An Overview of Indian Agricultural Sector in Digital Age

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Abstract

Agricultural modernization might be a potential remedy for feeding a rapidly rising population. Big data is a crucial instrument for digitalizing the farming sector. Despite a protracted dispute over its relevance to agriculture, the goal of this research is to see how big data technologies may help with appropriate farming systems. The research paper employs a comprehensive overview of recent agricultural research and evidence to identify the best and most consistent practices that can assist farmers at the grassroots level in ramping up production, maintaining efficiency, and ultimately enhancing their financial situation to improve their standard of living. This research identifies several big data tools and approaches in agriculture that can be used to address present and future difficulties in the area. According to the assessment, the use of big data technology in farming is increasing, although still at a minimal concentration. It also looks at how agricultural productivity, crop preservation, livestock farming, aquaculture, post-harvest handling, and marketing strategy are all affected by technology. The report identifies many obstacles, including personal data, accessibility of information, accuracy, and flexibility, capital investments, inadequate knowledge, and perspective innovation. According to the report, widespread use of agricultural big data technology would necessitate policy interventions, public-private cooperation, data availability, capital financing, and area base investigation.

Keywords

Digital agriculture, Big data, Sustainable agriculture, Precision farming, Artificial Intelligence (AI), and Drone technologies.

1. Introduction

Digital agriculture is a type of agriculture that employs current technology to achieve long-term crop, fishery, and livestock growth. For the shift from traditional agriculture to contemporary agriculture, modern agricultural techniques use digital technologies. The move from classical to digital farming necessitates a massive quantity of data from practically every step of crop, fishery, and animal production. Digital agriculture has evolved into a thorough strategy that integrates data science, atmospheric technology, computer and software

technology, structure science, GIS (Geographical Information System), GPS (Global Positioning System), remote sensing innovations, and simulated aerial photography to improve soil, climate, and ecologic assimilation with agriculture (Schuster.J.2017). Digital agriculture is a key to farm information and communications technologies and better agricultural production methods, especially in rural areas (Shi-Wei-2011). Increased population and family income levels contribute to increased demand for food and other agricultural goods, putting the country in a vulnerable position. Experts anticipate that as the world's population continues to climb, it will reach 9 billion people by 2050. To feed this larger, more urbanized, and richer population, the agricultural output must increase by 70 percent (Ayed and Hanana 2021). The only option to enhance targeted food production is to include contemporary sophisticated technology in every phase of agricultural production, such as artificial intelligence (AI) and drone technologies (DT) (Van and Woodard 2017). In the future, digital agriculture will help farmers meet their expanding food demands. Big data solutions are instruments for collecting a large number of data sets at a low cost, promoting additional perspective, sustainable, and economic agriculture. As a result, advances in information and technology are not limited to the service and knowledge industries as a component of a solution or for smart work. These technologies may also be used in agriculture to solve a variety of problems and to advance the smart agricultural situation in the country and throughout the world. Artificial Intelligence and Drone Technology are two developing digital era paradigms that are being debated. This research focuses on certain digital technologies that can assist farmers and other stakeholders in sustainably managing agricultural farms. As a result, the purpose of this research is to see if the application of big data for sustainable farm management through a digital agricultural strategy is feasible. The research will aid in the creation of policies and programs related to farmer capacity building for long-term agricultural development using innovations.

2. Objectives of the Study

The chief objective of this paper is to study the impact or influence of technological innovations on the agriculture sector, which is the "digital age of agriculture." This main objective is divided into three sub-objectives, which are as follows:

2.1 To know the importance and application of technology in agriculture.

2.2 To identify initiatives taken by union governments and various state governments to digitalize the agricultural sector.

2.3 To evaluate the response of rural agriculturists towards the digitalization of agriculture.

3. Research Methodology

This study is based on both primary and secondary data. The first two objectives are performed on secondary data, and by thorough academic evaluation of the literature. The study searches the literature for recently published research papers using keywords like "big data," "agriculture," "digital," "precision agriculture," "smart farming," "artificial intelligence," and "drone technology" in reputable databases like Web of Science, Scopus, Springer, Emerald, and Google Scholar. Journal articles, working papers, book chapters, magazine articles, and books linked to digital agriculture and tech innovations have been evaluated to determine the appropriateness of using technologies in agriculture and the initiatives of policymakers. The final objective, which is to evaluate the response of rural agriculturists towards the digitalization of agriculture, is performed on primary data. To collect the Primary data simple random sampling (probability sampling) method was used. And data was collected through interviews of Farmers with a set of a questionnaire carried out in the North Karnataka region. This is the Northern part of Karnataka State, India. This includes 13 districts, 110 taluk places, and 309 hobbies. From each hobbies, two farmers are interviewed for collecting the data. Totally 618 farmers responded.

4. Importance of Digitalization of Agriculture

Transportation, healthcare, finance, manufacturing, advertising, automobiles, and many other industries apply and use technology in their daily operations. In recent years, the agriculture sector has also been influenced by these innovations, and the concept of smart agriculture has emerged as a controversial topic. Every industry uses digital technologies for two goals. The first is to add value to the current infrastructure and enhance working conditions. The second step is to resolve any issues that arise. Technology was also employed in agriculture to boost farmer intelligence so that they could focus on new inventive ideas for better and higher-quality produce. Agriculture, on the other hand, is a natural phenomenon that must contend with several natural and climatic issues. Soil erosion, a greater reliance on artificial fertilizers, a reduction in soil richness, a reduction in groundwater supplies, and insect vulnerability are all factors. Reliance on unsustainable farming systems will only increase the likelihood of food scarcity and other associated difficulties as changing climate becomes more predictable and sensible. Controlling pests, monitoring soil and growing conditions, and organizing data for

farmers, lowering effort, and enhancing the food supply chain are all made easier by digital improvements.

5. Applications of Technology in Agriculture (Digitalization of Agriculture)

This is how the agriculture sector is becoming digitalized, from automated pest and plant disease diagnostics to smart spraying and produce sorting. The adoption of technology in agriculture has improved crop productivity, quality, and labor conditions. The following are the applications of technologies for different purposes.

5.1 Observing Crops and Soil

To ensure optimum agricultural production, it's necessary to monitor a crop's condition and discover crop pests proactively. Stress caused by factors such as environmental variation, nutritional deficits, and weed, bug, and fungi infestations must be discovered early time for farmers to counteract. AI may be used to forecast planting recommendations, pest management, and input control, which can assist the agricultural community, earn more money, and maintain stability. Monitoring the phases of growth once the crops have been planted is also important for maximizing output effectiveness. Understanding the relationships between crop development and the environment is critical for making crop health modifications. Drones (UAVs) are used to collect airborne picture data and train computer vision models to use for smart crop and soil maintenance.

5.2 Detection of Insects and Plant Diseases

Using deep learning-based image identification technologies Plant diseases and pests are detected by artificial machines. This uses picture segmentation, classification, and detection algorithms. It's known as the "keep an eye" on plant health model. Computer vision systems are also used to detect insects.

5.3 Keeping an Eye on Livestock's Health

Animals are another important part of the agriculture industry, and they require a little more surveillance than plants. The cow's health and behavior are examined using an overhead camera and computer vision algorithms; the cattle are followed and monitored using remote sensors, and the farmers are notified in real-time if a problem is detected. Computer vision may also be used to count animals, diagnose sickness, recognize aberrant behavior, and monitor important events like childbirth. All of these tasks are carried out using drones and cameras (UAVs). The algorithms are designed to analyze

footage and detect what animals are doing, such as drinking, eating, sleeping, or doing something unusual that might indicate sickness or behavioral issues. In the agricultural sector, "cattle eye" is a superb example of an AI-first animal tracking enterprise.

5.4 Smart Irrigation

In agriculture, soil and irrigation management are extremely important. Crop loss and quality degradation are caused by poor irrigation and soil management. As a result, a smart management system is required to boost production. The smart irrigation system is an Internet of Things (IoT)-based technology that can automate watering by assessing soil moisture and climatic conditions. Irrigation is one of the most labor-intensive farming activities that artificial intelligence can avoid since it is aware of previous weather patterns, soil conditions, and the type of crops to be cultivated. Automated irrigation systems make use of real-time machines that can maintain optimum soil conditions at all times to boost average yields. Not only does it alleviate farmers' misery, but it also has the potential to lower production costs. Given that agriculture consumes over 70 percent of the country's freshwater, AI awareness would have a significant influence on reducing water loss in agriculture.

5.5 Spraying with Intelligence

AI aids in the detection of agricultural problems as well as their prevention. UAVs fitted with computer vision AI can spray pesticides or fertilizer equally across a field automatically. Includes real-time target spraying area identification UAV sprayers can work with extreme accuracy, both in terms of spraying area and volume.

5.6 Aerial Photography and Survey

It should go without saying that computer vision has some fantastic possibilities for surveying land and monitoring crops and livestock. Farmers may use AI to evaluate imagery from drones and satellites to monitor crops and livestock. They can be warned promptly if something appears to be wrong without having to continually monitor the fields. Aerial imagery can also help improve pesticide spraying precision and efficiency. As previously said, guaranteeing that insecticides only travel where they're supposed to saves both money and the environment.

5.7 Sorting and Grading the Produces

Finally, even after the crops have been harvested, AI computer vision may assist farmers. Imaging algorithms can distinguish "good" produce from "bad" produce in the same way they can discover faults, illnesses, and pests as the plants develop. Computer vision can automate the sorting and grading process by evaluating fruit and vegetables for size, shape, color, and volume, with accuracy and speed much above that of a skilled expert.

5.8 Precision Farming

Precision farming is defined by the term "Right Place, Right Time, Right Product." This is a more precise and regulated process that takes the place of the labor-intensive and repetitive aspects of farming. Crop rotation, optimal planting and harvesting times, water management, fertilizer management, insect assaults, and other topics are covered.

6. Initiatives Taken by Union Governments and Various State Governments to Digitalize the Agricultural Sector

6.1 National Agriculture Market on the Internet (eNAM)

In India, eNAM is an online trading network for agricultural goods. Farmers, merchants, and purchasers can exchange commodities in the online market. The market facilitates improved market pricing and the easy selling of their products. Over 90 products, especially essential food grains, vegetables, and fruits, are already accessible for trade on its website.

6.2 Precision Farming using Artificial Intelligence

The government’s policies think tank, NITI Ayog, collaborated with IBM to build a crop yield forecast model utilizing artificial intelligence (AI) to deliver real-time advice to peasants in ten aspiring regions across Assam, Bihar, Madhya Pradesh, Maharashtra, Rajasthan, and Uttar Pradesh.

6.3 Pradhan Mantri Fasal Bima Yojana (PMFBY)

PMFBY will assist farmers who have suffered crop loss or damage as a result of unforeseeable circumstances, as well as stabilize farmers' income to ensure their continued farming. The agriculture ministry has decided to use specialized agencies to conduct pilot studies to evaluate agricultural output at the village level using advanced innovations like artificial Intelligence, remote sensing images, and modeling tools to speed up claim settlement for farmers under the existing crop insurance scheme.

6.4 AGRI-UDAAN

AGRI-UDAAN is a food and agribusiness accelerator 3.0 run by a- IDEA, NAARM's Technology Business Incubator, and funded by the Department of Science and Technology of the Government of India. Through rigorous mentorship, industry connections, and investor pitching, the program aims to catalyze scale-up stage food and agribusiness start-ups. This effort is a six-month program that began in Hyderabad.

6.5 Karnataka's Government has Signed an Agreement with Microsoft

The Karnataka government has struck an agreement with Microsoft Corporation India Private Limited. The cooperation aims to provide small-scale farmers with AI-based alternatives that will help them raise their revenue through the use of cutting-edge cloud-based technology, machine learning, and sophisticated analytics. Microsoft, in collaboration with the Karnataka Agricultural Price Commission (KAPC), intends to use digital tools to create a multivariate agricultural commodity price forecasting model that takes into account parameters such as sowing area, production time, yielding time, weather datasets, and so on.

6.6 Maha Agri-tech Initiative

The Maharashtra Remote Sensing Application Centre (MRSAC) and the National Remote Sensing Centre (NRSC) employ satellite pictures and data analysis to evaluate the landmass and the characteristics of specific crops in selected talukas in the initial phase of the project. The second phase, on the other hand, comprises an assessment of the data acquired to create a unified foundation for agriculture modeling and a geographic database of soil nutrients, rainfall, and moisture stress to provide farmers with location-specific advice.

7. Evaluation of the Response of Rural Agriculturists towards Digitalization of Agriculture

North Karnataka is very famous for its agricultural activities. More than 30 Lakh farmers are involved in farming activities (Karnataka at Glance 2018). The majority of the farmers are small and marginal farmers. Only 8 to 10 percent of farmers are large-scale farm holders. Area climate and natural sources in this area are suitable for cultivation. In this study, farmers are interviewed about how they are changing themselves with modern technologies. To increase productivity and quality are they applying modern agriculture methods? Are they digitalizing their

agriculture activities? To what extent farmers are using innovations in day-to-day agri activities? All these questions are answered and explained below with help of the primary data.

Table 1: Profile of the Farmers

Age of Respondent (in Years)	**Count**	**Count N %**
Up to 25	96	15.5%
26-30	159	25.7%
31-40	342	55.3%
41-50	21	3.4%
51-60	0	.0%
60 Above	0	.0%
Total	**618**	**100.0%**
Gender		
Male	599	96.9%
Female	19	3.1%
Third gender	0	.0%
Total	**618**	**100.0%**
Educational Qualification		
Below SSLC	439	71.0%
SSLC	143	23.1%
PUC / Equivalent	33	5.3%
under Graduation	3	0.5%
Graduation	0	0%
Professional Degree	0	0%
Total	**618**	**100.0%**
Type of Agriculture Land		
Irrigated	177	28.6%
Non-Irrigated	441	71.4%
Total	**618**	**100.0%**

Table 1, indicates that the majority of farmers are very experienced hands in farming. About 55.3 percent of farmers belong to the aged of 31 to 40, who are having more knowledge and interest in agriculture, 96.9 percent of people who are taking responsibility for agriculture in the family are male. The majority of the farmers are literate, 71 percent of farmers are done with their school education. Only 0.5 percent of graduates are involved in agriculture. In north Karnataka, irrigation is a major issue in agriculture, though having several rivers and dams only 28.6 percent of agri-land was irrigated, the remaining depends on rainwater for cultivating the agri-land.

Table 2: Generation of Family in Agri-profession

Type of Generation	1st Generation	2nd Generation	3rd Generation	4th Generation	**Total**
No. of Families	20	50	312	236	**618**

In table 2, the generation of the family in agri-profession shows the dedication and devotion to agriculture and how these families are stick-on to this particular profession for their livelihood; nearly 50 percent of families are agriculture-based families for more than 100 years, and 42 percent of families belong to 4th generation and this category of farmers know about the technological developments in agri-field and many farmers are interested in using such technologies.

Table 3: Source of Information to Access the Information about Agriculture

Sources	**No. of Responses**
Television	20
Radio	50
Newspaper	30
Mobile	400
Agri-agents	118

Agriculture mainly depends on accurate information it may be related to climate, rainfall, seeds, soil health, marketing fluctuations, etc. farmers in the rural area get to know information about agriculture through various media. Table 3 accessed various Media that 64.72 percent of farmers get all their information through their mobile phones. The present generation of farmers also belongs to the modern era of agriculture and is educated. In rural areas, 99 percent of farmers are having smartphones. Using mobile applications farmers are getting all the information related to agriculture.

Table 4: Farmers' Awareness, Usage, and Adoption Level of Digital Technologies in Agriculture Activities

Levels	**No. of Farmers**	**Percentage of Farmers**
Fully aware	30	4.8
Partially aware	40	6.4
Interested	50	8.09
Evaluating the concepts	5	0.8
In trial stage	10	1.6
Adoption	20	3.2

Levels	No. of Farmers	Percentage of Farmers
Discontinued	20	3.2
Not aware	143	23.13
Not interested	300	48.5
Total	**618**	**100**

In rural areas, farmers are cultivating agri-land in the traditional method for the last several decades. In this digital age, there is a shift from traditional methods to modern methods of agriculture, many innovations brought significant changes in the field of farming, to get quality and quantity out of agri-land the quality of the inputs must be high, and soil health, protection from diseases, etc., and post-harvesting activities i.e. marketing to get a good price for produces is very important, all these mechanisms are done by the technologies. Table 4 gives a piece of information about the rural farmers' awareness, usage, and adoption of technologies in their day-to-day activities to digitalize agriculture this makes farming activity very easy and effective. 4.8 percent of farmers in this survey are fully aware of the digitalization of agriculture; they know different types of innovations took place to uplift agriculture. Adoption of such digital innovations in agriculture is lower than awareness i.e. 3.2 percent. The same percentage of farmers discontinued the use of technology. Here the notable point is 48.15 percent of farmers are not yet all aware of innovations that took place in the field of agriculture. Still, in rural areas, the farmers need to be trained for the adoption of the technologies. It is necessary to give more attention to rural agriculture compared to structured farming, to make use of technologies in practice, through the digitalization of agriculture in rural may lead to another revolution in the farming sector.

8. Conclusion

Sustainable long-term agricultural growth is currently a top priority for feeding the world's rising population. The research focuses on the agricultural sector's readiness for technological advancement. At this point in technical advancement, digitalization can help transform conventional agriculture into contemporary digital agriculture from farm to fork. According to the report, widespread use of agricultural artificial technologies would necessitate government initiatives, public-private cooperation, data transparency, financial investment, and regional research. Though this study focuses on the non-technical aspects of technology application, it will aid policymakers, IT specialists, practitioners, political leaders, and researchers in developing and implementing policies to promote digital agriculture.

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