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Digital Farming: A Game Changer in Agriculture

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Abstract

Precision farming practices are now being adopted in order to sustainably feed the world's rapidly expanding population while managing resources effectively. Internet of Things (IoT), artificial intelligence (AI), information and communication technology (ICT), and big data analytics are all used in digital farming to improve precision farming techniques. By making accurate decisions at every step of the food production and supply chain, from the selection of the variety to be planted and the preparation of the land to the marketing of the produce, digital farming permits novel approaches to crop production. This article discusses how digital technologies can be used to improve conventional farming methods.

Keywords: Agriculture 4.0; Digital farming; Big data; IoT; AI; ICT

Introduction

The primary challenge facing the agriculture sector is feeding the world's expanding population while addressing significant issues like climate change and resource depletion. The fields of robotics, nanotechnology, gene technology, artificial intelligence and machine learning, and energy production have all seen significant technical advancements in recent years. A fourth agricultural revolution known as "Agriculture 4.0" is brought about by these new technology (Rose and Chilvers, 2018). It includes a wide range of prospective "future agricultures" or "future food systems" that are distinguished by cutting-edge, revolutionary, and possibly game-changing technologies. The first agricultural revolution, known as Agriculture 1.0, saw hunter-gatherers transition to settled agriculture; the second, known as Agriculture 2.0, was characterised by innovation as part of the British Agricultural Revolution and saw the invention of new tools like Jethro Tull's seed drill; and the third, known as Agriculture 3.0, involved production changes in the developing world with the

Green Revolution (Rose and Chilvers, 2018). Future food and agricultural systems under the new Agriculture 4.0 initiative are already being built, although they have not yet reached full operational capacity. It includes concepts like aquaponics, digital agriculture, bioeconomy, circular agriculture, and vertical farming.

Digital farming is the application of precision farming and smart farming techniques to the internal and external networking of farms and the use of web-based data platforms in conjunction with big data analytics. Precision farming approaches observe, measure, and analyses the needs of each individual field or crop, whereas smart farming approaches use data like geography and the history of production practices for farm management. The phrase "game changer" is used to describe how technologies have the potential to significantly alter how food is produced, processed, exchanged, and consumed.

Digital farming in Indian context

With a US$ 370 billion market value, India's agriculture industry is one of the country's largest economic sectors. The agriculture sector's contribution to GDP has increased from 17.8% (2019-20) to 19.9% (2020-21), as per the Economic Survey report 2020-21. This increase has been brought about over the past few years by government measures to promote and improve the agriculture sector using tried-and-true farming technologies and encouraging regulations. The current advancements in digital farming technology will hasten expansion by ensuring higher crop yields and enhancing sustainability by cutting back on water use and pesticide use. (Anon., 2022).

Digital Agriculture Initiatives in India

It is well acknowledged how important it is to digitalize Indian agriculture, and the necessary steps have also been taken.

Mr. Narendra Singh Tomar, the Union Minister of Agriculture & Farmers Welfare, launched the Digital Agricultural Mission 2021–2025 in September 2021 and signed five Memoranduums of Understanding (MoUs) with companies like Cisco, Ninjacart, Jio Platforms Limited, ITC Limited, and NCDEX e-Markets Ltd (NeML) to advance the agricultural field through pilot projects. The goal of the Digital Agricultural Mission 2021–2025 is to fund projects based on cutting-edge technologies including artificial intelligence (AI), block chains, remote sensing and GIS, as well as the utilisation of drones and robotics.

The Ministry of Agriculture & Farmers Welfare has developed major digital applications in order to boost technology adoption among farmers: -

- **National Agricultural Market (e-NAM):** e - NAM is a pan-India electronic trading portal launched in April 2016. It creates a unified national market for agricultural products by linking all the agricultural produce market committees. e-NAM helps farmers to gain higher returns by eliminating middlemen in the supply chain.
- **Direct Benefit Transfer (DBT) Central Agri Portal**: - It is a unified portal for agricultural schemes, launched in January 2013. It provides farmers access to farm machinery through government subsidies

In June 2021, the Ministry of Agriculture and Farmers Welfare signed an MoU with Microsoft to run a pilot program for 100 villages in 6 states. The government aims to create a unified platform to provide end-to-end services to farmers across the food value chain through Microsoft cloud computing services. It is made possible by creating unique farmer IDs across the country (Anon., 2022).

Why is digital farming important?

Digital farming can revolutionize agriculture by improving efficiency, sustainability, and profitability by:

- Increased efficiency: Digital farming technologies such as GPS, drones, and sensors can help farmers monitor crops, soil, and weather conditions more accurately and efficiently. It allows farmers to make right decisions on operations like time of irrigation, fertigation, and pest control based on the expert advisories received.
- Improved sustainability: Digital farming optimizes the resource (fertilizer, water, and pesticides) use efficiency and thereby reduces its impact on the environment. By using the field data, target sites can be treated with the specific quantity of the input, thereby avoiding excess application of the inputs.
- Enhanced crop quality: Digital farming technologies optimize crop growth by monitoring factors such as soil moisture, nutrient levels, and plant health. It leads to a better quality of crop produce and higher yields.
- Better risk management: Digital farming technologies can help farmers manage risk by providing real-time data on weather patterns, crop conditions, and market prices. This allows farmers to adjust their farming practices in response to changing conditions and make right decisions about planting, harvesting, and marketing the produce.
- Increased profitability: By increasing efficiency, reducing waste, and optimizing crop quality, digital farming can help farmers increase their profitability. This is especially important for small-scale farmers who may have limited resources and face economic challenges. Digital farming can help these farmers compete more effectively in the market and improve their livelihoods.

Components of digital farming

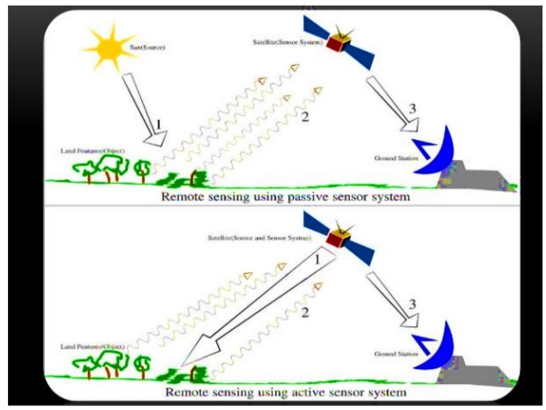
Digital farming includes components like remote sensing, GPS, GIS, artificial intelligence (AI), internet of things (IoT), big data analytics and information and communication technologies (ICT).

Remote Sensing

It is the acquisition of information about an object or a phenomenon without coming in contact with it, by using EM radiations.

The term "remote sensing" generally refers to the use of satellite or aircraft based sensor technologies to detect and classify an objects on Earth, which includes the surface and the atmosphere and oceans, based on propagated signals (electromagnetic radiation). Remote sensing is classified as "active" remote sensing (when the source of light is satellite or aircraft) and "passive" remote sensing (when the source is the Sun)

Working of remote sensing in agriculture



The light energy travels in the form of waves from the sun to the Earth. The distance between the peak of one wave to the peak of the next wave is known as wavelength. The energy emitted from the sun is known as electromagnetic energy and is part of the electromagnetic spectrum. Only a small part of the electromagnetic spectrum is used for agricultural applications. When electromagnetic energy hits the plant during hyperspectral remote sensing, the energy is reflected, absorbed, or transmitted depending on the wavelength of the energy and the characteristics of the plant itself. The reflected, absorbed, and transmitted energy can be detected by remote sensing technology.

Applications of remote sensing in agriculture

- Crop monitoring
- Soil management
- Precision agriculture
- Yield forecasting
- Land use planning

Global Positioning System (GPS)

"It is a satellite-based navigation system that provides location and time information anywhere on or near the Earth." The GPS system uses a network of at least 24 satellites orbiting the Earth to triangulate the position of GPS receiver on the ground. These technologies integrate real-time data gathering with precise location data and allows fast processing and analysis of massive amounts of geospatial data. Most importantly, the technology is now accessible to anyone with a smartphone equipped with a GPS chip.

Applications of GPS in agriculture

- The receivers collect location data to map field boundaries, roadways, irrigation systems, and problem areas in crops such as weeds or disease.
- Farmers may construct farm maps with specific acreage for agricultural areas, road locations, and distances between points of interest.
- Year after year, it allows farmers to precisely navigate to particular spots in the field to take soil samples or monitor crop conditions.
- Yield monitoring
- Tracking of live stock

Geographic Information System (GIS)

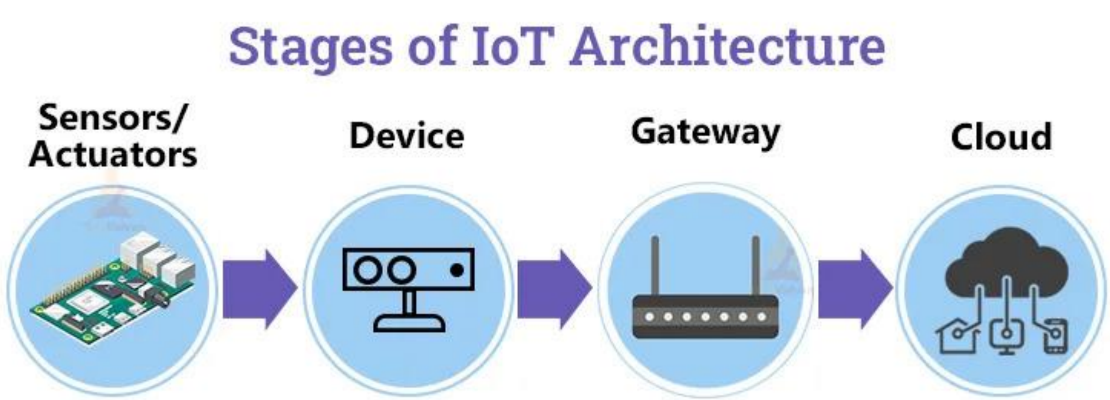
It is a system that captures, stores, manages, analyses and displays geospatial data. Acquisition of GIS data can be grouped into three categories: primary data capture, the direct measures of data collection from the field (e.g., remote sensing, the global positioning system); secondary data capture, the extraction of information from existing sources that are not in a GIS form (e.g., paper maps, through digitization); and data transfer, the copying of existing GIS data from external sources such as government agencies and private companies.

Applications in agriculture

- Agricultural mapping
- Soil analysis
- Precision farming
- Historical data comparisons

Internet of Things (IoT)

IoT is the network of physical devices. This system has ability to transfer data over a network without requiring human to human or human to computer interaction. It will improve the functionality of existing tools by making physical world a part of the information system.



IoT devices like drones, soil moisture sensors, air humidity sensors, temperature sensors and UV sensors collect field data and send it to cloud, where the information is stored, through gateway like wi-fi.

Applications in agriculture

The Internet of Things (IoT) has revolutionized many industries, and agriculture is no exception. IoTs are used in agriculture in:

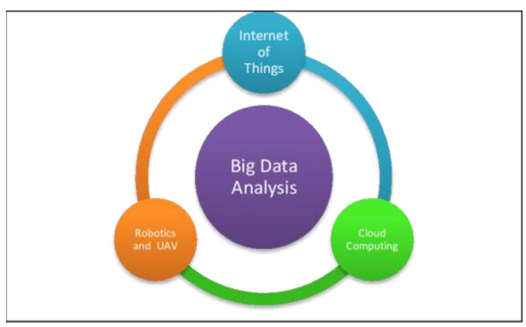
- **Precision Agriculture:** IoT is being used to make farming more precise and efficient. Sensors can be placed throughout fields to measure environmental factors like soil moisture, temperature, humidity etc. This data can be used to improve input use efficiency, resulting in higher yields and lower costs.
- **Monitoring Livestock:** sensors are used to track the livestock and also to monitor their health. This prevents the spread of diseases among the herds.
- **Monitoring Greenhouses:** IoT sensors are used in smart greenhouses to monitor and control environmental factors like temperature, humidity etc. It adjusts the conditions in greenhouse to optimize plant growth.
- **Management of Supply Chain:** IoTs are used to track produce throughout the supply chain, from the farm to the store. This can help prevent spoilage and reduce waste.
- **Crop Monitoring:** IoTs can be used to monitor crops remotely, using drones or satellites. This can help farmers detect problems such as pests or disease earlier, and take action to prevent crop losses.
- **Weather Monitoring:** real time monitoring of climate is possible using IoTs, which helps farmers make better decisions about time of planting and harvesting.

Big data

Big data technologies play a vital role in the digital agriculture revolution. In digital agriculture period, while machines are equipped with all kinds of sensors to gauge data in their surroundings, deep learning algorithms and machine behaviours can be generated as a result of analysis of these data. Big data is complements of techniques that require integration forms to distinguish unrecognized values from large scale, various and complex data sets. Big data enables farmers to view all production parameters of real-time operations and improve decision-making processes.

Three data collection methods in big data:

1. Process oriented: data derived from traditional operating systems like traditional agricultural practices.
2. Machine generated: It is the data derived from intelligent machines and sensors used to control various agricultural activities. This data ranges from simple sensor records to complex data like computer logs (Hashem, 2015).
3. Human sourced: The data derived personal experiences like social media, personal blogs and comments, pictures and videos are accepted in this category (Devlin, 2013)



Enormous amount of information collected from different sources like sensor data, social networking data and business data is called big data. The analysis of this data in agriculture by using multivariate statistics and machine learning algorithms is called big data analysis.

Cloud computing is the basic infrastructure that delivers computing services, including servers, storage, database, networking, software and analytics over the internet. Through cloud computing, large-scale data can be stored with low investment cost and instant access to this data becomes possible (Lakshmisudha *et al.*, 2016).

Artificial Intelligence (A. I)

Artificial intelligence is a simulation of human intelligence by machines in solving a problem, using tools like machine learning and expert systems. As shown in Fig. 1, machine learning is a subset of AI. Machine learning can be used as a technique to recognise, handle, and analyse data gathered from diverse sources. The study of artificial intelligence is crucial to modern agriculture. Due to its quick technological improvements and usefulness in problem-solving, especially for those that can't be adequately addressed by conventional computing techniques, this technology is becoming more and more important (Sharma, 2021). The term artificial intelligence (AI) refers to the ability of machines to think, understand their surroundings, and make choices that increase their chances of success. When combined with other technologies, including as robots, automated tractors, the Internet of Things, etc., AI has the potential to be a real game changer because it ensures complete automation of farming activities.

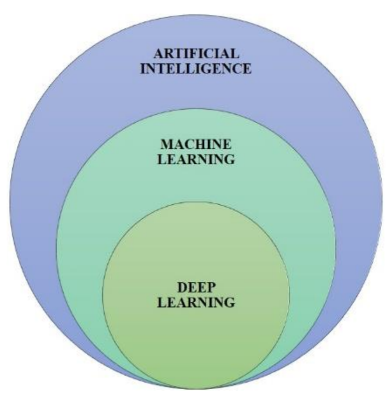


Fig. 1: subsets of AI

A.I when used with bid data and IoT helps in

1. Analyzing the market, predicting prices, and predicting the best time for sowing and harvesting.

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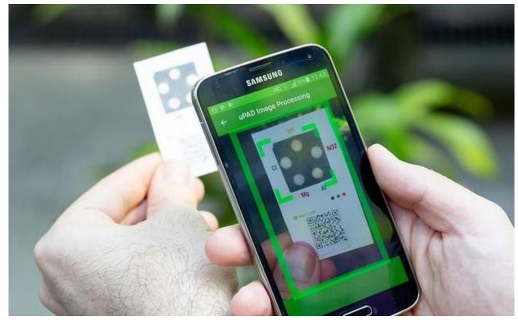
2. Offers real-time field insights that make it possible to locate areas of irrigation, fertigation in field and also in vertical farming operations.
3. It deals with the issue of labor shortage.
4. Real-time information enables farmers to make wise decisions.

Information and Communication Technology (ICT)

A computer-based programme called Agricultural Information Systems (AIS) contains information on agriculture and assists the farmer in making wise management choices (Singh et al 2015). The ICTs are the gadgets, such as televisions, mobile phones, radios, laptops, and tablets that provide people with access to agricultural information (Munyua and Adera 2009; Pande and Deshmukh 2015). ICT refers to any hardware that enables information exchange between a specialist and a user.



Classification of ICT's:

1. Traditional ICTs –Radio, Television, Print media
2. New ICTs –Internet, Portals, Call centers, Mobile, Community radio, Video.

Advantages and disadvantages of digital farming:

Advantages: -

1. Improved decision making
2. Community involvement
3. Reduced risk of crop failure

Disadvantages: -

1. Inadequate Infrastructure
2. Small size and Fragmented plots
3. Technical problems with respect to devices

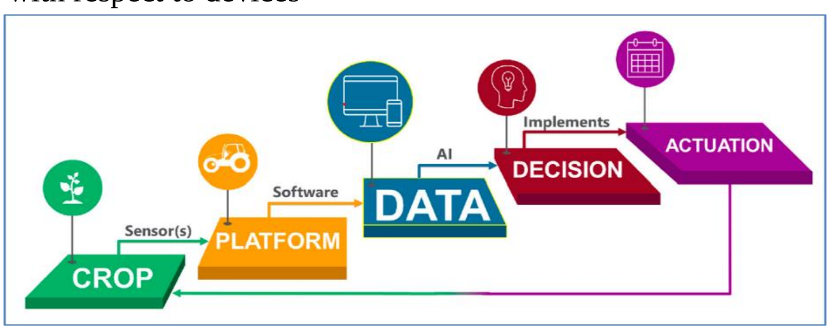


Fig. 2: Information-based management cycle for advanced agriculture

Here, Fig. 2 represents the process of application of internet of things in field i.e., first sensors are used to collect data from the crop or field, then the collected data is stored in a software for analysis. The data is analysed to make appropriate stite specific decision by using artificial intelligence. Then these decisions are actuated in the field (Rubio *et al*., 2020)

Conclusion

With the digitalization of agriculture, the world is currently experiencing yet another revolution in agriculture that makes use of contemporary technologies. To increase food output, food quality, and farm activity efficiency, digital farming integrates cutting-edge technologies into traditional agricultural processes. The severe workload of farm operations is reduced thanks to the sophisticated tools, which improves the calibre of work. The vast amount of farm data gathered and evaluated will aid the farmer in making precise decisions for increased agricultural output. Digital farming represents a holistic method of farming, when combined with big data analytics, directs farmers from the time they plant their seeds to the time they market their harvest. It is a game changer when it comes to dealing with concerns like population growth, climate change, and labour issues related to field operations from sowing of to harvest of crop.

References

Anonymous https://www.ibef.org/blogs/digital-agriculture-the-future-of-indian-agriculture

Anonymous, 2022, https://www.indiabudget.gov.in/economicsurvey/.

Devlin, B., 2013. *Business UnIntelligence: Insight and Innovation Beyond Analytics and Big Data*. Technics Publications, New Jersey, 151

Hashem, I.A.T., Yaqoob, I., Anuar, N.B., Mokhtar, S., Gani, A. and Khan, S.U., 2015, The rise of "big data" on cloud computing: Review and open research issues. *Info. Sys.*, *47*: 98-115.

Lakshmisudha, K., Hegde, S., Kale, N., Iyer, S., 2016, Smart Precision Based Agriculture Using Sensors. *Int. J. Comput. App*., 146(11): 36-38.

Munyua, H. and Adera, E., 2009. Emerging ICTs and their potential in revitalzing small-scale agriculture. Agricultural information worldwide, 2(1): 3-9.

Pande, N. and Deshmukh, P., 2015. ICT: A Path towards Rural Empowerment through Telecommunication, Egovernance, and E-Agriculture. *IBMRD's J. Manage. Res*., 4(2): 47-54.

Rose, D. C. and Chilvers, J., 2018, Agriculture 4.0: Broadening responsible innovation in an era of smart farming. *Front. Sustainable Food Syst.*, 2: 87.

Rubio, V. and Rovira-Más, F., 2020, From smart farming towards agriculture 5.0: A review on crop data management. *Agron.*, 10(2): 207.

Sharma, R., 2021, Artificial intelligence in agriculture: a review. *5th Int. Conf. Intell. Comput. Control Syst.*, 937-942. IEEE.

Singh, V., Sankhwar, S. and Pandey, D., 2015, The role of information communication technology (ICT) in agriculture. *Global J. Multi-discip. Stud.*, 3(4): 2-10.