ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25oct1182

# Information and Communication Technology in Rural Development: Challenges and the Way Forward

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Publication Date: 2025/10/30

**Abstract: ICT is revolutionizing rural development, particularly in agriculture. This paper explores how ICT tools, ranging from mobile phones to internet platforms, empower farmers through access to market data, weather updates, and expert guidance. Despite its progress, rural communities continue to face major challenges such as low levels of digital literacy, inadequate infrastructure, scarcity of localized content, and persistent socio-cultural barriers that hinder the effective adoption of ICT in agriculture. Drawing from case studies such as e-Choupal, eNAM, and government initiatives, the paper identifies opportunities and challenges in ICT adoption. It wraps up with practical strategies for inclusive digital growth in Indian agriculture, focusing on infrastructure, education, and policy support.**

***Keywords:*** *ICT, Rural Development, Agriculture, Digital Literacy, e-Governance, Farmers.*

**How to Cite:** Maruti L. Mang; Dr. Chandrika K. B. (2025) Information and Communication Technology in Rural Development: Challenges and the Way Forward. *International Journal of Innovative Science and Research Technology*, 10(10), 1784-1788. https://doi.org/10.38124/ijisrt/25oct1182

## I. INTRODUCTION

ICT has emerged as a transformative force in rural India. With more than 65% of India's population residing in rural areas, agriculture forms the backbone of their livelihoods. Yet, farmers face persistent difficulties in accessing timely information, expert advice, and fair markets (Mukherjee, 2011). ICT offers solutions to these challenges, enabling better productivity, empowering local governance, and improving the quality of life. ICT helps farmers by using mobile phones, the internet, radio, and television to connect them to important information and resources they need.

This paper focuses on the potential and challenges of ICT in rural development, with an emphasis on agriculture.

## II. BENEFITS OF ICT IN AGRICULTURE:

Better Access to Market Information means ICT tools, such as mobile phones, the internet, and radio, help farmers stay informed about market prices, weather forecasts, and product demand. This timely access enables farmers to decide the best time and price to sell their crops, reducing losses and increasing their profits.

Faster and Easier Communication: Farmers can easily share and receive important information with fellow farmers, agricultural experts, and buyers through ICT. This connectivity strengthens networks and facilitates quicker problem-solving and knowledge exchange to improve farming outcomes.

ICT-based tools help farmers increase their profits by improving how they manage their crops and resources. With better access to information, they can reduce waste, prevent losses, and use inputs more efficiently. Digital platforms also allow them to sell their products directly to customers, avoiding middlemen and cutting extra costs. As a result, farmers earn more income and benefit from a more profitable and sustainable farming system.

Support for Research and Learning ICT supports agricultural research by enabling efficient data collection and dissemination. Technologies like GPS, online databases, and digital platforms assist in planning, tracking crop progress,

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25oct1182

and teaching new farming methods to farmers, contributing to continuous learning and innovation.

Boosts the Country's Economy Modern and more productive farming supported by ICT contributes to the broader economy. It helps create employment opportunities, enhances the food supply chain, and reduces poverty, especially in rural communities where agriculture is the main livelihood.

Empowers Youth and Women ICT open new avenues for young people and women in agriculture, offering them opportunities for employment and entrepreneurship. It equips them with digital skills, access to resources, and involvement in decision-making, empowering these traditionally underrepresented groups in the farming community.

ICT refers to the application of digital tools, hardware, and software to manage efficiently, process, and exchange information. It encompasses a wide range of devices and platforms, like mobile phones, computers, the internet, radio, television, and satellite technologies.

UNESCO broadly defines ICT as technologies that facilitate the communication, processing, and transmission of information by electronic means (INFLIBNET)

## III. OBJECTIVES OF THE STUDY:

- To analyze the level of applications and benefits of ICT in agriculture and rural livelihoods.
- To identify the major challenges in adopting ICT in rural areas, particularly for farmers.
- To suggest the strategies to overcome barriers in adapting ICT among rural farmers.

➢ *Scope:*

This study focuses on ICT applications in rural India, assessing both challenges and opportunities with emphasis on agricultural sector.

➢ *Role of ICT in Rural Agriculture:*

ICT empowers farmers by giving real-time information on crop selection, how to control pest, irrigation, and markets. Platforms like e-Choupal and government services link farmers to expert advice and buyers, reducing reliance on middlemen. ICT not only boosts productivity and profitability but also reduces rural isolation and strengthens community networks.

In 2016 and 2017, the Kleffmann Group studied how corn farmers in India use the Internet. In 2016, 4,294 farmers took part, and in 2017, 4,225 farmers participated. In this article, we refer to these maize-growing farmers simply as "the farmers."

Internet access among Indian farmers has been growing. In 2016, 13% of farmers had Internet access, and this number went up to 17% the following year. Most farmers use mobile phones to go online, while only a few use computers or laptops. Even though more farmers now have Internet access, their overall use is still low, and there hasn't been a big rise in how often they use it.

There are big differences in Internet access across states. In Gujarat, over half the farmers use the Internet, and in Maharashtra and Punjab, about one in three farmers are online. However, states like Orissa, TN, and Himachal Pradesh still have very few farmers using the Internet. Use of the Internet to find farming information has grown quickly from 25% in 2016 to 41% in 2017. During the same time, farmers using the Internet for entertainment also increased from 70% to 81%. These changes show that the Internet is becoming a strong way for agricultural companies to reach and help farmers.

Mobile phones are now the widely used technology tool among Indian farmers, with a 2021 survey in Banda district, Uttar Pradesh, showing 100% usage. Internet use in rural communities has grown steadily from 25% of farmers using it for agricultural information in 2016 to 41% in 2017 and by late 2024, rural Internet penetration was around 41% according to the World Economic Forum. Smartphone apps like WhatsApp are popular, with 41.67% of farmers using it for farming purposes and 85.5% calling the Kisan Helpline in 2021. Despite this growth, awareness and adoption of advanced technologies such as GPS, drones, and precision agriculture remain low, with only 34% to 42% of farmers in Haryana aware of them in 2024. Traditional media continues to play a role, as a 2022 study in Mysore, Karnataka, found 73.3% of farmers still watched farming information on television, even though radio use is falling.

The Mass Media Support to Agricultural Extension Scheme uses the nationwide networks of All India Radio and Doordarshan to share the latest farming methods and information with farmers through radio and television programs. Implemented by Prasar Bharati, India's national public service broadcaster, the scheme aims to strengthen the agricultural extension system by providing farmers with timely access to technology, quality inputs, investments, and modern farming knowledge. In today's context, as farming becomes more commercial and cost-focused, this approach helps farmers stay updated and competitive. Radio and television are still highly effective because they can reach a wide number of people at a low cost, making them valuable tools for sharing agricultural information.

➢ *Significance of ICT:*

Information and Communication Technology (ICT) plays a key role in India's rural development by improving productivity, education, governance, and community empowerment. It connects farmers and villagers to real-time information on weather, market prices, crop health, and government schemes, helping them make better decisions and increase productivity. Through mobile apps and online platforms, farmers can access expert advice and use data-driven methods instead of relying on guesswork.

ICT also expands access to education through e-learning platforms and digital classrooms, especially in areas with limited teachers or schools. Online training and interactive

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25oct1182

lessons help rural learners gain new skills for jobs and entrepreneurship. In addition, digital tools support economic growth by promoting e-commerce and digital payments, allowing villagers to sell products directly and use services like UPI for safe, quick transactions.

E-governance initiatives have made public services more transparent and accessible. Programs such as e-Panchayat enable citizens to interact directly with officials, file grievances, and track government schemes. ICT further empowers rural communities by giving them a voice through social media and digital platforms, helping them share local issues, organize collectively, and participate in decision-making. Overall, ICT bridges gaps in information, opportunity, and participation, fostering inclusive and sustainable rural development in India.

➢ *Challenges in Adopting ICT in Rural Areas:*

Low digital literacy remains a major challenge in rural India, as many farmers lack the skills to use smartphones, apps, or online services like e-markets, weather updates, and digital payments. Without training, these tools often go unused or are used incorrectly. Poor infrastructure also limits digital adoption—slow internet, unreliable electricity, and expensive devices make it difficult for farmers in remote areas to access modern technologies. Economic barriers further widen the gap, as small and marginal farmers often cannot afford smartphones or data plans needed for digital farming.

Language and content limitations reduce the usefulness of online resources, since most information is available only in major languages and often lacks locally relevant details. Cultural hesitation and low confidence also play a role, as many farmers still trust traditional practices over digital tools and fear making mistakes. Additionally, women farmers face greater obstacles due to social norms, low literacy, and limited access to finances or training, widening the gender gap in digital participation. Finally, weak policy implementation and poor monitoring reduce the effectiveness of rural digital initiatives, which often fail to address local needs such as affordability, accessibility, and sustainability.

➢ *Applications and Case Studies:*

- e-Choupal (ITC): Village kiosks offering internet-based market updates, expert advice, and weather forecasts.
- Kisan Suvidha & m-Kisan Apps: Provide localized weather updates, pest alerts, and best practice guidance.
- Common Service Centres (CSCs): Rural digital hubs offering agricultural consultations and government services.
- eNAM (National Agriculture Market): A nationwide electronic platform improving transparency and farmer-to-buyer access.
- Community Radio & WhatsApp Groups: Platforms for local information sharing and peer-to-peer farmer networks.
- Government Initiatives: Programs under Digital India and PM-WANI for expanding digital access.

By 2025, India will have witnessed significant growth in the use of ICT in agriculture, with advanced technologies like artificial intelligence, the Internet of Things, precision farming, drones, blockchain, and smart management platforms driving major improvements in productivity and efficiency.

Table 1 Agricultural ICT Technology

| **Agricultural ICT Technology** | **Estimated Adoption Rate (2025)** | **Projected Impact on Crop Yield/Efficiency** |
|---|---|---|
| AI-Powered Drones | 38% | Up to 20% yield increase |
| IoT-Based Soil Sensors | 49% | 15–24% yield increase |
| Precision Irrigation Systems | 43% | 13–18% efficiency improvement |
| Smart Farm Management Platforms | 55% | 18–28% higher efficiency |
| Satellite Crop Monitoring | 34% | 10–23% yield uplift |
| Climate-Resilient Seed Technology | 31% | 10–15% yield improvement |
| Blockchain Traceability Solutions | 10–15% | ~10% loss/fraud reduction |
| Automation & Robotics (Harvesting, etc.) | 25–35% | Up to 19% yield enhancement |
| Precision Agriculture (overall) | 60% farms adopting | Boosted yields, efficient resource use |
| Climate-Resilient/Sustainable Practices | 60–70% | Reduced losses, better soil health |
| Vertical Farming & Controlled Environment | 7–12% | Urban & niche crop yield boost |

Source: Farmonaut.com is a company that uses satellites and artificial intelligence (AI) to help farmers improve their farming methods. Its platform gives farmers real-time information and personalized advice to check crop health, manage water use, and decide when to use fertilizers and pesticides.

By 2025, more than 60% of Indian farms are expected to use precision agriculture, which uses real-time data, AI, and IoT to grow more crops and manage resources better. About 55% of farmers are adopting smart farm management systems, and 49% are using IoT soil sensors. Automated tools like robots and AI-powered drones are becoming common, with over one-third of farms using them. Although still less common, blockchain and vertical farming are growing in use,

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25oct1182

especially for improving supply chains and urban farming. This increase in technology use is helping Indian agriculture become more efficient and sustainable. These trends show that India is rapidly digitalizing its agricultural sector, enhancing crop yield, sustainability, and farmer empowerment through innovative ICT solutions.

➢ *Farmer's Mobile and Internet Access in India*

Farmer mobile and internet access in India reached near-universal levels by 2025, reflecting a major digital transformation in rural regions.

Table 2 Farmer's Mobile and Internet Access in India

| Indicator | Rural India (%) | Urban India (%) | National Average (%) |
|---|---|---|---|
| Households with at least one smartphone | 85.5 | 89.2 | 85.5 |
| Persons (15-29) using mobile phones | 96.8 | 98.2 | 97.6 |
| Smartphone ownership among rural males | 79.2 | 91.3 | — |
| Smartphone ownership among rural females | 75.6 | 90.2 | — |
| Households with internet access | 83.3 | 91.6 | 86.3 |
| Households with mobile internet access | 98.8 | 98.9 | 98.8 |
| Households with optical fiber connection | 3.8 | 15.3 | — |
| Rural internet subscribers (total, 2025) | — | — | 405.3 million |
| Farmers using mobile agri apps | Over 60 | Over 65 | Over 60 |

Source: Ministry of Statistics & Programme Implementation (MoSPI). (2025). "Results of Comprehensive Modular Survey: Telecom (CMS:T), January–March 2025." National Sample Survey, 80th Round. Released May 28, 2025.

- Over 96% of rural youth (age 15–29) regularly use mobile phones, demonstrating high digital literacy.
- 83.3% of rural households report internet access within the home, driven primarily by mobile internet penetration, which stands at nearly 99%.
- The number of rural internet subscribers grew to over 405 million by September 2024, largely attributed to government initiatives like BharatNet.
- More than 60% of farmers use mobile apps for crop management, market access, and advice, illustrating widespread adoption of digital agri-services.

This table shows a major step in India's rural digital transformation. By 2025, mobile and internet access in villages is almost equal to that in cities, showing strong digital inclusion. Government programs like BharatNet and Digital India have improved connectivity, and the growing use of smartphones among rural youth shows their readiness for digital farming. However, challenges like gender gaps and limited fiber networks remain important areas for improvement. The increasing use of agricultural apps also shows that farmers are now widely accepting ICT tools to get real-time information, market updates, and expert advice.

Strategies for Improving ICT Adoption:

- Expand rural broadband, mobile towers, and reliable electricity.
- Organize digital literacy workshops for farmers.
- Develop localized content in regional languages.
- Promote women's inclusion in ICT programs.
- Strengthen public-private partnerships for wider reach.
- Pilot projects to build farmer confidence in ICT solutions.
- Ensure effective monitoring of government ICT schemes.

## IV. ANALYSIS AND INTERPRETATION:

ICT has become a transformative force in rural India, especially in agriculture, which is the livelihood of over 65% of the population. ICT tools including mobile phones, the internet, radio, and television enable farmers to access crucial information such as market prices, weather forecasts, pest alerts, and expert advice in real time. This enhanced access improves decision-making, increases productivity, and helps farmers reduce losses while maximizing profits. Digital platforms like e-Choupal and eNAM have empowered farmers by linking them directly to markets and reducing reliance on intermediaries.

However, the adoption of ICT in rural areas faces several challenges. Low digital literacy is a significant barrier; many farmers lack the skills to use smartphones and digital apps effectively without proper training. Poor infrastructure—such as unreliable internet, weak mobile networks, irregular electricity supply, and the high cost of devices—limits access in remote regions. Economic constraints further inhibit many small and marginal farmers from investing in digital technology or data services. Moreover, the lack of localized, region-specific content in local languages reduces relevance and usability for many rural users.

Cultural factors also play a role. Traditional farming practices and skepticism towards new digital tools lower confidence in adopting ICT solutions. Gender disparities exist, with women farmers facing social norms, limited mobility, and less access to digital literacy programs, increasing inequality. Additionally, weak implementation and coordination of rural digital policies result in inefficiencies and reduced impact.

Despite these challenges, the growth of mobile internet access and smartphone use in rural India is impressive, with

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25oct1182

internet penetration reaching around 83% in rural households by 2025. Farmers increasingly use mobile apps for crop management, market access, and advisory services. Advanced technologies such as AI, IoT, precision farming, drones, and blockchain are beginning to be integrated into farming systems, driving greater efficiency and sustainability.

The document emphasizes the need for multifaceted strategies to maximize ICT's benefits in rural agriculture. These include expanding infrastructure like reliable internet and electricity, conducting widespread digital literacy programs with localized content, promoting women's digital inclusion, and strengthening public-private partnerships. Ongoing monitoring and adaptation of policies are crucial to ensure sustainable, inclusive digital growth.

In conclusion, ICT holds substantial promise for rural development by empowering farmers, improving agricultural productivity, and boosting rural economies. Achieving this potential requires collaborative efforts focused on infrastructure, education, culturally sensitive approaches, and policy effectiveness, fostering an inclusive digital revolution in Indian agriculture.

## V. CONCLUSION

The farmer community is central to rural development, and ICT has immense potential to enhance livelihoods by providing timely information, reducing risks, and increasing profitability. However, bridging the digital divide requires targeted investments in education, infrastructure, and inclusive policies. A collaborative and sustained approach combining government, private sector, and community efforts can ensure that ICT catalyzes rural prosperity. Future research should also explore emerging technologies such as AI, IoT, and blockchain in agriculture to drive sustainable development.

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