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Article

Digital Technologies Transforming Indian Agriculture: A Survey

Priyanka G Yadav[1], Vandanadevi R Yadav[2]

[1,2]Thakur Insitute of Management of Studies and Career Development & Research, Mumbai, Maharashtra, India.

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Corresponding Author:
Priyanka G Yadav, Thakur Insitute of Management of Studies and Career Development & Research, Mumbai, Maharashtra, India.
E-mail Id:
priyanka21yadav04@gmail.com
Orcid Id:
https://orcid.org/0000-0002-5827-5408
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A B S T R A C T

As a source of livelihood agriculture remains the largest sector of Indian economy. It provides employment to 58.2% of the population. The social transformation of the country and the economic growth depends on the performance of the agriculture sector. The huge and disparate climatic and crop diversity across India, it is a challenge to keep the farmers informed about the best practices in agricultural processes. The most developed economies have mechanised farming and reduced dependency on rains through state interventions and good planning, Indian farmers still plod along with obsolete

farming techniques to support a growing population. Achieving sustainable agricultural systems will require transformative changes in markets, policy, and science. Internet initiatives for Rural and agriculture development must consider the fact that different regions; organizations and communities have different applications and technical needs. This paper focuses on understanding the concept of digital ag riculture and how it propels the development of Indian agriculture.

Keywords: Agriculture Advancement, Role of Technology, Digitization, Indian Economy

Introduction

Out of 100% approximately 60% Indians derive their livelihood from the agricultural sector. 70% to 80 %of Indian rural population depends on agriculture and allied activities. Integrated forming gives daily income to the formers for sustain. Indian farmers are not getting the yield they expected. Indian Government working more on integrated forming (Dairy, Fishery, horticulture etc.). Indian the limiting factors of farmers in maximizing their farm incomes are access to technology, government endeavour, resources, markets, institutions and services. Farming community is facing lots of problems in maximising the crop productivity. In spite of successful research on new agricultural practices, the majority of farmers are not getting upper bound yield due to several reasons. One of the reasons is that expert scientific advice on crop production and marketing is not reaching the farming community in a timely manner etc. Information and Communication Technology for agriculture is derived frome- agriculture platform. The information need of Indian farmers across the country is varied. Introduction of Information and Communication Technology (ICT) enables the dissemination of requisite information at the right time. This revolution in information technology has made access to the information easy and cost-effective.

Farmer Producer Organizations (FPOs) have also witnessed some amazing growth in the last four or five years, in part building on digital innovations. The number of FPOs is growing at nearly 18 percent per year in India right now. This basically means farmers are realizing the benefits of aggregation—better access to inputs, better market-price realization. One of the biggest challenges of this kind of aggregation of farmers was lack of transparency within that group, and digital has kind of solved it in a way.

There is need to provide efficient and modern technology with low cost incurred and resulting in higher level of production to move form traditional practices. So, by taking this in mind government tried to establish and implement new technological way for the better means of production and enhancing the agriculture output in its several plans to uplift the condition of farmers and agriculture sector. Some of the recent technologies used by the innovative farmers are well define irrigation system, use of pesticides, enriching nutrients of fertility of soil, use of playhouses, multiple cropping etc.

Soil Moisture Sensors

The world, at present is facing shortage of water which is hampering the development of agriculture and hence the food production. Judicious use of water is therefore necessary and in agriculture particularly, optimum use of water is necessary (Munoth et al.,2016) as there is shortage of water in most parts of India. Soil moisture is primary information in achieving optimum water requirements for the crops (Schroder, 2006). The various levels of soil moisture content are shown below in figure 1.As the water infiltrates into the soil, the pore spaces are filled with water and water starts percolating downwards. As this process continues, the soil attains field capacity but the percolation of water continues due to capillary action and gravity. When soil water exceeds the field capacity, the excess water drains out (saturation point). Permanent wilting in this figure indicates the point at which plant shave absorbed all of the available water and they wilt such that they cannot recover (Yontset al., undated). The available soil water holding capacity of soil is different for different types of soils.

Peter set al., 2013 have given the range of available soil water for different soil textures which clearly shows that coarse sand has least available water capacity (0.2-0.8 in/ft) whereas peat mucks has highest available water capacity (1.9-2.9 in/ft). Initially, as the soil water is depleted from field capacity (100% of available water) towards permanent wilting point (0% of available water), plant growth is not affected until the depletion reaches the point of minimum balance (also known as management allowable deficit). Depletion of soil water below this minimum balance leads to yield losses. Hence, care should be taken such that water in the crop root zone retains between minimum balance and field capacity. There are generally two methods of measuring soil moisture, which are Direct inspection (Feel and appearance method, Hand-push probe, and Gravimetric method), and Meters and Sensors (Soil moisture blocks, TDRs, FDRs, etc.) (Evans et al.,1996). The soil moisture sensors are very productive instruments in measuring soil moisture to assess crop growth (Scherer et al., 2013). Soil moisture sensors measure the water content at the root zone and is useful in irrigation scheduling (Clarke et al., 2008), precision agriculture and hydrology (Skierucha et al.,2010), residential gardens, landscapes, rainfall monitoring, environmental testing etc. There are various types of soil moisture sensors available in the market.

Different Types of Sensors

There are numerous types of sensors available today, each having variable performances (Francesca et al.,2010). Some measure soil moisture content while other measure soil water potential and dielectric constant (volumetric content).Although there are numerous techniques available for soil moisture sensing, but in this review the soil water tension based sensors (tensiometers and granular matrix sensors) and soil water content based sensors (TDR, FDR and VH400) are discussed. The nuclear scattering and gamma ray attenuation techniques have not been discussed here as they use radioactive material which may prove to behazardous (McKim et al.,1980).

Tensiometers

Tensiometers are simple soil moisture tension measuring devices used frequently in irrigation scheduling. The figure 2 shows a typical tensiometer which consists of a porous ceramic tip connected to vacuum gauge through a PVC tube. The tube consists of water which should be free from air. The porous ceramic cup is installed into the soil in such a way that soil water pressure is transmitted to the tensiometer which is read by pressure sensing devices mounted on the tensiometer. This instrument do not measure soil moisture content directly, instead it measures soil water tension (Freeman et al., 2004). Generally, the response time of a tensiometer is 2 to 3 hours (Zazueta et al., 1994). There are tensiometers available which can be automated with the irrigation system with the help of pressure gauge.

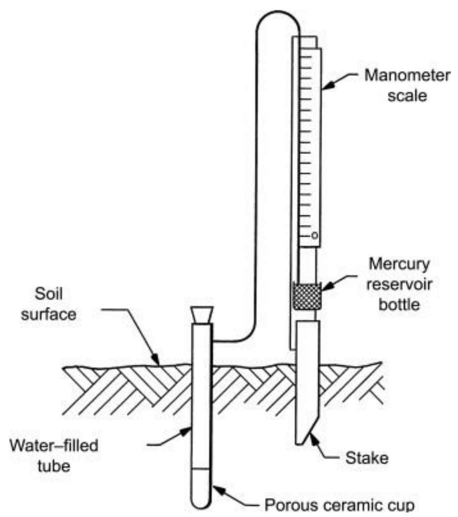

Figure 1

Advantages

- GMS is cheaper and requires less maintenance compared to tensiometer (Shock et al., 1998).
- Automation of irrigation in fields can be achieved (Muñoz-Carpena et al., 2005).
- Negligible change in sensor performance with variation in soil temperature (Irmak et al.,1990).

Disadvantages

- It shows different response to different soil types (Enciso-Medina et al., 2007).
- Sometimes, poor contact between the soil and the sensoroccurs which could cause highreadings which is most likely to occur in heavy soils (Berrada et al., 2014).
- It is less responsive to small rains (<0.5 in.) (Berrada et al., 2014).
- It is low accurate in sandy soils because of their larger particle size (Zazueta et al., 1994).

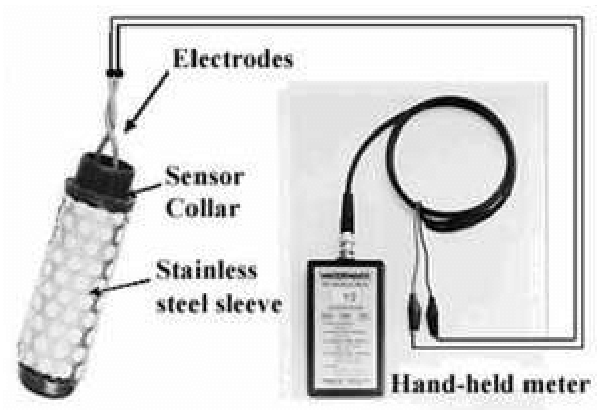

Figure 2.Granular matrix sensor (Model 200 SS)

Granular Matrix Sensor (GMS)

The granular matrix sensor is made of a porous ceramic external shell with an internal matrix structure containing two electrodes as shown in figure 3. The electrodes inside the GMS are imbedded in the granular fill material above the gypsum wafer. The water conditions in the granular matrix change with variation in corresponding water conditions in the soil and these changes are continuously indicated by difference in electrical resistance between two electrodes in the sensor (Berrada et al.2014).This resistance between the electrodes is inversely related to soil water (Irmak et al.,2006).

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Drones in Agriculture

The impact of Technology in agriculture is a positive trend, as it is the solution to feed the teeming population. Food security is a question that needs to be addressed, in the background of environmental degradation, pollution, and water scarcity, and an effective solution is a high priority. This is where usage of Drone can guarantee a sustainable solution.

Drones in agriculture can ignite a big change in improving the efficiency of agriculture. Drones are alternative to lack of skilled human resources and also to other heavy machines and tools. To a very good extent, it is a cheap and economical way to manage farming.

There are several types of drones say, Crop Spraying Drones, NVDI Drones, Seeding Drones, Surveillance Drones for agriculture purpose. These drones are fully automated and can help in improving productivity.

Drones can be used in Agriculture in India but there are several drone laws that needed to be followed, which keeps on changing. The Director General of Civil Aviation has finally announced its policy for remotely piloted aircraft or drones. Set to come into effect from December 1, 2018, the new policy defines what will be classified as remotely piloted aircraft, how they can be flown and the restrictions they will have to operate under.

General India Drone Laws

- Do not fly your drone over densely populated areas or large crowds.
- Respect others privacy when flying your drone
- Do not fly your drone within 5km of airports or in areas where aircraft are operating
- Hurdles before drones in agri-tech take off
- You must fly during daylight hours and only fly in good weather conditions
- Do not fly your drone in sensitive areas including government or military facilities. Use of drones or camera drones in these areas are prohibited
- You must be at least 18 years old and have completed a training course
- All drones must be equipped with a license plate

identifying the operator, and how to contact them
- You must only fly your drone within visual line of sight
- You cannot fly more than one UAV at a time
- Do not fly your drone within 50km of a border
- Do not fly your drone more than 500 meters into the sea, from the coastline
- Do not fly within 5km of Vijay Chowk in Delhi
- Do not fly over national parks or wildlife sanctuaries
- All drones must have liability insurance

The operators have to ensure that they must follow basic drone laws when flying a drone over 250 grams weight. The basic criteria for operating drone is that it has to be done only in daytime. Besides this legal question there are practical problems like skill to use a drone for spraying fertilisers, then the fragmented nature of farms.

Crop Sensors

Crop sensors help apply fertilisers in a very effective manner, maximising uptake. They sense how your crop is feeling and reduce the potential leaching and runoff into ground water.

Instead of making a prescription fertiliser map for a field before you go out to apply it, crop sensors tell application equipment how much to apply in real time.

Optical sensors are able to see how much fertiliser a plant may need, based on the amount of light reflected back to the sensor.

Vision About Modern Agriculture

Nearly everyone working on the future of modern agriculture is focused on efficiency. A wide range of technologies will enable the transition of modern agriculture in the field.

Some technologies will need to be developed specifically for agriculture, while other technologies already developed for other areas could be adapted to the modern agricultural domain such as autonomous vehicles, artificial intelligence and machine vision.

If modern agriculture is applied widely in the near future, millions of farmers will be able to benefit from the acquisition of real-time farm information.

Farmers need not spend significant amount of time on acquiring farm data and will have access to disaster warnings and weather information when a disaster event occurs.

Role of Data Analysis in Agriculture

Application of science and new technologies is currently lacking within this space. Many companies and start-ups are looking to fill this information gap. If Big Data has made serious advancement in fields like information technology, healthcare, education and even sports, there is an obvious need for it in the agricultural industry too.

While the vast majority of farmers and ranchers did great work for maintaining and increasing soil health using conservation practices alone, measurement tools will be instrumental in ensuring a sustainable farming future.

To maintain yields and meet the food demands of a growing population while also protecting natural resources required, making additional changes and data tools can help determine what these changes should be.

The end result of gathering data is to analyse it and come up with actionable solutions with better results. For example, a satellite image of a plot of land has several layers of data embedded into a single spectrum giving us a tonne of information to analyse. The geospatial approach and satellite monitoring of farms have led to major advancement in how farmers and companies make their decisions.

Conclusion

The technology platform will bring the desired outcomes in agricultural sector like reduced costs, improved productivity and quality, improved prices, reduced risks and ultimately sustainable ecosystem. Many software companies (including Microsoft) have entered into agreements with various State Governments in India to help build this digital transformation. This has already seen much progress in Hyderabad, Assam, Karnataka to name a few.

Policies need to adapt to this changing Digital world to ensure that the challenges mentioned above are overcome and lead to increased efficiency in the production, distribution and consumption of agriculture produce.

We have to change the narrative on agriculture towards more diversified high value production, better remunerative prices and farm incomes, marketing and trade reforms, high productivity with less inputs, cost effective, less chemical and pesticide.

There are many challenges at global level such as climate change, geo-political and urbanization. These factors and anti- globalisation is the changing context for agriculture.

To conclude, agriculture is a state subject according to the Indian constitution. States have to play active role along with central government in achieving the three goals of growth, inclusiness and sustainability. Achieving high growth is important.

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