International Journal of Psychosocial Rehabilitation, Vol. 23, Issue 1, 2019
ISSN: 1475-7192

Technological Innovations and their Role in Transformation of Agriculture in India: An Analytical Study

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Abstract

The agrarian sector is a momentous contributor to the Indian economy, with a considerable number of people reliant on it for sustenance. The adoption of technological innovations has played a crucial role in revolutionizing agriculture in India. This study examines the function of technological innovations in the agrarian sector of India, with a spotlight on the impact of advancements such as precision farming, genetically modified crops, mobile technology, and blockchain on productivity, profitability, and sustainability. The research has concluded that technological innovations have noticeably enhanced agrarian practices in India by optimizing resource utilization, amplifying yields, and curbing costs. The Green Revolution played a pivotal role in elevating food production, while precision farming has facilitated farmers in diminishing input expenses and improving crop management practices. Genetically modified crops have resulted in increased yields and reduced crop losses due to pests and diseases. Mobile technology has allowed farmers to access real-time information, leading to informed decision-making and increased profits. In general, technological innovations have transformed agriculture in India and will persist in playing a pivotal role in its expansion and advancement.

Keyword- Agricultural reform, Technology in agriculture, agricultural advancement

Introduction

According to reports from the United Nations and a recent scholarly investigation, it is projected that the world's populace will reach an astounding 8.5 billion by 2030. This marked increase in population presents a formidable challenge to global food production systems. In the impending years, the demand for food is anticipated to soar, as it is estimated that the world must produce no less than 50% more food to satiate the approximately 9 billion people expected to populate the planet by 2050. Consequently, the agricultural domain must undergo a considerable metamorphosis to satisfy the mounting food demand. Byerlee, De Janvry, & Sadoulet, (2009) mentioned that the advancement of technology plays a crucial role in driving

agricultural growth, optimizing resource utilization, and promoting sustainable farming practices. It's fortunate that the agricultural sector in India has been leading the charge in technological progress. Precision farming has considerably enhanced the efficiency of farming operations. This methodology allows farmers to fine-tune input usage, resulting in increased yields and decreased costs. Moreover, precision farming aids in mitigating environmental impacts, curbing the use of water, fertilizer, and other inputs, which promotes sustainable farming practices. Figure 1 lists some of the technological innovations in the agriculture field.

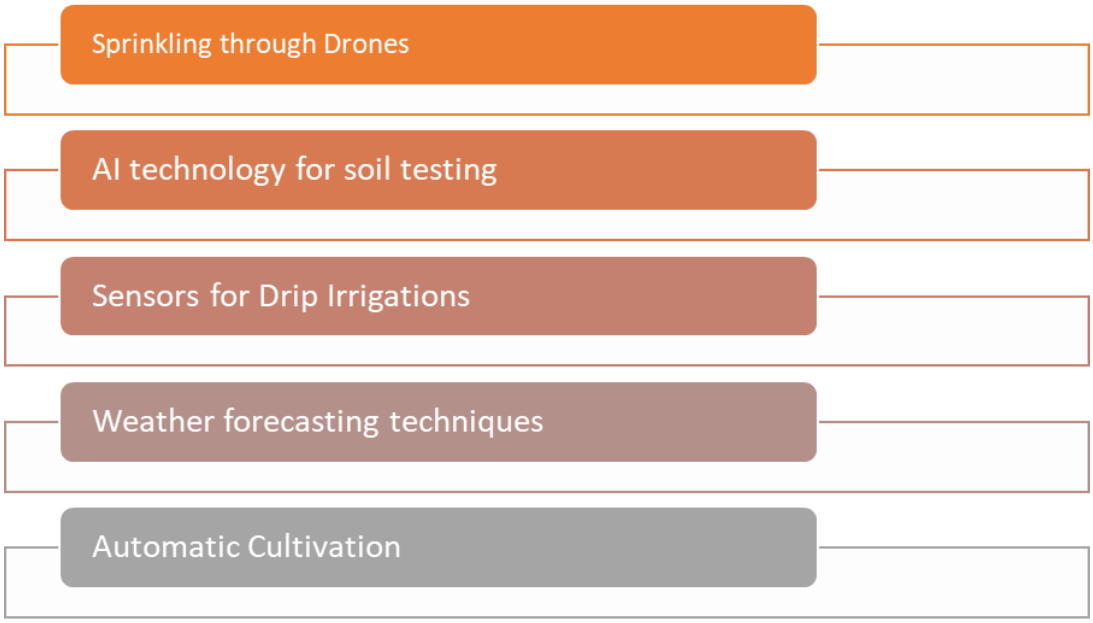

Figure 1 Technological Innovations in Agriculture

Dharmaraj & Vijayanand, (2018) found that the manipulation of genetic material in crops has been pivotal in augmenting crop yields and minimizing losses from pests and diseases. GMCs have granted farmers the ability to increase food production on the same acreage by fusing genes that bestow resistance. This has resulted in an agricultural framework that promotes sustainability. The advent of mobile technology has empowered farmers with access to real-time information, such as meteorological updates, market prices, and other valuable insights that optimize farming techniques, reduce expenses, and boost profits. The Green Revolution, which originated in India in the 1960s, was instrumental in heightening food production and ensuring food security. The implementation of high-yield seed varieties, coupled with contemporary farming techniques, yielded unprecedented levels of food production.

Deichmann, Goyal, & Mishra, (2016) found that the proliferation of technology is vital in driving agricultural growth, optimizing resource utilization, and promoting sustainable farming practices. The agricultural sector of India is an essential element of its economy, serving as the primary source of livelihood for over fifty percent of its population. With the exponential increase of the world's populace, the demand for food is rapidly surging, and the agricultural industry must keep up with the pace to ensure food security. However, due to the paucity of resources, the necessity to generate more food with less land, water, and energy has become an insurmountable obstacle. In response to this conundrum, India's agricultural sector underwent a metamorphosis, with technological innovations serving as a pivotal factor in its development. India's agricultural industry has been a harbinger of technological advancements, and these innovations have substantially improved the country's agricultural practices. Nonetheless, governments must allocate funds towards research and development, enhance farmers' access to credit and insurance, and provide infrastructure to sustain eco-friendly farming practices. This analytical study aims to examine the role of technological innovations in the transformation of agriculture in India. A comprehensive analysis will be conducted on the influence of novel technologies like precision farming, genetically modified crops, mobile technology, and blockchain on the threefold aspects of productivity, profitability, and sustainability. The research will thoroughly scrutinize the benefits and challenges associated with the adoption of these innovations and their effect on the livelihoods of cultivators. The outcomes of this study are expected to offer invaluable insights into the role of technology in agriculture in India and its potential in resolving the issue of food security in the nation.

Literature Review

Agriculture plays a crucial role in the economy of India, contributing around 17% of the country's Gross Domestic Product (GDP). Technological innovations have been a significant driver of the transformation of the Indian agricultural sector over the past few decades. Dhanabalan & Sathish, (2018) found that the agricultural sector in India has undergone a transformative shift, thanks to the advent of technological innovations. In the yesteryears, the primary means of farming in India was manual labor and hand tools. However, these traditional methods had their limitations, particularly in tropical environments, with energy and output being the major constraints. The introduction of machines in agriculture has been a game-changer, considerably enhancing the efficiency of agricultural practices. Mechanization has facilitated farmers in the preparation of land, sowing seeds, and harvesting in considerably

lesser time compared to the past. Consequently, farmers can now cultivate crops on more extensive tracts of land, culminating in higher yields and profits.

Majumdar, Naraseeyappa, & Ankalaki, (2017) found that The usage of machines has considerably reduced the demand for labor, which has made farming more cost-effective and efficient. The assimilation of technological advancements has further led to the development of better irrigation systems. In India's previous years, farmers had to depend on rainfall to water their crops, which was erratic, resulting in crop failures. The advent of contemporary irrigation methods, including drip irrigation systems, has facilitated the efficient watering of crops, leading to heightened agricultural yields and the production of superior-quality crops. The incorporation of innovative farming technologies, such as precision agriculture, biotechnology, and remote sensing, has bestowed farmers with the capacity to make informed decisions regarding their crops.

Singh, (2016) revealed that these state-of-the-art technologies furnish farmers with accurate information concerning soil quality, weather patterns, and other factors that exert an impact on crop growth. The upshot of this has been more effective crop management, diminished wastage, and increased profitability. In India, farmers have historically relied on their intuition and familiarity with local weather trends to determine the most suitable planting and harvesting periods for their crops. However, the weather has become increasingly capricious in recent times, rendering it problematic for farmers to schedule their farming activities. Thanks to the deployment of AI-based tools, vast amounts of data on various crop growth-affecting factors such as soil moisture levels and weather patterns can be gathered and analyzed. This data is then employed to make predictions about upcoming weather trends, empowering farmers to make knowledgeable decisions about the optimal timing of planting, harvesting, and other essential activities.

Bendre, Thool, & Thool, (2015) found that the implementation of AI-based tools has facilitated the adoption of precision farming by farmers. This method involves utilizing technology to manage crops on a more intricate level, considering the inconsistencies in soil quality, water availability, and other relevant factors. To elaborate, farmers can employ sensors to track the levels of moisture in the soil and subsequently regulate irrigation systems to achieve optimal growth conditions. The result is a significant enhancement in crop yields as the crops can flourish in ideal settings. Additionally, the utilization of AI-powered tools has instigated the

development of new crop strains that are more adept in adapting to alterations in climatic conditions. These crops are more resilient to adversities such as droughts, heat, and other weather-related stresses, ultimately rendering higher yields compared to their conventional counterparts.

Jagannathan & Priyatharshini, (2015) found that the utilization of artificial intelligence (AI)-based tools in the agricultural sector of India has been a significant advancement that has revolutionized the industry. The implementation of AI-powered climate and weather forecasting has allowed farmers to make knowledgeable decisions about their crops based on precise meteorological predictions, which has resulted in an increase in crop yields, reduced wastage, and amplified profits. As climate trends continue to shift, the application of AI-based tools will become progressively crucial in ensuring the sustenance of food security and promoting sustainable agricultural development. The traditional method of crop breeding involved the deliberate selection of plants possessing desirable traits, followed by controlled breeding to produce offspring that expressed those traits. However, this process is both time-consuming and subject to certain limitations with respect to the number of traits that can be feasibly selected for.

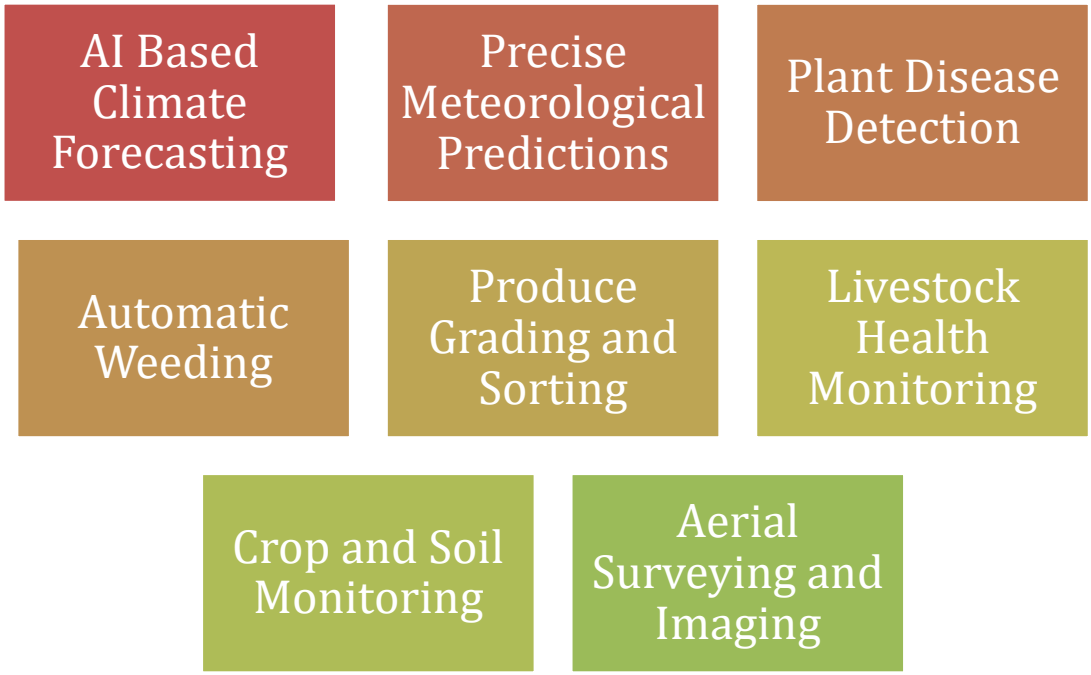

Figure 2 AI based agricultural tools

The utilization of extensive data to enhance farm productivity and improve supply chain management is gaining significant momentum. Big data refers to the accumulation and processing of voluminous amounts of data, which can be analyzed to aid in decision-making and problem-solving. In the agricultural sector, big data plays a vital role in amassing information about diverse factors such as weather patterns, soil conditions, and crop growth, all of which impact farm yields. By examining this data, we can identify patterns and make predictions about future crop yields. Farmers can then use this knowledge to make informed choices about various activities, including planting, harvesting, and more. Ultimately, this leads to improved crop yields and an increase in revenue for farmers. The utilization of biotechnology has facilitated the swift and effective inclusion of favourable attributes into crops. One of the most significant progressions in biotechnology is the innovation of genetically altered crops. These crops have been genetically modified to embody beneficial attributes, such as immunity to pests, resilience to herbicides, and enhanced nutritional content.

Mahendra Dev, (2014) found that genetically modified crops have been embraced on a broad scale in India and other nations, resulting in amplified crop yields and improved food security. Apart from genetically modified crops, biotechnology has also resulted in the creation of crop varieties that are more resistant to environmental pressures. For instance, scientists have manufactured crop varieties that are more tolerant to drought, heat, and other weather-linked strains. These crops can cultivate in territories that were formerly unsuitable for agriculture, leading to an increase in agricultural production and improved food security.

Mondal & Basu, (2009) found that biotechnology has also brought about the creation of microorganisms that can be employed in agriculture. These microorganisms can aid in enhancing soil fertility, managing pests and diseases, and promoting plant growth. The utilization of microorganisms in agriculture can diminish the necessity for chemical fertilizers and pesticides, leading to more sustainable agricultural practices.The employment of Big data is becoming more and more prevalent in supply chain management, especially in the agriculture sector.

Ali & Kumar, (2011) found that the technique involves collating data regarding crop yields, market demand, and transportation logistics to optimize the distribution of agricultural products to consumers. The optimization leads to an upsurge in efficiency and profitability for the

farmers and other participants in the supply chain. This technique also contributes significantly to reducing wastage. Apart from supply chain optimization, Big data also plays a crucial role in monitoring and managing the ecological impacts of agriculture. It is achieved through gathering relevant information about water use, soil erosion, and other environmental factors that farmers can adopt to reduce their environmental footprint. The technique leads to the adoption of more sustainable agricultural practices and ultimately contributes to the preservation of the environment. Big data is indeed revolutionizing the agricultural sector by enhancing supply chain management, improving the yields and managing the ecological impact of farming practices. By adopting this technique, farmers, stakeholders, and consumers can benefit from enhanced efficiency, profitability, and sustainable practices. With the help of chips and body sensors, farmers can monitor the health and well-being of their livestock, prevent disease outbreaks, and improve productivity. In the past, monitoring livestock was a labour-intensive and time-consuming process. With the implementation of modern technology, agriculturalists now possess the capability to closely monitor their livestock in real-time. This empowers them to detect and mitigate potential health issues before they escalate. The foremost benefit of this type of surveillance is disease prevention. By observing the wellness of their animals, farmers can identify early signs of affliction and take measures to impede the spread of infection. This is particularly important in large-scale livestock management, where disease outbreaks can have devastating consequences. Livestock monitoring can also help to improve productivity. The examination of animal behaviour is crucial for farmers to make calculated decisions about their livestock's feeding, breeding, and other necessary activities. This type of observation can lead to the improvement of the meat's quality, increased milk production, and superior reproductive performance. India has seen an uptick in the use of chips and body sensors for livestock monitoring. These technological advancements can be attached to the animals' anatomies to track their movement, heart rate, and other essential signs. The data generated from these devices can be scrutinized to discover patterns and trends, which can assist farmers in making wise choices about their animals.

Conclusion

The analytical study of technological innovations and their role in transforming agriculture in India highlights the significant impact that technology has had in modernizing the agricultural sector. The agricultural industry has seen significant progress in terms of precision farming

methodologies and the adoption of cutting-edge machinery and tools. These technological developments have played a crucial role in elevating agricultural efficiency, productivity, and sustainability. Furthermore, the implementation of technology has enabled farmers to overcome various challenges, including but not limited to climate change, water scarcity, and the shortage of labor. However, there is still room for improvement, and further investment in research and development is required to ensure that technology is accessible to all farmers.

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