotely controlled and have the potential to capture and seize images and record videos in crop surveillance and transport items to far off places. Drones provide proper blanket aerial view to the concerned area to the farmers and aid in detecting and inspection of issues, related to soil, irrigation, diseases outbreak or insect invasion, hence these drones aid in monitoring and evaluating crop development and yield estimation. With high flight timing and ability to carry double its weight with very stable functioning, drones are found in the modern era of agriculture. Commonly used types of drone include- fixed wing, multi rotor and single rotor with a wide range around 3 to 30 miles distance. Drones currently operate at 0.5 - 10 cm resolution and aerial drones (UAV – unmanned aerial vehicle) can fly close to the surface of the canopy of natural stands or crops. The uses of drones for gathering valuable data via a series of sensors, multispectral, thermal, and visual, for use in analytics, mapping and surveying of agricultural land.

Remote Sensing Satellite

These constitute of artificial spacecrafts that accumulate facts and figures of a specific area or field from space on a wide range of environmental features – temperature, soil parameters, irrigation quality and inputs. Over the years, these kinds of satellites have taken role as bird's eye view for the common man, in helping them to monitor and keep a close view of crop development and soil management [18]. These devices are also compared to crop modelling systems as they provide accurate results and accurate ground data example- ALOS and RADARSAT-2 systems that collect data from satellite and get analysed into the crop model. Despite of the cost limitations, these devices access precise data and also help in forecasting crop production [19].

With the emergence of Precision livestock farming (PLF), it has helped in achieving better outcome from the animal farming sector. This is a form advanced and smart automation in the handling and governing of livestock with the use of potentially advanced technology which result in close monitoring of each livestock. PLF focuses on continuous observation and use of advanced smart tools and managing models under its principles so that would benefit the farmers as they solely depend on the animal for their source of income. Proper handling of the animals, close monitoring of the physical health and behaviour during growth, development stages –milk and egg production under controlled environment keeping in mind animal welfare. These devices and models are placed on the farm houses where the animals are located and they generate data and information into the systems. However, limitations are a part of the system like- time taking, energy consuming and high priced are the major constraints.

New Day Inventions

a. ICRISAT in alliance with Microsoft company thrived an Artificial intelligent sowing app that assists the farmers by sending them sms / texts in regard to optimum sowing date for their respective crops without any other apps or extra expenditure.

b. Forecasting pest invasion - United Phosphorous (UPL), in partnership with Microsoft lead to the invention an Artificial Intelligence for predicting pest invasion in helping to forecast and alert the farmers incase of pest or insect (thrips, aphids, hoppers, jassids, whitefly)- takeover in their respective fields. This risk prediction app, helps the farmers to avoid risks and take preventive measures before the pest attack occurs.

c. To understand the role of digital technologies like GPS, GIS and remote sensing systems, the ISRO Ahmedabad, has collaborated with Central Potato Research Farm Station, Jalander

d. With the emergence of new technologies, trading and marketing has been made easier across the globe.

National Agriculture Market in short, eNAM, is an online marketing and trading platform that is designed to allow the online dealing of agriculture and related commodities between the buyers, traders and farmers. Introduced by the Ministry of Agriculture in 2016, this portal deals with existing prices of products and related issues, local markets and for smooth running of the trading industry. Due to the success of this app, several others apps have been developed with collaboration of GOI for the farmers, especially in the rural areas.

Mentioned below are some apps that has transformed the market through cell phones and provided platform for easy trade for agricultural commodities:

Kisan Suvidha

Launched under the leadership of PM, India on 2016 this user-friendly app, designed with wide range of language and provides precise data and facts with figures about weather forecast and price of goods/ services along with cost of seeds, inputs – fertilisers

Pusa krishi

Launched by the Union Agriculture Minister with IARI on 2016, focused to aid the farmers in accumulating reliable data and information about the new inventions related with crop varieties and conserving the soil and maintaining sustainable environment.

Crop insurance

This app is designed to determine and figure insurance premium on fixed crops and providing reliable data on basis of that to the concerned farmer. This app also provides a portal in dealing with premium details, insurance schemes and stake holders.

IFFCO Kisan

Launched under the Indian Farmers Fertiliser Cooperative Limited, is engrossed in assisting the farmers in interact and associate with scientists, field experts and consists a wide range of information about crop, field preparation, disease prevention and deals with market price of commodities. This app also helps to make calls towards kisan call centres for queries.

RML farmer- Krishi Mitr

It is one of the most trusted apps in India, when it comes to agriculture sector. This app keeps the farmers updated in regards to rise of price of commodities or inputs or trade related issues, predicting weather conditions. There is a library consisting of range from 450 varieties of crops, 3500 weather sites, over 50,000 villages across 17 states in the country with preferable language option and easy access to any agriculture related news, with an average rating of 4.3, in goggle play store.

Krishi Gyan

Launched by ICAR, New Delhi, this app functions alike whatsapp, however, it provides farmers to be notified with general news and information and allows them to interact with field experts and scientists related to framing and related issues. There is also a site for farmers to upload their queries and images related to farming or livestock.

Kheti badi

This is a socialising app basically for trading and aims at providing free access to farmers on prices of commodities and inputs and news. It designed to focus on promoting organic farming and also allows a platform for farmers to share their queries and articles within the app. There is also wide range of language available for the farmers for their preference of use with features for both organic cultivation of crops and vegetables.

Agri app

This app provides a platform for farmers to get acquainted with the latest course of agriculture and in sustaining the environment status. It provides access to all data and information related to crop safety, production and help in maintaining soil health. It also allows the farmers to communicate with experts and video conferencing option is also included.

Agri- market

This app was setup by GOI besides Crop Insurance app by the GOI, focuses on providing prices of market products on procuring the location of the user within a range of 50km, the app also provides the latest trends and news in related to agriculture.

An andriod app "MEGHDOOT" under the initiative of IMD and ICAR was introduced to allow the weather prediction- rainfall, relative humidity , wind direction, speed and temperature in their local dialects to farmers in local languages, which is convenient in 150 districts across the country and gives access to images and maps giving clearer image to the farmers. The app also provides crop advisory and gets updated twice a week.

Conclusion

As in the USA, and Europe the development and adoption of precision agriculture in India is a slow process. The small size of farms and fields in most of Indian agriculture limits economic gains from currently available precision farming technology, while the population density, and public concerns for the environment, food safety and animal welfare mean that those potential benefits of precision agriculture are being given more attention.

Improvements in agriculture performance has weak linkage in improving nutrition, the agriculture sector can still improve nutrition through multiple ways: increasing incomes of farming households, diversifying production of crops, empowering women, strengthening agricultural diversity and productivity, and designing careful price and subsidy policies that should encourage the production and consumption of nutrient rich crops.

Diversification of agricultural livelihoods through agri-allied sectors such as animal husbandry, forestry and fisheries has enhanced livelihood opportunities, strengthened resilience and led to considerable increase in labour force participation in the sector. The digitalization of agriculture will cause a significant shift in farming and food production over the coming years. Potential environmental, economic and social benefits are significant, but there are also associated challenges. Smallholder famers and others in rural areas are particularly at risk of being left behind, not only in terms of e-literacy and access to digital resources but also in terms of productivity and aspects of economic and social integration. Launching of new improved technologies may enable generating detailed and more specific information on land and water resources. To facilitate deriving information on crops during the Kharif season, India has proposed to launch a dedicated microwave mission viz., Radar Imaging Satellite (RISAT) with a c-band SAR. These technologies should infiltrate in to agricultural sector at micro level for greater and sustainable benefits.

Role of the funding source
The author is currently a recipient of "National Fellowship and Scholarship for Higher Education of ST Students" from Nagaland University, Nagaland.

Application of research: This investigation will be considerate in understanding the digital era and how it is being helpful to the people in the agricultural sector of our country.

Research Category: Agriculture technology

Abbreviations: GDP: Gross Domestic Product
NGO: Non-Governmental organisation
SWOT: Strength, weakness, Opportunities, threats
ISRO: Indian Space Research organization
IMD: Indian Meteorology Department, SAR: Specific absorption rate

Acknowledgement/Funding: Author are thankful to Department of Agronomy, School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema, 797106, Nagaland, India

***Research Guide or Chairperson of research: Dr A. P. Singh**
University: Nagaland University, Medziphema, 797106, Nagaland, India
Research project name or number: PhD Doctoral seminar (Major)

Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Nagaland, India

Cultivar / Variety / Breed name: Nil

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

References

[1] Kasturirangan K., Aravamudan R., Deeshatulu B. and Joseph G. (1996) *Current science*, 70(7).
[2] Liu A. and Changyao W. (2003) *Geography and Geo-information science*, 19 (4),101-104.
[3] UN DESA (2019) *Population, surface area and density. New York, UN DESA.*
[4] UN DESA (2017) *World Population Prospects: Key findings and advance tables. New York: UN DESA*.
[5] Vaghjiani K. (2018) *Perspectives in the Indian Agriculture Sector. International Conference, Pattaya, Thailand*.
[6] World Bank (2016) *World Development Report 2016: Digital Dividends. Washington, DC: World Bank*
[7] Ceccato P., Fernandes K., Ruiz D. and Allis E. (2014) *Earth Perspectives*, 1,16.
[8] Hakkim A., Abhilash V, Joseph E. and Gokul A. (2016) *Journal of Applied Biology & Biotechnology*, 4 (06), 068-072.
[9] Wagh R. (2007) International Archive of Applied Sciences and Technology, 8 (4), 04-09.
[10] Lang L. (1992) *GPS, GIS, remote sensing: An overview. Earth Observation Magazine*, 23-26.
[11] Davis G., Massey R. and Massey R. (2005) *Precision agriculture: An introduction.*
[12] Batte T. and Buren V. (1999) *Precision farming- Factor influencing productivity. In Northern Ohio Crops Day meeting, Wood County, Ohio, 21 Jan.and VGT Data, vegetation 2000, conference, Lake Maggiore- Italy*
[13] Burrough P.A. and McDonnell R.A. (1998) *Principles of geographic information systems. Oxford University Press. Oxford, UK, pp* 10-16.
[14] Trimble (2005) Precision agriculture. www.trimble.com.
[15] Chen F., Kissel D., Clark R, West L., Rickman D, Luval J. and Adkin W. (1997) *Determining surface soil clay concentration at a field scale for precision agriculture, University of Georgia, Huntsville*.
[16] Bingfang W., Chenglin L. (2000) *Crop Growth Monitor System with Coupling of AVHRR*
[17] Bingfang W. (2004) *Journal of Remote Sensing*, 8 (6), 482-496.
[18] Rao T., Ayyangar S. and Rao N. (1982) *Machine Processing of Remote Sensed Data. Symposium*, 1103-1112.
[19] Haiqi L. (1999) *Journal of China Agricultural Resources and Regional Planning*, 20(3), 55-57.