Digital Agriculture: The Future of Farming in Indian Agriculture Sector

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Abstract: In India mainstream of the populace livelihood is agriculture which cannot ever be undervalued. The nation’s GDP growth of about 16.5% were contributed by India’s agricultural sectors. In financial year 2019, the overall contribution of agriculture and connected operations stood INR 27.56 lakh crore active from the previous year’s INR 20.93 lakh crore. India stood ninth major trader among others in trading abroad the agricultural product in FY 2019 having a worth of USD 37.4 billion, considered from for about 12.6% of India’s total merchandise exports.

In initial stages in India plentiful stages such as AI, cloud computing and like skills in the field of varied agricultural operations of agro value chain are present. Presently around USD 204 million is a face value of the agritech market in India, which comprises AI-based agri innovation start-ups, which is around 1% of the presently addressable market opportunity worth USD 24 billion. Investment activity in India is primarily dominated by supply chain and output market linkage AgTech. A mixture between AI technology and the social and policy dimensions of the Indian agriculture sector will help in socially embedding this enabler and realising the sector’s full potential.

Keywords: Digital Agriculture, Artificial intelligence, Drone Technology, IoT & ML

I. INTRODUCTION

Its predication about populace to be spread to 9.6 billion by year 2050, which will cause a raise of food demand even as arable terrestrial and freshwater resources are lessening hastily. Consequently, it becomes relevant to adapt technological progression in the agriculture sector and Digital agriculture is a crucial answer to the rising problem. The Internet of things (IoT), artificial intelligence (AI), machine learning (ML), nano technology all are attaining fame with Industry 4.0. India secured Rank 1 in production of milk, jute and pulses and secured rank 2 in producing wheat, rice, groundnut, vegetables, fruits, cotton and sugarcane when agricultural making is anxious. One of the chief sector in Indian economy is the agriculture sector, which presently appreciated at US$ 370 billion. Conferring to the Economic Survey in year 2020-21, the GDP influence through the agriculture sector is probable to be 19.9%, cumulative from 17.8% which is recorded in 2019-20. India is the country which have plenty of arable land with 15 agro-climatic zones as defined by ICAR, having nearly all kinds of weather circumstances, soil kinds and capable of budding a diversity of yields. From years to years, administration has booked chief stages to assistance and improve the agriculture sector through confirmed agricultural skills and helpful strategies. The current progress of digital skill in farming will more hasten development by safeguarding developed crop yields and improve sustainability by reducing liquid ingesting and the practice of agrochemicals.

II. OBJECTIVE OF STUDY

1. To build trust and transparency through quality and traceability;
2. To analyses of transformational Innovations in Indian agriculture
3. To find out the challenges and opportunities of uses of IoT, AI/ML and agri-drones in India

III. DIGITAL AGRICULTURE

Digital agriculture is fundamentally a usage of digital technologies to assimilate agricultural production from the meadow to the buyer. These technologies can provide the agricultural industry with tools and information to make more informed decisions and improve productivity. The progression of
Digital technologies, such as artificial intelligence (AI), machine learning (ML), remote sensing, big data, block chain and IoT, are altering agricultural value chains and renovating processes. Whereas Netherlands, US, Australia and Israel, have effectively accepted and exploited digital answers to revolutionise agriculture, but in India digital technologies implementation is still in its beginning.

**Technological Connectivity’s potential for value creation in agriculture:**

*Figure 1: Technological Connectivity’s potential for value creation*

- **Smart Crop Monitoring:** To advance the observation and to screen the corps a diversity of ways are offered by connectivity. By forecasting and recognizing the insufficiencies more precisely Integrating weather data, irrigation, nutrient, and other systems improve resource use and boost yields.

- **Drone Farming:** This is based on image analysis and connected sensors which is communicating data with the drone. The major aim of this is to provide more frequent, cost-effective remote monitoring of large areas which enable the remote interventions. The drone farming boosts the yield and reduce the losses from pests and optimise the deployment costs.

- **Smart-livestock monitoring:** This is used to take care of animals by individual feeding and care plans which is based on connected body sensors data movements and tracking. The aim of smart livestock monitoring is to detect illnesses early and providing each animal with its optimal feed and medicine mix to maximise growth.

- **Autonomous-farming Machinery:** Self operated machines and robots perform majority of work by interventions using connected sensor data, GPS data and imagery analysis. The aim of autonomous farming is to optimise the resource usage, reduction in labour requirements and boosting yield through individual involvements.

- **Smart-building and equipment management:** Through this technology it provides rigid maintenance and real time environmental adjustments. The aim of this technology is to improve the performance and extend the useful life of farm equipment and other assets as well as decreasing risk of mould, fire and other threats.

**IV. TRANSFORMATIONAL INNOVATIONS IN INDIAN AGRICULTURE:**

*Figure 2: Transformational Innovations in Indian Agriculture*

There are so many transformations happen just because of the technology in Indian agriculture. The agriculture work is conducted in two phase ie. Pre-harvesting & post harvesting.
1. Pre-harvesting

Prior to plant seed it become necessary to understand the fertility capabilities of the soil. In traditional agriculture, the farmers plant the crop as so many people plants or whatever their forefathers have done. But due to AI technology, now the farmers are able to understand the type of soil, which yield is suitable. When to sow a seed & all so decision-making process become easy for farmers. Now, they are able to understand which plant need to be planted & when to be planted. Using data analytics and technology, it become easy to understand the production cost, as farmers are well are about the yield volume and quality.

With the help of IoT & analytical tools it become easy to understand when to harvest & how to harvest. In traditional agriculture, farmers face lots of problems due to weather & hence the harvest the yield before it grains.

2. Post-harvesting

There are 3 steps in post harvesting where innovations and technology play a very vital role.

Pricing is the main concern of farmers & AI & machine language tools farmers are able to predict & quote accurate price for their yield. With the help of GPS & Image recognition, farmers are able to tract the transportation of the yield & check time to time weather it was in good condition or not. Block chain technology helps in transportation of the yield. Through these innovations, now farmers are getting good price and market for their yield crop.

V. CURRENT INITIATIVES UNDER DIGITAL AGRICULTURE IN INDIA

The demand for digitisation in Indian agriculture is well understood and acknowledged, likewise efforts have also been made towards digitising the prevailing value chain.

In September 2021, the Union Minister of Agriculture & Farmers Welfare, Mr. Narendra Singh Tomar, announced the initiation of the Digital Agriculture Mission 2021–2025, while signing five memorandum of understandings (MoUs) with CISCO, Ninjacart, Jio Platforms Limited, ITC Limited and NCDEX e-Markets Limited (NeML), to forward digital agriculture through pilot projects. The Digital Agriculture Mission 2021–2025 aims to support and accelerate projects supported new technologies, like AI, block chain, remote sensing and GIS technology and use of drones and robots.

Cisco developed an Agricultural Digital Infrastructure (ADI) solution in August 2019, that enhances farming and knowledge sharing. This ADI is probably going to play a vital role in the data pool that will be created by the Department of Agriculture under the National Agri Stack. The pilot program for this initiative will take place at Kaithal (Haryana) and Morena (Madhya Pradesh).

The Jio Agri (JioKrishi) platform launched in February 2020, digitises the agricultural ecosystem along the whole value chain to empower farmers. The core function of the platform uses stand-alone application data to supply advisory, the advanced functions use data from various sources, feed the info into AI/ML algorithms and provide accurate personalised advice. The pilot program for this initiative will take place at Jalna and Nashik (Maharashtra).

ITC has proposed to make a personalized ‘Site Specific Crop Advisory’ service to turn conventional crop-level generic advice into a personalised site-specific crop advisory for farmers, employing a digital crop monitoring platform, hosted on ITC’s e-Choupal 4.0 digital platform. The pilot program for this initiative will take place at Sehore and Vidisha (Madhya Pradesh).

The Ministry of Agriculture & Farmers Welfare has developed major digital applications so as to boost technology adoption among farmers:

- National Agriculture Market (eNAM): - Launched in April 2016, the National Agriculture Market (eNAM) may be a pan-India electronic trading portal that links the existing Agricultural Produce Market Committee (APMC) mandis, to make a unified national market for agricultural commodities. eNAM helps farmers sell products without the interference of any brokers or mediators, by generating competitive returns from their investment.

- Direct Benefit Transfer (DBT) Central Agri Portal: - Launched in January 2013, the DBT Agri Portal may be a unified central portal for agricultural schemes across the country. The portal helps farmers adopt modern farm machineries through government subsidies.

In June 2021, The Ministry of Agriculture and Farmers Welfare signed an MoU with Microsoft to run a pilot programme for 100 villages in 6 states. Under the MoU, Microsoft will create a ‘Unified Farmer Services Interface’ through its cloud computing services. this is often a major part of the ministry’s future
plan to create ‘AgriStack’ - a unified platform to provide end-to-end services across the agriculture food value chain to farmers. For this the govt is planning to create unique farmer IDs for farmers across the country to integrate it with various government schemes and create digital agricultural ecosystems.

VI. FUTURE OF DIGITAL AGRICULTURE IN INDIA

The future adoption of digital agriculture in India is anticipated to nurture under the Public-Private Partnership (PPP) mode.

Application of Digital Agriculture : Technological interventions supported remote sensing, soil sensors, unmanned aerial surveying and market insights, etc., permit farmers to collect, visualise and assess crop and soil health conditions at different stages of production, during a convenient and cost-effective approach. they will act as an initial indicator to identify potential challenges and provide options to deal with them in a timely manner.

Artificial Intelligence/Machine Learning (AI/ML) algorithms can generate real-time actionable insights to assist improve crop yield, control pests, assist in soil screening, provide actionable data for farmers and reduce their workload.

Blockchain technology offers tamper-proof and precise data about farms, inventories, quick and secure transactions and food tracking. Thus, farmers don’t need to be dependent on paperwork or files to record and store important data.

VII. BENEFITS OF DIGITAL AGRICULTURE

Implementing these technological solutions enable reliable management and monitoring of farms. As farmers get a complete digital analysis of farms in real-time, they can act accordingly and don’t have to apply excess pesticides, fertilizers and reduce overall water consumption.

Other benefits include:
- Increases agriculture productivity and lowers production cost
- Inhibits soil degradation
- Lessens chemical application in crop production
- Promotes effective and efficient use of water resources
- Uplifts socio-economic statuses of farmers
- Reduces environmental and ecological impacts
- Augments worker safety

VIII. CHALLENGES AND OPPORTUNITIES

Despite the very fact that technology can revolutionize the agriculture sector, a scarcity of technical knowledge among farmers to use the technology-led machinery is a major challenge in the ecosystem. the simplest way to tackle this is to keep the farmers in mind while developing the systems. The designers have to focus on the user interface in the case of digital products and providing solutions in local languages are the possible ways to overcome the challenge. the standard and cost of the devices and sensors are major concerns for small scale farmers, to adopt the advanced technology. The reliability of the system also has paramount importance in IoT solutions. the choice made using the decision support systems directly impacts the agriculture practices so any threats to the operation or failure of any component will lead to reliability issues. Regarding the info management and security of the general IoT applications, being a network of small objects which are cosmopolitan, IoT systems have very limited resources in terms of their processing and storage. Proper data management strategies are to be used to make the most out of these resource constraint networks. Since the IoT devices are heterogeneous, interoperability is extremely crucial and the devices need to be in proper synchronization for a better operation. The presence of multiple vendors and an outsized number of devices make this a difficult task. the info from the IoT devices are increasing day by day and horizontal scaling will be required at any point in time (Villa-Henriksen et al., 2020). The heterogeneity of the info from the devices is also a major challenge that has been addressed by researchers, because the data can be structured, semi-structured, or maybe unstructured. The system should be ready to handle and process all forms of data. Designing cloud-based architecture for IoT applications are often used to tackle this challenge as the cloud service can provide immense computing power, huge storage capacity, and is very scalable. Also within the case of AI algorithms, the standard and quantity of data decide the quality of decision making. Getting an enormous volume of quality data is a big concern for building AI-based models.
Fig. shows five major challenges within the adoption of IoT and analytics solutions and it is clear that security is a major concern among all (Bosche et al., 2018). The agriculture solutions cater to very less personal data as compared to other health care and military applications. Still, the farm and crop information is skilled a channel, there are high chances for a security breach. The communication delay is another major area that must be focused on. Since IoT solutions are targeted to figure in real-time, the messages and knowledge passed to the end user should reach them on time. Any delayed information are going to be of no use as the user has to act on it spontaneously.

**Figure 3: Top 5 barriers in the adoption of IoT/analytics solutions**

IoT and AI systems are continuing to grow and they enhance the opportunities for increased value creation and capture. Despite all the challenges, they are expected to contribute in future to make agriculture automated and smart. There are opportunities for these technologies in transforming the agriculture activities. The evolution of 5G technology will be pivotal in enhancing the opportunity of the Internet of things in the upcoming years. 5G is having a hundred times better capacity than 4G networks and this can incredibly contribute to increased internet speed. Since the communication delay is a constraint of current IoT systems, this will be solved by the evolution of 5G, wherein the response can be obtained faster than the blink of an eye. The sensors and embedded technologies will continue to be cheaper and widely available in the future and will make IoT very promising in the future. The growth of Artificial intelligence and advanced algorithms fuel up the decision making of smarter applications.

**IX. GRAPHICAL VIEW**

**Artificial Intelligence (AI) Market in Agriculture- Growth Rate by Region (2019-2024)**

*Figure 4: AI Market in Agriculture-Growth Rate by Region*
Implementation of Digital Agriculture in India

The main factor behind the gradual acceptance of digital farming in India is the prominence of segregated small-holder farms in the country, this complicates data gathering. Additionally, limited penetration of mechanisation tools and frequent natural calamities, like droughts, floods and excessive monsoon rains, have negatively impacted the deployment of digital solutions in the sector. Thus, a customised approach would be needed to implement digital agriculture to a typical Indian small farm, this can be later be scaled up and made available to many Indian farms. Following measures could be implemented to make digital agriculture a success in India:
Figure 6: Measures to make digital agriculture a success in India

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<th>Measures to make digital agriculture a success in India</th>
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<tbody>
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<td>Low Cost Technology</td>
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<tr>
<td>Portable Hardware</td>
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<td>Renting &amp; Sharing for agriculture equipment &amp; Machinery</td>
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<td>Academic Support</td>
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Low cost technology: This low income explains the precarious financial circumstances during which a typical farmer operates in India. Thus, lowering the value of technology will help.

Portable hardware: As typical Indian farms are small, plug and play hardware features a better opportunity in the Indian market. Also, agricultural land leasing is widely prevalent under various farming arrangements, therefore a farmer farming on a selected plot of land may move to another farm plot next season. In such scenarios, investing in portable equipment is best for farmers.

Renting and sharing platforms for agriculture equipment and machinery: Due to both constrained financial resources and small farm plots, opportunity exists for digital platforms that provide equipment renting and sharing services instead of outright purchases. Some agritech start-ups like Farmkart (rent4farm), EM3 AgriServices and Trringo, are already providing equipment rental services.

Academic support: The local agricultural organisation and academic institutes regularly interact with farmers through various locally conducted programs and government initiatives. Training facilities provided by various academic institutes and agricultural organisations will improve digital adoption among farmers.

X. CONCLUSION

Artificial Intelligence and Internet of Things are contributing significantly in the area of modern agriculture by controlling and automating farming activities.

Data generated by various sensors are of paramount importance and need to be managed and analysed using machine learning and deep learning based approaches to foresee upcoming challenges in farming practices.

As the Indian Agriculture and Allied sector is on the verge of adopting modern technologies, like IoT, AI/ML and agri-drones for unmanned aerial surveying, Indian and foreign agritech players can play an important role in supplying these advanced technologies to farmers. Currently, there are few players within the market, but catering to ~267 million farmers during a country exhibits a huge opportunity for private and foreign entities to expand their footprint in the country. However, influential factors which will define the success of digital agriculture in India are technology affordability, simple access and operations, easy maintenance of systems and supportive government policies.

Adopting a holistic ecosystem approach to deal with challenges faced by the Indian agriculture sector is of national interest, to realize objectives, like doubling farmer incomes and sustainable development. Thus, a multi-stakeholder approach are going to be required for the wide-scale adoption of digital agriculture in India, with the govt playing a key enabler’s role in the ecosystem.

BIBLIOGRAPHY


