

A Study of the Impact of New Technology on Indian Agriculture and Its Future

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Abstract- *The study investigates how modern technology is revolutionizing agriculture, with an emphasis on precision agriculture, nanotechnology, blockchain, and their adoption in developing nations like India. Farmers' opinions about precision agriculture technologies and their benefits—such as higher yields, lower production costs, and more convenience—are evaluated in this study. It also probes the influence of these technologies on employment in Indian agriculture. The study delves deeper into how blockchain technology might enhance agricultural techniques and establish dependable food supply systems. The role of nanotechnology in agriculture and its implications for food supply, safety, and environmental sustainability are also scrutinized. The research highlights the necessity for a balanced approach to technology adoption, considering the distinct socioeconomic conditions of each country. The paper concludes with an examination of the challenges and opportunities in boosting agricultural productivity, emphasizing the importance of understanding farmers' perceptions and the environmental impact of these technologies.*

Keywords- *Agritech, Precision Agriculture, Nanotechnology, Blockchain, India, Farmers' Opinions, Environmental Sustainability, Technology Adoption.*

INTRODUCTION

India has established itself as a major player in international agriculture thanks to its varied Agroecological landscape. India's agriculture industry, which employs 45% of the labor force (Sanghi et al., 2015) [1] and generates roughly 18% of the GDP, is essential to the nation's economy (Redseer Strategy Consultants). India is the eighth-largest agricultural exporter in the world with a 2.33% share, according to the Press Bureau of India (PIB). Ernst & Young's

report points to a potential US\$ 24 billion value in the Agritech sector in India, despite the industry's 1.5% penetration rate.

The fully evolved Agritech ecosystem, characterized by reduced input costs, enhanced productivity and price realization, improved access to finance, and diversified revenue streams, has the potential to increase Indian farmers' income by 25 to 35% and contribute an additional US\$ 95 billion to the national GDP (NITI Aayog).

According to research, the global agritech market is expected to grow at a compound annual growth rate (CAGR) of 12.1% between 2020 and 2027.

Given its high demand in India and globally, the Agritech sector is considered a crucial pillar for building a sustainable future. Over the past six years, India's agricultural sector has witnessed a growth of 4.6%, as reported in the Economic Survey of India 2022–23, with over 1300 Agritech start-ups emerging in the sector (Khanna, T 2023) [2]. Infrastructure development is critical for the success of the Agritech industry. The Indian government is formulating a comprehensive strategy for sustainable development, with Agritech being a priority sector. The government is vigorously promoting digitalization among all industry stakeholders to enhance productivity and efficiency while minimizing dependence on unpredictable factors such as socioeconomic and meteorological uncertainties.

REVIEW OF LITERATURE

Even while traditional agricultural hoes are still used in the farming sector, the industry is becoming more and more data-driven, necessitating the use of state-of-the-art innovations and precise, advanced information.

One of the many innovative data and communication technologies that are advancing the horticulture industry is the Internet of Things (IoT). Modern agriculture is one business that has benefited greatly from the rapid advancement of cutting-edge innovation, moving from a measured to a quantitative approach. This massive shift has upended customary cultivating practices and revealed a variety of difficulties in expanding to untapped opportunities. This extensive graphical paper explores the potential advantages of the Internet of Things (IoT) for horticulture as well as the difficulties in integrating cutting-edge innovation with traditional rural frameworks.

From harvesting to sorting, electronics and artificial intelligence (AI) technology can serve as a facilitating mechanism for the nation's agriculture sector, reducing costs and increasing farmer earnings- - (S. Krishnan, 2023) [3]

To increase yields and make small-scale operations unprofitable, farmers have been adopting more technology throughout time, solidifying the idea that "bigger is better" in farming. However, the farming status quo is under threat from developments in robotics and sensing technologies. George Kantor, a robotics engineer at Carnegie Mellon University in Pittsburgh, Pennsylvania, asserts that intelligent robots have the ability to alter the farming industry's economic structure and allow small farmers to continue operating- King, A. (2017) [4]

The potential of data innovation (IT) in a rural environment can be broadly categorized into two areas: (a) using it as a tool to specifically increase rural efficiency and (b) using it as a backhanded tool to encourage farmers to make informed decisions that will improve horticultural operations and related activities- (Mittal, S.C., 2013) [5]

The future of agriculture is uncertain because it depends so heavily on atypical normal elements such as season, water, soil quality, and climate. Therefore, it is essential to sense, record, control, and store precise information on all biotic and abiotic components in order to plan to meet the requests for nourishment in terms of both amount and quality while maintaining the environment's supportability - (Servin et al., 2015), (Bhattacharyya et al., 2016) [6]

Agri-tech advancements basically impact the Indian economy. Still, the US\$370 billion horticultural sector—which accounts for 19.9% of the country's

GDP—provides the majority of income for almost 40% of the population (FY 2021). By the way, despite industry commitment, fundamental shortcomings continue to hinder efficiency and development. Indian agribusiness requires technology-assisted modernization backed by long-lasting adjustments to shed light on these problems and increase farmers' incomes; Agri-tech is expected to play a significant role in this regard- (Naina Bharadwaj 2022) [7]

Improvements in farming surpass the computerization of manual labor. Additionally, they manage automation and trigger responses to specific data-driven disclosures. Think about GPS-coordinated automobiles used for remote work gatherings. A single administrator can supervise and operate up to several of these cars at simultaneously. Add up to generation increases over time as the likelihood of human error decreases – (Precision Market Research 2022) [8]

"E-commerce innovation in farming" refers to the electronic exchange of agricultural goods and services. To promote interactions between ranchers, purchasers, and other stakeholders in the horticultural value chain, this may entail using online markets, smartphone apps, and other technological platforms. The ability of e-commerce to connect ranchers with contemporary markets and consumers outside traditional geographic boundaries is one of the main advantages of farming. By doing this, farmers may be able to increase revenue, reach a larger consumer base, and lessen their reliance on adjacent markets. Additionally, real-time showcasing data can be accessed by farmers through e-commerce platforms, enabling them to make more informed decisions on cost and generation- - (Mamta Patel et al., 2022), (Sneha Pandey et al., 2022), (Sanjana Shrivastava et al., 2022), (Parul Sharga et al., 2022) [9]

IT has untapped side advantages that could help farmers in India. Indian ranchers desperately need quick access to reliable sources of information so they can make decisions. Currently, the rancher relies on the contradictory and delayed cascade of inputs for decision-making from regular sources. In the dynamic work environment of Indian farmers, data is not so much beneficial as it is necessary for them to remain competitive - (Arun Bhagat et al., 2013), (Mangal A. Patil et al., 2013), (Ragini Dashora et al., 2013), (Upma Sharma et al., 2013) [10]

For Indian farmers and those advocating for their welfare, inventive strengthening is essential in light of

the impending deregulation and reduction in government assurance, the opening up of agricultural markets, the changes within the agrarian environment, and the likelihood of trade openings. Excellent sources of information can help improve rural living conditions by guiding decision-makers toward better options. Innovation has the potential to significantly impact rural India's ability to address these challenges and slow down the rapidly expanding digital divide – (S.C. Mittal, 2015) [11]

It has been observed after reading through a few articles that the connection between innovation and agribusiness hasn't been thoroughly examined. We believe that this essay is fundamental in discussing how innovation is becoming more and more common in the horticulture industry.

RESEARCH METHODOLOGY

This study employs diagnostic methodology to examine the influence of technology on agriculture from an environmental sustainability perspective. The study is presented as a qualitative report that analyses secondary data. The foundation of the data analysis is gathered from a variety of sources including newspapers, websites, and earlier research studies.

RESEARCH OBJECTIVES

1. To analyze the impact of technology in agriculture and how can it help in improving the agriculture industry
2. To investigate the extent of technology to analyze the growth.

DATA ANALYSIS



Source: Persistence Market Research 2022

This image is a graphical representation of the AgriTech Platform Market Share by region for the years 2022 and projected for 2032.

Internet Penetration in India			
	2015	2020(P)	2025(P)
Rural internet penetration	12.2%	30.3%	66.7%
India's internet penetration	21.7%	36.3%	67%

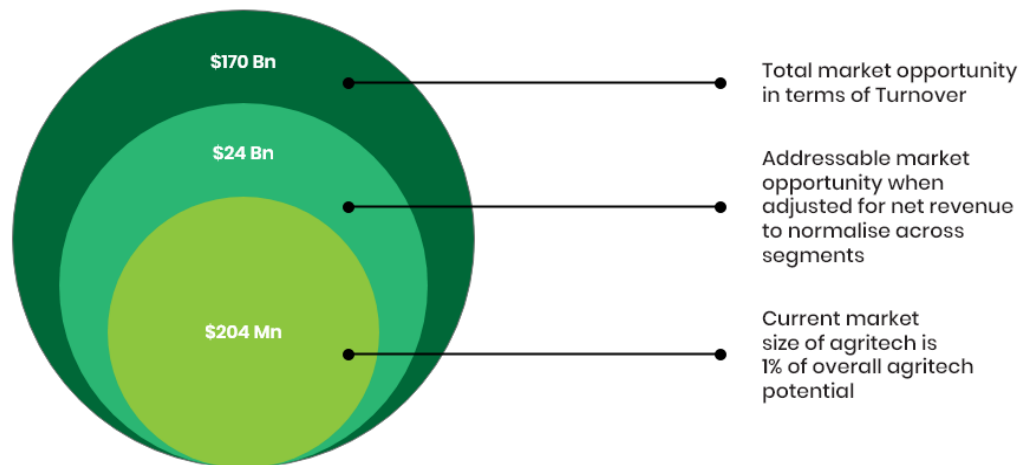
Graphic © Asia Briefing Ltd.

Source: Graphic @ Asia Briefing, LTD, 2021

The image is a graphical representation of the potential reach and impact of technology in rural areas, which is highly Agri Tech research. It shows the progression of internet penetration in India, both rural and overall, from 2015 with projections for 2020 and 2025. With the increase in internet accessibility, especially in rural areas where it is expected to rise to 66.7% by 2025,

there is a significant opportunity for Agri Tech innovations to reach and benefit these communities. Enhanced internet penetration can facilitate the dissemination of modern agricultural techniques, real-time weather updates, market trends, and online resources or platforms dedicated to agricultural advancements.

India's Agritech Market Opportunity



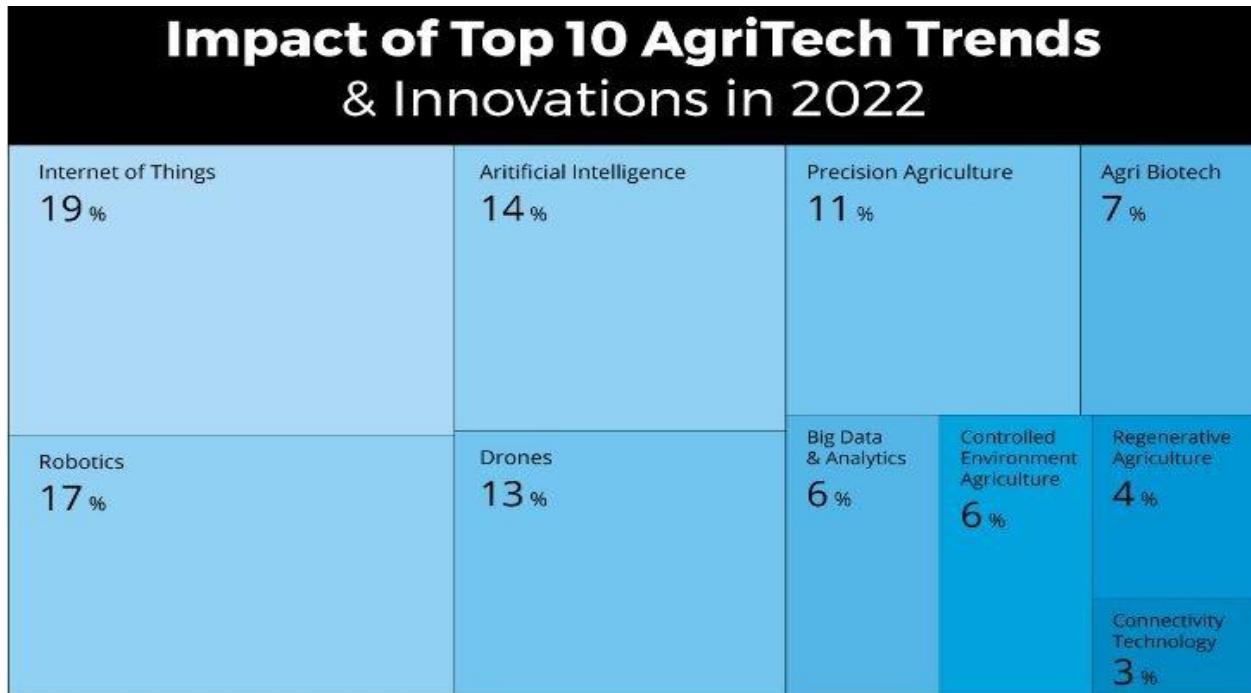
Source: EY Report, Inc42 Plus



Source: EY Report Inc42 Plus, 2021

The is a graphical representation of India's Agritech market opportunity. The figure represents the aggregate market potential valued at \$170 billion, as well as the marketable potential after adjusting for net revenue to

normalize across segments (\$24 Bn), and the current market size of Agritech, which is 1% of overall Agritech potential (\$204 Mn).



Source: StartUs Insights, dated November 2021

The image is a tree map illustrating the impact of the top 10 Agritech trends and innovations in 2022. It shows that the Internet of Things (IoT) has the highest impact at 19%, followed by Robotics at 17%, Artificial Intelligence at 14%, and Drones at 13%. Other technologies listed include Precision Agriculture, Agri Biotech, Big Data & Analytics, Controlled Environment Agriculture, Regenerative Agriculture, and Connectivity. This indicates a significant opportunity for growth and innovation in this field.

RESEARCH OUTCOMES

The main conclusions of the Agritech Research are as follows:

- Sustainable Agriculture: Agritech research has simplified the understanding and implementation of sustainability standards in farming.
- Enhanced Techniques: With the help of improved methods involving various agricultural and animal components, small and marginalized rural families in Manipur can achieve sustainable production, income generation, and employment opportunities.
- B2B as a Major Revenue Source: In the Agritech sector, B2B has emerged as a significant revenue-generating segment.

- Indian Enterprises Eyeing Overseas Markets: To expand, Indian enterprises are increasingly considering foreign markets.
- Growing Interest in Agritech Research: The number of journal articles published in the Agritech and AI research domain between 2015 and 2019 indicates a growing interest in Agritech research over the past decade.
- However, Agritech is still nascent in India, having reached only 1% of the potential US\$ 24 billion industry.

RESEARCH GAP

Scholars and practitioners continue to investigate the many unanswered questions surrounding the impact of technology on agriculture, which is a broad and dynamic field. Key research gaps in this field include the following:

- Technology Adoption and Diffusion: It is essential to comprehend the variables influencing technology adoption and diffusion in agriculture. This entails researching farmers' perspectives, driving forces, obstacles, and decision-making procedures concerning embracing new technology like artificial intelligence, drones, sensors, and precision agriculture.

- **Sustainability and Environmental Impact:** Evaluating how technology in agriculture affects sustainability and the environment is a significant topic of research. This entails researching how technology affects biodiversity, soil health, water use, greenhouse gas emissions, and general ecological sustainability.
- **Digital Divide and Technology Access:** Since not all farmers have equal access to technology and digital tools, it is imperative to look into the digital divide in agriculture. Finding access gaps, assessing how well extension services encourage the adoption of new technologies, and creating plans to close the digital divide should be the main goals of research.
- **Data Privacy and Security:** As data-driven technologies (such as farm management software and Internet of Things devices) become more widely used in agriculture, issues with data privacy, security, and ownership must be addressed. Best practices, guidelines, and frameworks for protecting data while maximizing the advantages of agricultural technology can be investigated through this field of study.
- **Human-Centric Design and Usability:** Improving agricultural technologies' usability and user experience is crucial to their successful uptake and impact. To increase farmers' adoption and use of technology, research should concentrate on user-centric design concepts, user interface optimization, user feedback systems, and user training techniques.
- **Integration of Traditional Knowledge with Technology:** An expanding field of study is the acknowledgment and integration of traditional knowledge and practices with contemporary agricultural technology. This entails realizing how technical advancements for sustainable and culturally relevant farming methods can be enhanced and complemented by indigenous knowledge.

Through the resolution of these research gaps, academics and industry professionals can further the comprehension and application of technology in agriculture, resulting in more egalitarian, efficient, and sustainable agricultural systems.

CONCLUSION

In summary, the incorporation of advanced technologies such as precision agriculture, nanotechnology, and blockchain has demonstrated substantial potential in revolutionizing the agricultural sector, especially in developing nations like India. These technologies have been favorably received by farmers due to their advantages, including enhanced yield, decreased production costs, and increased convenience. The study also shed light on the influence of these technologies on employment within Indian agriculture.

Blockchain technology has exhibited potential in forming dependable food supply chains and improving farming methodologies, while nanotechnology has implications for food supply, safety, and environmental sustainability among others. However, the adoption of these technologies necessitates a balanced approach, considering the distinct socioeconomic conditions of each country.

Despite the challenges, the opportunities these technologies offer in augmenting agricultural productivity are vast. It is crucial to understand farmers' perceptions and the environmental impact of these technologies in this context. The research emphasizes the need for ongoing exploration and adaptation of these technologies to local conditions to fully exploit their potential in advancing agriculture.

Utilizing these technologies to create productive, efficient, and sustainable agricultural systems that can fulfill the growing global need for food while reducing their negative effects on the environment is essential to the future of agriculture. To make sure that agriculture is a sustainable and profitable enterprise for coming generations, it is essential to keep researching and developing as the sector changes.

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