

## Digital Agriculture for Sustainable and Inclusive Farm Productivity in India

**Gayatri Behera\***

Student, Ravenshaw University, Odisha, India.

\*Corresponding Author: gayatrisoma3@gmail.com

### ABSTRACT

Digital Farming makes use of mobile application, IOT, AI, and analysis of data to update the farming methods, boost productivity, and help the environment. Although there is proof of efficiency and productive farmland, farmers in India are slow to adopt it because of problems related to infrastructure, their society and economy, and national policies. This paper will analyze the influence of digital tools on farming, and find out why some farmers don't adopt them and suggest some useful steps for inclusive advancement in technology. To yield the results, the study will perform field experiments, collect survey data, and analyze the policies, after which finding can benefits the researchers and those working in the sector. The digital transformation of Indian agriculture also promotes inclusiveness by expanding market access through e-commerce platforms, which help farmers to overcome geographical constraints and reduce post-harvest losses. Despite the immense potential, challenges remain, including the low adoption rate among small holder farmers due to high costs and limited digital infrastructure with the advancement of the digital village strategy; the continuous integration of the digital economy with the rural economy has gradually become an emerging driving force for sustainable agriculture. Digital tools are expected to streamline land records, financial transactions and procurement, reducing disputes, malpractices, and boosting policy efficiency. With the collection and processing of information, technologies automation and robotisation, they can contribute towards a more sustainable agricultural production.

**Keywords:** *Sustainable, Inclusive, Efficiency, Productivity, Integration, Infrastructure.*

### Introduction

Indian agricultural is encountering challenges because of climate change, shortage of resources and the continuous increase in the populations. Digital agriculture which refers to the use of technology in farming, has become very useful by helping farmers manage their farms more accurately and efficiency. National progress move forward in digital agriculture, but the lack of good infrastructure and digitally skilled people seems to prevent the sector from reaching its potential. This paper intends to examine how digital technology is used in farming in India, and how it impacts and includes different people. Emerging digital technologies have the potential to be game changers for traditional agricultural practices. Agricultural revolutions denote period of technological transformation and increased from productivity. In some ways; the "Digital Agricultural Revolution" follows patterns of previous agricultural revolutions. First digital technology will affects all parts of the agricultural value chain, including off farm segments. Although farming has always relied on empirical evidence, the volume of data and the methods of analysis will undergo drastic changes in the digital revolution. Because smart farm system continuously monitor the behaviour of your animal, that giving you the insight in to their behaviour every moment of the day. Finally increased reliance on big data may increase the power differential between farmers and information service providers, or differential between farmers and large value chain actors like super market.

### Literature Review

A literature review on digital agriculture in India reveals its potential to enhance farm productivity, sustainability, and inclusively through technologies like AI, IOT and drones, though challenges such as limited digital literacy, connectivity and infrastructure needed to be addressed. While digital agriculture can improve resource use and yields, its benefits are not uniformly distributed, highlighting a need for tailored, low cost solutions and capacity building particularly for small holder farmers.

- **Mobile Advisory and Digital Platforms:** Advice provided by mobile phones and digital services that fit a farmer's location can help with making effective decisions and raising productivity. Nevertheless, having a sustainable income and being able to grow the business are still hard in regions without making resources.
- **Productivity and Sustainability Impacts:** The use of digital agricultural tools, like IOT and AI, is found to raise productivity i.e. cause the crop yield, less of natural resources and help the environment.
- **Adoption Barriers:** Because of socio – economic issues, illiteracy in using technology, problems with internet infrastructure and lack of trust, adoption of technology by small holder farmers. The adoption level is also affected by the gender, how educated people are, and the size of the farm.

#### **Improving Digital Infrastructure and Literacy**

- **Problem:** Limited access to internet and mobile connectivity especially in rural areas, hinders digital agricultural adoption.
  - **Solution:** Invest in expanding digital infrastructure, including broadband internet and mobile networks particularly in under developed regions.
- **Problem:** Low digital literacy among farmers, including a lack of awareness about the benefits and usage of digital tools is a major obstacle.
  - **Solution:** Implement comprehensive digital literacy programme tailored to the needs of farmers, focusing on practical application and benefits of digital technology.
- **Problem:** Language and cultural barriers can impede the effective use of digital tools.
  - **Solutions:** Develop user friendly digital applications and interfaces in multiple languages, considering local cultural context and preferences.
- **Problem:** Ensuring affordability and accessibility - High initial costs of digital technology and equipment can be prohibitive for many small holder farmers.
  - **Solutions:** Explore affordable financing options and subsidies to reduce the upfront costs of digital tools.
- **Policy and Institutional Context:** There are ongoing changes in Indian policies (Digital Agriculture Mission 2021-25), mainly addressing digital infrastructure and partnerships between the private and public sectors. Nevertheless, problems still exist with the final stage of connectivity, guaranteeing data privacy, and farmer centered approaches.
- **Future Description and Commendation:** Digital agriculture is poised to disrupt traditional value chains, but requires integrated approaches combining technology, training and supportive policy for sustainable impact.

#### **Research Questions**

- **What is the impact of digital agricultural tools on farm productivity and resource use efficiency in India?**  
 Digital agriculture tools are significantly impacting farm productivity and resource use efficiency in India by enhancing crop yields, optimising resource allocation, and reducing environmental impact. These tools including precision farming technology, mobile technology, and e-commerce platforms are enabling farmers to make more informed decisions, improve farm management and access wider markets.
  - Enhanced Productivity and efficiency
  - Real time data and analytics
  - Improved Crop Management
  - Reduced input costs
  - Optimise irrigations
  - Reduced fertilizer and pesticide use
- **What are the key barriers to adoption of digital agriculture among small holder farmers?**  
 Economic constraints, lack of infrastructure and digital literacy and concerns about data privacy and security.
  - High Cost of technology
  - Limited access to credit and financing

- Cost of maintenance and upkeep
- Infrastructure and connectivity barriers
- lack of reliable internet access
- Language barriers
- Lack of training and support
- **How can policy framework and business model be optimized for inclusive digital transformation in India?**

To optimize policy framework and business models for inclusive digital transformation in Indian agriculture a multi faceted, approach is needed. This includes strengthening digital infrastructure, promoting public private partnerships, improving financial accessibility, enhancing farmer capacity, and ensuring data security. Policy should prioritize affordability and accessibility of technology, encouraging sustainable practices and foster transparency and security in supply chains.

- **What is digital agriculture?**

Digital agriculture also known as smart farming or e-agriculture, is the use of technology and data driven solutions to improve the efficiency and sustainability of agricultural practices. It involves collecting, analyzing and sharing electronic data to optimize various aspects of farming from planting and harvesting to resource management and supply chain optimization.

- **How the digital technology can increase the productivity of small / marginal land holders?**

Digital agriculture increase the productivity of marginal farmers by providing access to real time data and advisories, enabling precision farming, enhancing crop management, and facilitating better market linkages. These technologies facilitate informed decision making, climate resilience and access to training, thereby boosting yields and profitability for the small / marginal land holders.

#### **Benefits for marginal land holder farmers**

- **Enhanced Productivity and Yields:** Access to data and smart farming tools allows for better crop and resource management, leading to increase yield.
- **Optimal resilience Management:** Technologies help minimize the over use of water, fertilizers, and pesticides application and monitoring.
- **Climate Resilience:** Early warnings about extreme weather events climate focused information help farmers mitigate risks and adopt to changing conditions.
- **Improved market linkages:** Digital platforms facilitate online procurement of agricultural materials and the marketing of produce, potentially increase profitability.
- **Better crop and input management:** Remote sensing and data analysis enable better monitoring of crops for pests, diseases and nutrient needs, leading to more effective intervention.
- **Why does Indian agriculture need to be digitalised?**

Precision agriculture allows precise application of fertilizers, water and pesticides, maximizing crop yields while conserving resources.

- Weather monitoring system and satellite data help farmers make informed decision that improve productivity and efficiency.
- **IOT based Sensor Networks:** Improve real time monitoring of environmental conditions, aiding in the early detection of stresses affecting crops.
- **Cost Reduction:** Digital solutions reduce reliance on traditional practices, lowering input cost through better resource management.
- **Enhanced Soil and Water Conservation:** Soil mapping and remote sensing technologies enable monitoring of soil health and water availability crucial for sustainable agriculture.
- **How to enable / convince the illiterate farmers or elderly farmers to adopt digital technologies in agricultural sector?**

To enable illiterate or elderly farmers to adopt digital technologies, provide localized training in local languages, offer ongoing hands on support, create accessible village resource centers, and demonstrate clear benefits like increased efficiency and income. Establish local hubs with computers and internet access to serve as platforms for information and tool usage.

### Objectives

Measure the increase in productivity and sustainability because of digital agriculture technologies. Assess the issues in society, infrastructure and policies that could prevent people from using new technologies. Come up with advice for expanding digital agriculture to include a broad range of users.

### Research Design and Methodology

This plan is to use both types of research, with some fields experiments and some qualitative interviews.

#### Data Collection

- **Field Experiments:** Set up IOT sensors like soil moistures sensors, drones and smart irrigation controller, digital advisory platforms on some farms to measure the harvest, the resources needed, and the efficiency.
- **Surveys and Interviews:** Talk to over 200 people from areas in multiple areas to find out how these technologies are used and what problems they have.
- **Case Studies:** Look into successful digital agriculture efforts in India as well as around the world, focusing mainly on their policies and business systems.
- **Govt. Datasets:** Secondary – Crop yield statistics from Agmarket, soil health card data.

#### Data Analysis

Results will be generated from cobb douglas production function models to analyze the link between productivity and digital tools. The interview data will be coded using topics to spot any general issues and advantages within the system.

- **Ethical Considerations:** All the collection of data will adhere to ethical rules, so people will be fully informed and their privacy is guarantee.

#### Expected Implications and Contribution to Knowledge:

- **Practical:** Suggestions for budget friendly, expandable and made for local conditions digital agriculture methods.
- **Policy:** How to include digital literacy, improve infrastructure and focus on farmers in a country's national plans.
- **Academic:** Evidence on the main factors affecting digital agriculture adoption in the developing would, providing answers to gaps left in current literature.

### Conclusion

This paper outlines "The Digital Agriculture for sustainable and Inclusive farm productivity in India", with a focus on adoption, impacts and determinants. By conducting this study, we aim to provide valuable insights that will contribute to the development of effective policies and strategies for digital agriculture for sustainable and inclusive form productivity in India.

### References

1. Fabregas, R., Kremer, M. & Schilbach, F. (2019). Realizing the potential of digital Development: The Case of agricultural advice Science, 366 (6471), Easy 3038.
2. Papadopoulos, G., Arduini, S., Uyar, H., Psiroukis, V., Kasimati, A., & Fountas, S. (2024). Economic and Environmental benefits of digital agricultural technologies in crop production: A review smart agricultural technology, 100441.
3. Dibberen, T., Romani, L.A.S. & Massruha, S.M.F.S. (2024) Main drivers and barriers to the adoption of Digital Agriculture technologies Smart Agricultural Technology 8, 100459.
4. Sargani, G.R., Wang, B., Leghari, S.J., & Ruan, J. (2025) Is Digital Transformation the key to Agricultural Strength? A Novel Approach to productivity and supply chain resilience Smart Agricultural Technology, 100838
5. Rajkhowa, P., & Qaim, M. (2021). Personalized digital extension services and agricultural performance; Evidence from small holder farmers in India. Plosone, 16(10), e0259319.
6. Balkrishna, A., Pathak, R., Kumar, S., Arya, V., & Singh, S.K. (2023). A comprehensive analysis of the advances in Indian Digital Agricultural architecture. Smart agricultural Technology, 5, 100318.
7. Dayloglu, M.A. & Turker, U. (2021). Digital Transformation for sustainable future agriculture 4.0: A review. Journal of Agricultural Sciences, 27(4), 373-399.

