**Digital Agriculture and Information and Communication Technology for Ensuring Sustainable Development**

**in India: A Review**

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## ABSTRACT

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| India is described as an agricultural powerhouse on a global scale due to its vast agri-ecological diversity. While achieving food sufficiency in production, India still faces concerns about resource-intensive agriculture and low farmer productivity, resulting in poverty and malnutrition. The role of information and communication technology (ICT) in advancing agriculture has become even more necessary. It assists farmers with timely information related to environmental conditions, soil health, and crop management and beyond it, where it has the potential to stimulate growth in agricultural productivity and promote sustainable farming through informed decision-making and resource management. This paper reviews the relevance of ICTs in farming for rural development, food security, and resilience. Newer technologies such as 5G, AI, and cloud computing provide exciting new possibilities to explore for a robust vision for Indian agriculture that is organised, data-oriented, and productive.It can stimulate economic development through improved access to markets and knowledge sharing, with ICT playing an important role in supporting rural communities. However, challenges such as limited connectivity and low digital literacy must be addressed to facilitate widespread adoption of ICTs. ICT in agriculture draws parallels to the "Third Green Revolution," where there is a need to strive towards more affirmative inclusion of small farm households and women, especially amongst developing countries.Enhancing the agenda of sustainability through ICT and sustainable practices will be a major strategy in creating ecological balance, environmental health, and resilience for agricultural systems for the future. |

*Keywords: Information communication technologies; sustainable farming; agriculture; rural development; artificial intelligence.*

## 1. INTRODUCTION

Agriculture is the predominant economic activity in rural areas of developing countries (Capozucca, Sarni, & krause, 2012) (Torero, 2014). It therefore presents the best potential to decrease poverty, improve food security and generally improve the livelihoods of rural people (Mohamad & Gombe, 2017) (The World Bank, 2018) Communication, information exchange, transactions, and knowledge transfer are fundamental in nearly every aspect of agriculture (El Bilali & Allahyari, 2018; Sharma & Bhambri, 2025). In recent years, Information and Communication Technology (ICT) has emerged as a transformative tool, bringing forth game-changing agricultural innovations. ICT has revolutionised the sector by offering solutions such as sensor networks, data analytics, satellite imagery, and mobile applications. These technologies have provided farmers with access to timely, location-specific information, enabling them to make better decisions, optimise resource usage, and adopt sustainable practices. ICTs enable the capture, processing, transmission, storage, retrieval, and display of various forms of information, including text, images, video, graphics, animations, etc. This implies a significant enhancement in addressing almost all information requirements within the realms of agriculture and development processes (Mukherjee et al., 2025). The integration of ICT in agriculture is often referred to as e-agriculture, a rapidly growing field aimed at empowering farmers through digital solutions (Kshetri, 2014). India is described as an agricultural powerhouse on a global scale due to its vast agri-ecological diversity. Agriculture is a foundation of the Indian economy, being approximately 18% of GDP and nearly 45% of the workforce population (Redseer Strategy Consultants, 2023). After becoming developed, the agritech ecosystem has the potential to increase the incomes of Indian farmers by 25 to 35% and contribute US$ 95 billion to the country's GDP through lower input costs, augmented productivity, price realisation, more affordable finance, and additional sources of income (NITI Aayog). India has pursued agricultural self-sufficiency since gaining independence. While achieving food sufficiency in production, India still faces concerns about resource-intensive agriculture and low farmer productivity, resulting in poverty and malnutrition. Agriculture employs around half of the country’s workforce and uses three-fourths of the country’s freshwater resources; though, it contributes only one-sixth of the GDP (Lajoie-O'Malley et al., 2020). This specifies low worker productivity and an inefficient use of resources in the agricultural sector in India. This is because a majority of agricultural production comes from small family farmers and stock breeders who do not have the capacity or necessary technological assistance to improve farm efficiency (Ernst & Young Report, 2020. Press Bureau of India (PIB), India ranks 8th with a share of 2.33% among the world's top agricultural exporters. Also, Ernst & Young's report shows that agritech firms in India present a US$ 24 billion opportunity, although the market is still largely untapped (with only 1.5% penetration). Agritech firms in India present a US$ 24 billion opportunity, although the market is still largely untapped (with only 1.5% penetration). Between 2020 and 2027, the global agritech industry is likely to grow at a compound annual growth rate (CAGR) of 12.1% (Ernst & Young Report, 2020).

Despite these advancements, challenges remain. Connectivity issues, low computer literacy among rural farmers, and the disintegration of markets continue to hinder the widespread adoption of ICT. Moreover, small and marginal farmers, who constitute over 86% of India's farming community, often struggle to access these technologies. The average farm size in India is only 1.08 hectares, making it difficult for farmers to invest in advanced technologies (Shetty & Philip, 2022). To alleviate these challenges and enhance ICT adoption further, several initiatives have been taken by the Indian government that function on multiple dimensions. These include water use efficiency, better crop seeds, diversification of livelihoods by improving the scope of rotation of crop plants, and soil health management as a part of NMSA. Also, by increasing the budgetary allocation, their initiatives promote and engage resource usage in a combined manner with the adoption of technologies using drones, artificial intelligence, etc (AG Horizon Group Pvt. Ltd., 2023). In India's agricultural sector, ICT holds immense potential to drive sustainable development, enhance productivity, and improve the livelihoods of millions of farmers. This section explores the transformative impact of ICT on Indian agriculture, highlighting its role in promoting inclusive growth and fostering rural development, Through the use of progressive technologies including 5G, artificial intelligence (AI), cloud computing and blockchain India's agricultural landscape is on the verge of a digital revolution that could ensure a more resilient, data-driven, and sustainable future for the sector.

Indian agriculture is now self-reliant and a major exporter of agricultural produce. India is the first, second, or third leading producer of many agri-commodities worldwide. However, Indian agriculture is based with several handicaps. The foremost challenges faced by the Indian agriculture sector are smallholder farmers, lack of reach of Farmer-Producer Organisations (FPOs), scarcity of Agri data, and conflicts of actual value awareness by farmers. The regulated market model (mandi) presented obstacles such as scarcity of such hubs, steep operational costs, and lack of clarity in pricing formulation (Adhya & Sahoo, 2022). Information and communication technology (ICT) aids provide up-to-date information on the market prices of commodities, inputs, and consumer trends, which ultimately can improve a farmer's negotiating position and their livelihood. A major aspect of ICT is that accurate information should reach the farmers at the right time to make more sustainable use of on-farm resources. ICT is going to play a greater role in agricultural extension as well as private sector agribusiness, market information, and market intelligence. Rohila et al found out the role of ICT not only in providing greater awareness and knowledge in agriculture technology and information but also in terms of farmers’ attitudes towards trying to adopt new technologies (Rohila, Yadav, & Ghangh, 2017). Spanaki et al outlined a single normative reference for the definition, context, and lines for future research in this field for further investigation and further engagement in the context of agritech. Findings specify that Agritech research and the disruptive potential of AI in the agricultural sector are still at the beginning of operations research. Through the systematic review, they intend to inform a wide range of agricultural stakeholders (farmers, agripreneurs, scholars, and practitioners) and to provide a research agenda for a growing field with multiple potentialities for the future of agricultural operations (Spanaki, Sivarajah, Fakhim, Despoudi, & Irani, 2022). Additionally, Ganesh kuma et al in their study examine artificial intelligence (AI)-based product benefits and problems of the agritech industry. Results show that better information for faster decision-making has been ranked as the topmost AI benefit. This implies that the executives of agritech units have a concern about the quality of decisions they make, and resistance to change from employees and internal culture has been ranked as the topmost AI problem (Ganeshkuma, David, & Jebasingh, 2022). Blockchain technology, still challenged with key limitations, is a transformative information and communications technology (ICT) that has changed our notion of trust. Improved efficiencies for agricultural sustainable development have been established when ICT-enabled farms have access to knowledge banks and other digital resources. ICT e-agricultural systems with blockchain infrastructure are absolute and distributed ledger systems for record management; baseline agricultural environmental data integrity is safeguarded for those who participate in transparent data management. The model of the ICT e-agriculture system with a blockchain infrastructure is projected for use at the local and regional scale. To determine context-specific technical and social necessities of blockchain technology for ICT e-agriculture systems, an evaluation tool is available. The proposed system and tool can be assessed and applied to further developments of e-agriculture systems (Lin, et al., 2017).

Chowhan and Ghosh found that the use of ICT-based services in agriculture is currently very low, mainly due to limited access, high costs, and lack of training. It suggests that solutions like IT-based training, affordable ICT tools, better internet and electricity infrastructure, and the adoption of advanced technologies (such as AI, IoT, and big data) are essential for improving agricultural productivity and sustainability (Chowhan & Ghosh, 2020). The Indian agriculture sector is rapidly adopting innovative technologies such as IoT and other advanced tools, with both Indian and foreign agritech companies playing a crucial role in this transformation. These advancements are essential for boosting India's agricultural growth and are reshaping the industry for the benefit of farmers, society, and all stakeholders (Anajli, Yadav, & Priya, 2023). The NSSO survey estimated that there were 93.094 million agricultural households in rural India, representing roughly 54% of all rural households which includes a significant portion (70.4%) of agricultural households possessed less than one hectare of land, while a very small percentage (0.4%) held more than 10 hectares (National Sample Survey Office, 2022). Patil et al., evaluates the Indian scene suggests that market information and weather updates are of prime interest; illiteracy, cost and lack of awareness are the major adoption constraints. Human capital enhancement was understood to be the main remedial factor to change the low rate of ICT adoption and its effectiveness (Patil, et al., 2008). The use of drones in agriculture offers significant benefits, including higher efficiency, reduced operational delays, and lower costs for spraying and fertilizer application. Drones also minimize wastage of inputs, save water, and reduce farmers’ exposure to hazardous chemicals compared to traditional methods (Press Information Bureau, 2022). ICT has the potential to revolutionize Indian agriculture by providing timely information, precision farming tools, and improved market access, yet many projects remain at the pilot stage and widespread breakthroughs are still lacking[5](https://iipseries.org/assets/docupload/rsl20244E0330B2B1FB571.pdf)[6](https://epubs.icar.org.in/index.php/IndFarm/article/download/165715/59652/457860). There is an urgent need to evaluate, compare, and scale up ICT initiatives to ensure farmers receive accurate information and benefit from advanced digital technologies (Singh, Ahlawat , & Sanwal, 2017).

**Table 1. Impact of technological intervention on foodgrain production (in million tonnes)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Year** | **2017-18** | **2018-19** | **2019-20** | **2020-21** | **2021-22** |
| Production of food grains | 285.01 | 285.21 | 297.50 | 310.74 | 315.72 |

*Source: Ministry of Agriculture & Farmers Welfare; https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1884*

## 2. RESEARCH GAP

Present studies highlight the transformative role of ICT in agriculture, mainly its potential to augment productivity, sustainability, and farmer livelihoods. However, gaps remain in the extensive adoption of these technologies, particularly among smallholder farmers who constitute the majority of India’s agricultural workforce. Significant challenges such as low computer literacy, poor connectivity, and limited access to advanced technologies hamper progress, despite the potential economic benefits of agritech solutions. Besides, while technologies like AI and blockchain are familiar for their potential, their adoption remains limited due to technical, cultural, and infrastructural barriers. Moreover, in terms of sustainability, the incorporation of ICT into agriculture has not adequately addressed the longer-term environmental challenges. During a time when ICT provides tools devoted to improving productivity and resource management among farmers, there is not enough research devoted to understanding environmental resilience, sustainable use of resources and environmentally friendly practices, or the relationships with smallholder and marginal farmers. Simultaneously, the integration of ICT into agronomic systems and/or sustainable agriculture systems is still largely unexplored, providing opportunities for continued research into how technologies can address the environmental challenges.

## 3. UTILISING TECHNOLOGY 4.0 FOR A SUSTAINABLE AGRICULTURAL REVOLUTION IN INDIA

India is headed towards the era of Agriculture 4.0 with the active participation of digital farming techniques and incorporation of advanced technology such as artificial intelligence, machine learning, data analytics, drones, and robotics to revolutionise the traditional Indian agriculture ecosystem. The rising innovation ecosystem has brought countless growth opportunities for farmers to take advantage of technology for their benefit. As per the report of WWF India, through innovative interventions in repulsing 86% of

animals, a 60% surge in crop production has been recorded, where agri-tech startups have occupied a major role.

The government, through various schemes and initiatives such as the AGNIi Mission and National e-Governance Plan in Agriculture (NeGP-A), is readily engaging the startup and innovation ecosystem of the country to increase crop yield and agricultural productivity sustainably. According to a NITI Aayog report, the adoption of artificial intelligence in the Indian agriculture sector is projected to attain a total growth of 22.5% CAGR during the years leading to 2025 to become US$ 2.6 Bn. This growth will also have implications for improved cropping, resource-efficient farming practices, and gainful productivity.

The Economic Survey of 2022–23 also highlights more than 1000 agri-tech startups, which have powered the Indian agriculture sector to 4.6% growth in the last six years. The continuous upgrade in agricultural infrastructure is playing the catalyst role with increasing opportunities for livelihood and business in the agriculture and rural sectors. To address the rising challenge of food security, the digitalisation of Indian agriculture will play a pivotal role and empower Indian farmers to leverage the potential of technology to improve sustainability (AG Horizon Group Pvt. Ltd., 2023).

* 1. **Role of ICT in Indian Agriculture**

Information and Communication Technology (ICT) provides a backbone for reforming and digitising agriculture. ICT provides several solutions to enhance agricultural productivity, market access, and sustainability, including decision-making support and enhancing crop marketing. By using web and mobile applications and all digital tools, ICT enables farmers to receive timely, relevant information to improve farm operations. ICT does this by providing real-time future forecasts, current market prices, and expert opinions so that farmers can make informed decisions around crop choice, when to plant, and market approach. This, in turn, has contributed to higher yields and better income for farmers. ICT includes all the technical tools to handle information and facilitate communication. ICTs are increasingly being used to disseminate information to farmers. Radio and TV programs both feature agricultural information. Due to their allure and widespread use, information and communication technologies have a significant impact on the rural economy (Dutta & Anand, 2023).

Below are some of the key roles of ICT in agriculture:

1. **Decision Support System:** ICT tools empower farmers by delivering real-time, localised data on weather, crop varieties, and soil conditions. This helps farmers make informed decisions at each stage of farming, from crop selection to post-harvest, improving resource efficiency and productivity.
2. **Expanding Market Access:** Digital platforms connect farmers directly with buyers and markets, reducing reliance on middlemen. This allows farmers to access better prices, widen their customer base, and stay informed about market demand, enhancing their revenue.
3. **Empowering Farming Communities:** ICT fosters collaboration among farmers, institutions, and experts. It provides access to updated knowledge on agricultural practices and innovations, allowing farmers to improve techniques, share experiences, and strengthen community networks.
4. **Access to Information:** Through mobile apps and SMS services, farmers receive timely updates on weather, pest control, and market prices, allowing them to adapt quickly to changing conditions and make proactive decisions that boost productivity.
5. **Precision Agriculture:** By utilising data from sensors and drones, farmers can manage resources like water and fertilisers with pinpoint accuracy. This leads to more sustainable farming, lower costs, and improved yields while minimising environmental damage.
6. **Financial Inclusion:** ICT enables access to digital financial services, helping farmers secure credit, insurance, and subsidies. This empowers them to invest in modern technologies and improve their livelihoods.
7. **Data Analytics:** ICT systems analyse vast amounts of agricultural data, providing farmers with insights into soil quality, crop health, and yield predictions. These insights help manage risks, improve decision-making, and enhance productivity.
8. **Climate Resilience:** ICT tools offer early warning systems for extreme weather, helping farmers take precautionary measures. This promotes climate-smart agriculture, allowing farmers to adapt to and mitigate the impacts of climate change.
9. **Supply Chain Management:** ICT improves transparency and coordination across the agricultural supply chain, reducing waste, improving product quality, and ensuring efficient logistics from farm to market.
10. **Capacity Building:** Online training programs and virtual resources equip farmers with new skills, keep them updated on technological advancements, and offer expert advice, helping them stay competitive and innovative.
11. **Policy and Governance:** Governments use ICT to efficiently implement agricultural policies, distribute subsidies, and monitor sector performance. This ensures that farmers receive the necessary support for growth and development.

## 4. CHALLENGES IN IMPLEMENTING ICT IN INDIAN AGRICULTURE

Implementing Information and Communication Technology (ICT) in Indian agriculture holds significant potential to transform the sector. However, the process is fraught with challenges that limit its widespread adoption. Below are the key challenges derived from reports and research by Indian agricultural organisations:

1. **Connectivity and Infrastructure Gaps:** Many rural areas, especially in states like Jharkhand and the North East, lack reliable internet, limiting farmers' access to ICT tools. Significant investments in rural infrastructure are required to enhance connectivity.
2. **High Initial Costs:** The high upfront costs of ICT tools like drones and sensors deter small-scale farmers, particularly in states like Bihar and Uttar Pradesh, where financial support and access to credit are limited.
3. **Low Digital Literacy:** Many farmers, especially in Odisha and West Bengal, lack the digital skills needed to use smartphones and online platforms. Training programs are essential to bridge this gap.
4. **Data Privacy and Security:** Concerns about data misuse deter farmers from adopting data-driven technologies. This issue is prominent in states like Punjab and Haryana, where trust in data privacy needs improvement.
5. **Fragmented Land Holdings:** Small, fragmented land plots, common in states like West Bengal and Kerala, complicate the adoption of precision farming technologies that require larger, uniform fields.
6. **Tailored Solutions for Smallholders:** Most ICT solutions are designed for large-scale farming and do not address the specific needs of smallholders, such as localised weather data and crop management practices.
7. **Limited Awareness and Trust:** Many farmers are unaware of the benefits of ICT, and there is a lack of outreach to promote its use. Scepticism about the accuracy of ICT tools further limits adoption.
8. **Insufficient Government Support:** While the government has introduced initiatives like Kisan Call Centres, a lack of coordination between agencies leads to fragmented implementation. More integrated policy frameworks are needed for effective ICT deployment in agriculture.

## 5. ICT INITIATIVES IN INDIAN AGRICULTURE

India has made significant strides in integrating information and communication technology (ICT) into agriculture, with both government and private entities introducing various digital platforms, tools, and services to empower farmers. These initiatives aim to enhance productivity, improve market access, and provide critical information to farmers.

The Government of India is also encouraging sustainable agriculture through several initiatives that work on manifold dimensions, such as better crop seeds, livelihood diversification by enlarging the landscape of crop rotation, water use efficiency, and soil health management, part of NMSA. With increasing budgetary allocation, the government is also promoting resource utilisation in an integrated manner through the adoption of technologies using drones, artificial intelligence, etc. The reports indicated that 45 per cent of the world’s ICT projects were implemented in India (Manzar, 2004). Also, Asia’s highest number of information kiosks is employed across rural India. However, most of the rural ICT projects are implemented in the socio-economically developed states of South and North India (Saravanan, 2012). Some of the Agricultural initiatives in India are mentioned below.

**Table 2. Agricultural initiatives in India**

| **S. No.** | **Projects/Web Portals** | **Description** |
| --- | --- | --- |
| **Web Portals** |
| 1. | aAQUA | Online Indian farmer knowledge exchange which answers questions of farmers in 4 languages in 420 districts in India and Abroad with 7,674 posts, 3.3 million views by 12,964 viewers (www.aaqua.org). |
| 2. | KISSAN Kerala | It is a multimodal agriculture information system for Kerala to support better land and water management. It helps in Online information, video channel, Tele-advisory, SMS, and GIS-based agro-services (www.kissankerala.net). |
| 3. | TNAU AGRITECH Portal | Dynamic portal and e-linkage with research stations and the farm sciences centre for agro-advisory services (www.agritech.tnau.ac.in). |
| 4. | AGRISNET | Agriculture Resources Information System Network, a mission-mode project funded by the Ministry of Agriculture to develop online knowledge portals (multiple state-specific portals). |
| 5. | DACNET | 46 websites and 39 applications for crop information, extension services, and more (www.dacnet.nic.in). |
| 6. | e-Krishi | Collective initiatives that use ICT for agriculture and rural development provide market information, Web-based farm advisory services, a resource library, and online expert advisory (www.ekrishi.org). |
| 7. | ASHA | Agricultural information for Assam farmers (www.assamagribusiness.nic.in). |
| 8. | India Development Gateway (InDG) Portal | Multilingual portal for agriculture and rural information for rural communities, Dispersed content management system by 225 institutional, Private, NGO’s Government support (www.indg.in). |
| 9. | Rice Knowledge Management Portal (RKMP) | Comprehensive rice information portal with an e-learning platform for farmers, extension personnel, and researchers (www.rkmp.co.in). |
| 10. | Agropedia | Agricultural knowledge repository built in a collaborative mode in multiple languages, hosting over 9,000 pages till date (agropedia.iitk.ac.in). |
| **Web Portals for Market Information and Agri-Business Firms’ Portal to Farmers** |
| 11. | AGMARKNET | Portal launched to connect agriculture produce markets, State Agriculture Marketing boards and directorate of Agriculture Marketing all over India (www.agmarknet.nic.in). |
| 12. | ITC-e-Choupal | Initiative helps farmers to provide access to information and services, reaching 4 million farmers in 40,000 villages (www.echoupal.com). |
| 13. | EID Parry- Indiagriline | Provide agricultural services to rural peoples in all over in India, (www.eidparry.com/agriland.asp). |
| 14. | Indiancommodities.com | Agricultural collateral management companies working in India, Provides Fee-based market information on several commodities including cotton, sugar, oilseeds, pulses, etc. (www.indiancommodities.com). |
| 15. | Mahindra Kisan Mitra | Web portal providing information on mandi prices, weather, loans, insurance, agri-news, and more (www.mahindrakisanmitra.com). |
| 16. | IFFCO Agri-Portal | Agricultural services portal in the local language portal and 100 farmer kiosks running in 16 states (www.iffco.nic.in). |
| 17. | Agrowatch Portal | Largest agribusiness portal covering more than 15 sub-sectors of agriculture and food industries (www.agriwatch.com). |
| 18. | iKissan | Crop-specific agricultural information, local agri-news, market data, and diagnostic packages (www.ikisan.com). |
| **VKCs/ VRCs/ CICs/ CSCs** |
| 19. | Village Knowledge Centres (VKCs) - MSSRF | 101 VKCs providing location-specific content and services with 315 partners (www.mssrf-nva.org). |
| 20. | Village Resource Centres (VRCs) – ISRO | 473 VRCs set up in 22 states, providing agricultural, healthcare, and educational services (www.isro.org/scripts/villageresourcecentres.aspx). |
| 21. | Community Information Centres (CICs) | e-Infrastructure for accessing rural information in North-East India (www.cic.nic.in). |
| 22. | Common Service Centres (CSCs) | Provides Digital e-governance services, including agriculture information related to crops, cattle, soil, etc (www.csc-india.org). |
| **Telephony/ Mobile Telephony** |
| 23. | Farmers Call Centre (Kissan Call Centre) | 32 call centres, answering over 6 million calls from farmers in 5 years. |
| 24. | Lifelines India | Internet and telephony-based services, reaching 200,000 farmers (www.lifelines-india.net). |
| 25. | IFFCO Kisan Sanchar Limited (IKSL) | working to advance technology-enabled farms, distribution advisories and building sustainable agriculture practices. Based on Voice messages in local languages, success to reach 10 lakh farmers and 40,000 cooperative societies (www.iksl.in). |
| 26. | Fisher Friend | Mobile-based advisory services for fishing communities of coastal Tamil Nadu, providing information on weather, market prices, etc. |
| 27. | Reuters Market Light (RML) | Micro-information services covering over 440 crops and 1400 markets, providing significant economic benefits to farmers (www.reutersmarketlight.com). |
| 28. | Mobile Advisory Services by Krishi Vigyan Kendras (KVKs) | Provides Mobile advisory services to farmers by KVKs (Farm Science Centres) of ICAR. |
| **Hybrid Projects (Mix of ICTs, Info-mediaries & Conventional Extension Methods)** |
| 29. | e-Arik | Internet based and offline advisory services, showing substantial economic benefits for registered farmers (www.earik.in). |
| 30. | e-Sagu | Agro-advisory services via digital photographs and coordinators, benefiting farmers with increased earnings (www.esagu.in). |
| 31. | Digital Green | Video-based agricultural extension, significantly increasing adoption of farm practices (www.digitalgreen.org). |
| 32. | Knowledge Share Centres | Information provided through touch-screen kiosks, IVRS, bilingual web portal, and awareness campaigns in Andhra Pradesh (www.naipsri.org/ikisan). |

## 6. CONCLUSION

The employment of information and communication technology (ICT) in Indian agriculture has the potential to fundamentally transform the sector through facilitating access to information, boosting productivity, and supporting economic development. Despite the momentum of the advances, it is nevertheless clear that many ICT projects have not made considerable inroads in agricultural information services. This needs to be a more targeted and strategic application of ICT solutions aimed specifically at the needs of farmers and rural areas. India can fully leverage ICT to create a data-driven, efficient, and sustainable agricultural sector that would not only benefit farmers with timely, reliable information but also align with larger agricultural modernisation and economic growth objectives. Additionally, ICT has the potential to drive agricultural sustainability by facilitating practices that conserve inputs, the ecological use of climate resilience, and balance. Enhancing the agenda of sustainability through ICT and sustainable practices will be a major strategy in creating ecological balance, environmental health, and resilience for agricultural systems for the future.

## DISCLAIMER (ARTIFICIAL INTELLIGENCE)

We hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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