Article ID 240203047

Scope and Potential of Digital Farming in Crop Production for Resource Poor Farmers

Dhiman Mukherjee

Regional Research Station (Red &Laterite Zone), Bidhan Chandra Krishi Viswavidyalaya, Jhargram-721507 (West Bengal)

*Corresponding Author: dhiman_mukherjee@yahoo.co.in

As the demand for food continues to increase on a global scale, farmers are faced with the pressing challenge of producing more food, enhancing its quality, and adopting sustainable practices. In order to accomplish this, they require access to high-quality data and innovative tools that can translate insights into actionable steps. This is where the concept of digital farming comes into play. Digital farming (DF) referred to as digital agriculture, involves the utilization of digital technologies to enhance the efficiency and productivity of agricultural practices. These technologies encompass a wide range of tools, including remote sensors, drones, precision irrigation systems, and GPS-guided machinery. Additionally, data analytics, artificial intelligence (AI), and machine learning are employed to make informed decisions regarding crop management and the allocation of farm resources. By leveraging these digital solutions, almost every aspect of agricultural production can be optimized, ultimately leading to more sustainable and productive farming practices. Farmers are essential producers who face the challenges of climate change and the natural world (Mukherjee, 2024). They also take on roles as managers and traders, relying heavily on tools for their success. The introduction of farm machinery and the use of chemicals in the last century have significantly boosted production and reduced the burden of labor for farmers. In recent years, digital technology has made its way onto farms in various parts of India, revolutionizing the selection of varieties and breeds, as well as the use of robots for tasks like milking. These advancements have transformed the landscape of farming, with sensors providing valuable insights into agroecosystems. The data collected has paved the way for decision support systems that help farmers make informed choices about water, fertilizers, and pesticides. However, implementing these technologies in underdeveloped or remote areas, of West Bengal, Jharkhand, and Orissa, presents unique challenges.

Technologies for digital farming

Digital farming involves the use of varied technologies, including sensors, drones, precision irrigation systems, GPS-guided machinery, and data analytics and machine learning tools. These digital farming technologies can be used to collect data about soil conditions, crop health, weather patterns, and other factors that impact agriculture. Use of this technology in appropriate manner become very difficult for resource poor farmer's. Various factor's are responsible to use this technique in time bound manner in different location. In various circumstances, the following factors will influence how agriculture will use digital technology:

1. The fundamental prerequisites for using technology include accessibility, connectivity, affordability, the use of ICT in education, and supportive policies and initiatives (such as e-government)
2. The use of the internet, mobile phones, and social media, digital skills, and support for an entrepreneurial and innovative culture (talent development, sprint programmes like hackathons, incubators, and accelerator programmes) are examples of enabling conditions, or "enablers," that make the adoption of technologies even easier.

Benefits of digital farming

Digital farming practices offers a wide range of advantages, including enhanced crop and agricultural production efficiency, cost reduction, improved crop yields, and minimized environmental impact. It enables farmers to make better decisions regarding crop management and resource allocation, ultimately enhancing food security through increased production and reduced waste. This is achieved by decreasing

chemical usage in crop production, optimizing water efficiency in agriculture, preventing soil degradation, boosting farmers' socioeconomic status, and mitigating negative environmental effects while enhancing worker safety.

Adoption of digital farming

Crop production under high-tech horticulture

Crop production under polyhouse using digital technology

Training programme on digital farming

Weed identification through IoT at field levels

The accelerated development and adoption of technologies in the 20th and at the beginning of the 21st century and the way in which they are changing our lives and the environment is not a new phenomenon. The prevalence of segregated small-holder farms in India is a major reason for the slow adoption of digital farming in that nation because it makes data collection more difficult. The sector's use of digital solutions has also been significantly influenced by the low penetration of mechanization equipment and frequent natural disasters including droughts, floods, and excessive monsoon rains. Artificial intelligence, machine learning, the IoT, sensors and blockchain, are just some of the examples of new technologies (Lazovic, 2020), and it's adoption become challenging due to poor net and infrastructure facility in remote and farflung area of West Bengal and other parts of India. In our system more crop productivity under limited land resource is possible by improving production, tracking products, and cutting down on labor-intensive tasks, digital technology is now a fact of farming life. Dramatic climate change, especially rapid depopulation, air, water and land pollution, increasing urbanization and shrinking agricultural land, and unprecedented demographic shocks have contributed to the technological transformation of the crop production sector in recent decades. This refers not only to the automation and application of machines with new possibilities, but also to the greater use of digital technologies, especially Internet of Things (IoT). In this way, farmers can gain better control over agricultural land, take corrective action and achieve desired yields. According to marketing estimates, the use of IoT in agriculture is expected to reach 20.9 billion dollars by 2024 (Chui *et al.*, 2021). This is mostly influenced by increased demand, wider acceptance of IoT and related technologies by farmers, as well as the desire to increase the efficiency of agriculture.IoT has brought a great revolution in agriculture environment by examining multiple complications and challenges in farming (Ray *et al.*, 2017).

Information system and mobile technology

The digitalization of farming involves the use of information and communication technology to provide delivery services related to agriculture. This includes utilizing GIS, wireless devices, and remote sensing techniques to share information among extension agents, researchers, and farmers. Categorizing information into different clusters helps in coordinating the procurement and distribution of produce along the value chain. Access to information is crucial for making informed decisions, and the use of information technology has a positive impact on agricultural productivity and overall economic growth. Mobile technology is expected to enhance market efficiency and transparency, empowering farmers as sellers of commodities (Mukherjee, 2023). Market information, particularly price information for inputs and farm implements, is shared through mobile applications to facilitate knowledge transfer from researchers and extension agents to farmers. This leads to increased productivity and economic growth by enabling farmers to adopt innovations effectively. Raising awareness about the importance of information technology in agriculture is essential to promote the adoption of precision agriculture, ultimately boosting agricultural productivity and economic growth.

Recent technological advancement

The emergence of Big Data has led to the development of new processing technologies. Artificial intelligence (AI) now enables the generation of original knowledge from vast amounts of data. These data, collected in large quantities to cover a wide range of possibilities, undergo cleaning and processing to predict values, create classifications, or identify patterns. Deep Learning and Machine Learning technologies are utilized for processing intricate images, satellite images, or temporal series (such as continuous or repeated measurements of a specific parameter over an extended period). Data mining techniques are employed to extract information from online data sources. Integrating the agroecological and digital transitions is a significant challenge that requires further refinement of modern tools and software programming. Analyzing the results achieved by digital farming can help agricultural producers and scholars make better decisions to increase yields, improve efficiency, reduce costs, and manage resources.

Challenges of digital farming

There are several challenges associated with digital farming. These challenges encompass the high expenses related to equipment, implementation, and management of digital farming technologies. Moreover, rural areas often face limited access to data and connectivity, which hinders the adoption of digital farming practices. Additionally, there are concerns regarding data privacy and security that need to be addressed. Another challenge is the learning curve involved in implementing new technologies, which may require time for farmers to fully embrace digital farming solutions. Furthermore, some key challenges include the connectivity issues in rural areas, lack of knowledge about various agriculture-producing processes, the dimensions of each management zone, barriers to entry for new businesses, scalability issues, and configuration problems. Lastly, there may be benefits of digital farming that are not immediately apparent but can be realized over time.

Future of digital farming

The Indian government's initiative "Vocal for Local and Digital" is a bold effort to tackle these issues through the incorporation of digital technology in agriculture. The goal is to modernize methods, improve nutrition, strengthen food security, increase exports, and promote sustainability. Digital farming is anticipated to be instrumental in addressing worldwide food security challenges and supporting farmers in embracing climate-smart agricultural techniques.

Conclusion

In the upcoming years, we will encounter a significant challenge in addressing the needs of a growing population in a sustainable, secure, and nutrient-dense manner, all while addressing critical environmental concerns like climate change and water scarcity. While technology can certainly contribute to addressing these challenges, many of the proposed technical solutions seem to favor corporate entities rather than supporting independent farmers in making informed decisions about their agroecological systems. The current trajectory of agricultural technology may exacerbate existing disparities between small and large-scale farmers, as well as between farmers and agro-food businesses, and marginalized actors within the food supply chain. Both Indian and foreign agritech companies have the potential to play a pivotal role in providing farmers with cutting-edge technologies, given that the Indian Agriculture and Allied sector is on the brink of embracing modern technologies such as IoT, AI/ML, and agridrones for unmanned aerial surveys. Foreign companies can also contribute significantly to equipping farmers with these innovative technologies, as Indian agriculture and its associated industries are poised to adopt new technologies on a widespread scale for the farming community.

References

Chui, M., Collins, M. and Patel, M. 2021. The internet of things: Catching up to an accelerating opportunity. McKinsey & Company, New York. Ppp66-67.

Luković, M., Pantović, D. and Ćurčić, M. 2021. Wild edible plants in gourmet offer of ecotourism destinations: case from biosphere reserve “GolijaStudenica”. *Economics of Agriculture,* 68(4), 1061–1076.

Mukherjee, D. 2023. Impact of social media on farming community. *In : Mobile Apps for Development of Farmers* (eds. Arpita Sharma Kandpal). Jaya Publishing House, Delhi, India. Pp 33-51.

Mukherjee, D. 2024. Challenges and opportunity for higher crop productivity in red-laterite belt of West Bengal. Futuristic Trends in Agriculture Engineering & Food Sciences (e-ISBN: 978-93-5747-402-3 IIP Series) Volume 3, pp 150-161.

Ray, P.R. 2017. Internet of things for smart agriculture: Technologies, practices and future direction,' *Journal of Ambient Intell. Smart Environmen*t, 9(4):395-420.

* * * * * * * *