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Empowering women through digital inclusion: A pathway to sustainable agriculture in India

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Abstract
Digital inclusion has become a powerful tool for promoting gender equity and sustainable agricultural growth in India. Even though women make up a large part of the agricultural labour, they still have a hard time getting digital tools, ICT-based advisory services, and e-governance platforms because of structural, socio-cultural, and infrastructural impediments. This study looks at how digital inclusion might help women farmers by giving them better access to information, markets, loans, and farming methods that can withstand climate change. The research identifies effective methods that address the digital gender barrier, including national programs like the Digital India programme and the Mahila Kisan Sashaktikaran Pariyojana (MKSP). The study incorporates data from national surveys, FAO and World Bank publications, and GSMA gender gap statistics to assess the socio-economic effects of digital access. Results indicate that focused digital literacy instruction, cost-effective internet access, and gender-sensitive agricultural technology improvements markedly improve women's productivity, financial stability, and autonomy in decision-making. The study finally asserts that the integration of gender-responsive digital methods into agricultural policy is essential for the attainment of SDG 5 and SDG 2 and also for fostering climate-smart, sustainable agriculture in India.

Keywords: ICT in agriculture, digital inclusion, sustainable agriculture, gender empowerment, digital literacy, rural development, agricultural extension, gender gap

Introduction
Agriculture in India is not merely an economic activity; it is deeply intertwined with the socio-cultural fabric of rural life. Within this domain, women form the backbone of agricultural labour, contributing significantly to farming, livestock care, and post-harvest operations. According to the Food and Agriculture Organization (FAO), women constitute nearly 33% of cultivators and about 47% of agricultural labourers in India. Despite this, they remain marginalized in decision-making and access to resources.

One of the key factors hindering women's empowerment in agriculture is the digital divide. Digital tools can democratize access to information, financial services, weather forecasts, crop advisories, and markets. However, women in rural India face numerous challenges in accessing and utilizing digital technologies due to socio-cultural norms, limited digital literacy, and inadequate infrastructure. Bridging this gap through inclusive digital initiatives can significantly enhance agricultural productivity and ensure sustainability.

This study explores how digital inclusion can empower women in agriculture and pave the way for sustainable development. It discusses current challenges, successful interventions, and the transformative potential of digital tools for inclusive growth.

Women in Indian Agriculture
Despite their extensive involvement, women farmers are often considered 'invisible' in policy and practice. Most lack land ownership, which restricts their access to institutional credit, training, and government schemes. This structural exclusion translates into economic and social marginalization. Women farmers are also less likely to benefit from agricultural extension services. Agricultural extension services in India have evolved over decades, from state-led community development programs to pluralistic models involving government, non-governmental organizations (NGOs), private players, and digital advisory platforms. Extension systems act as the bridge between scientific research institutions and farming communities, translating complex scientific knowledge into practical, adoptable techniques.

However, while extension systems have contributed significantly to agricultural growth, their outreach has not been equitable.

A large body of literature reveals that women farmers, who constitute nearly 42% of the agricultural workforce and perform 60-80% of farming tasks, remain largely marginalized within extension frameworks. This gender gap undermines productivity, perpetuates poverty, and stalls progress toward sustainable and inclusive rural development. According to a report by the Indian Council of Agricultural Research (ICAR), only 5% of women farmers receive formal agricultural training. This situation is further exacerbated by low levels of digital literacy. GSMA's Mobile Gender Gap Report (2022) notes that only 30% of women in rural India own a smartphone. Social norms and intra-household gender dynamics limit their access to digital devices and the internet.

Digital Inclusion: Concepts and it's importance for women farmer

Digital inclusion involves ensuring equitable access to technology, internet connectivity, digital literacy, and tools that enable women farmers to make informed decisions, access services, and participate fully in the agricultural ecosystem.

- **Bridging the digital divide enhances productivity and empowerment:** Bridging the digital divide refers to closing the gap between those who have ready access to digital tools, internet connectivity, and information, and those who do not. For women farmers in India, this divide is particularly stark due to systemic gender inequalities, socio-cultural barriers, and infrastructural limitations. However, studies and on-ground evidence show that when this gap is bridged, it significantly enhances not just agricultural productivity but also women's economic empowerment, autonomy, and leadership in rural communities. According to the Food and Agriculture Organization (FAO, 2023), digital inclusion helps women farmers transition from passive to active participants in agriculture by improving their access to market and climate-related information (FAO, 2023, International Women's Day briefing). A study by Kumar & Choudhary (2021) [7] in Haryana demonstrated that ICT tools significantly improved agricultural decision-making and farm productivity among female respondents. Mittal & Mehar (2016) [9] highlight that digital technologies reduce social constraints for women by removing the need for physical mobility in accessing advisory services (International Food Policy Research Institute). Research on tribal communities in Wayanad (Kerala) shows that limited internet and social media access leads to digital disempowerment among marginalized women, impeding their economicand social inclusion (Arya S, Pradeep Kumar B (2025) [7].
- **Women's Inclusion in ICT Tools Drives Agricultural Extension:** Agricultural extension services in India have historically been male-dominated, limiting women farmers' access to timely and relevant information. Meera *et al*. (2004) [8] have noted that women farmers often receive agricultural information second-hand through male relatives, leading to delays, misinterpretation, and reduced application of modern farming techniques. The introduction of Information and Communication Technology (ICT) tools such as mobile-based advisories, community radio, interactive voice response systems, and agri-apps has emerged as a transformative force in overcoming these barriers. When women farmers gain access to ICT tools, they not only improve agricultural productivity but also enhance decision-making power, income levels, and overall empowerment. ICT tools remove several structural barriers by providing direct, real-time access to weather forecasts, pest alerts, market prices, and crop advisories. It allows two-way communication between farmers and extension agents. It also creates opportunities for peer learning through women-focused WhatsApp groups, digital storytelling, and video demonstrations. Qiang *et al*. (2011) [15] in World Bank ICT in Agriculture Sourcebook highlight that mobile-based agricultural information services can increase smallholder productivity by 5-30%, with a stronger effect when women farmers are direct users. Digital Green's participatory video approach has shown that women farmers in Odisha and Bihar who engaged with ICT-based learning adopted improved farming practices at rates 3-4 times higher than those relying on traditional extension (Gandhi *et al*., 2009) [5]. FAO & SEWA (2018) [16] report that integrating ICT into women's agricultural training reduced post-harvest losses by 15-20% in Gujarat. A 2022 NITI Aayog study on rural digital inclusion found that women who actively used ICT-based agricultural platforms were 40% more likely to participate in local agri-policy consultations.

- **Digital Tools as Enablers of Financial Inclusion for women farmer:** Financial inclusion the access to affordable financial services such as savings, credit, insurance, and remittance facilities is critical for rural women farmers and agri-entrepreneurs in India. Digital financial tools are transforming rural women's economic participation by:
  - Reducing dependence on informal moneylenders
  - Enabling direct benefit transfers (DBT) of government subsidies into women's accounts
  - Providing micro-credit through fintech apps without physical collateral
  - Facilitating cashless transactions in local markets, enhancing safety and transparency

Mookerjee *et al*. (2021) [10] in World Development reported that Aadhaar-enabled payment systems increased women's control over household spending and improved agricultural investment decisions. A UN Women (2022) study in rural Maharashtra showed that women with access to mobile banking were 35% more likely to invest in high-value crops and agricultural equipment than those without digital financial access. Government-backed schemes like Pradhan Mantri Jan-Dhan Yojana, Stand-Up India, and the Digital Saksharta Abhiyan provide a foundation for financial literacy and inclusion. Under the Mahila Kisan Sashaktikaran Pariyojana (MKSP), women self-help groups (SHGs) are trained to use digital kiosks for banking transactions, enabling them to operate agri-based microenterprises. An evaluation by NABARD (2020) [12]

reported that SHG members with digital finance access had 22% higher incomes than their non-digital counterparts.

Challenges in digital inclusion for women farmers in India

While digital inclusion has transformative potential for women in agriculture, its benefits are unevenly distributed due to structural, socio-cultural, and infrastructural barriers.

- **Limited digital literacy and skills gap:** According to the National Sample Survey Office (NSSO, 2019), only 14.9% of rural women in India are able to operate a computer or use the internet. It has been also observed that digital literacy programs often fail to account for women's time constraints and existing workloads, leading to poor participation rates.
- **Poor connectivity and infrastructure gaps:** Rural areas, particularly remote villages, still suffer from poor mobile network coverage, unreliable electricity supply, and high internet costs. World Bank (2021) [18] data shows that poor connectivity disproportionately impacts women farmers, as they are less likely to travel to urban areas to access digital services.
- **Socio-cultural barriers and mobility restrictions:** Patriarchal norms and safety concerns can restrict women's ability to attend ICT training programs or visit digital service centres. FAO (2018) reports that women in rural India often face family opposition to participating in mixed-gender digital training sessions. Meera *et al*. (2004) [8] found that women are more likely to adopt ICT tools when training is conducted in local languages, in women-only groups, and within their villages.
- **Affordability and Economic Constraints:** Even when digital tools are available, their cost can be prohibitive for women farmers with limited independent income. GSMA (2021) [6] notes that affordability remains a major barrier, with device costs and data tariffs consuming a higher proportion of women's earnings compared to men's.
- **Fragmented Policy Implementation:** Although multiple schemes like Digital India, Digital Saksharta Abhiyan, and Mahila Kisan Sashaktikaran Pariyojana exist, coordination between ICT training, financial literacy, and market linkage programs is often weak. NABARD (2020) [12] notes that without convergence between agricultural extension, rural development, and digital literacy schemes, benefits are diluted.

Government initiatives and digital inclusion for women in India

"Gender and Inclusion in Digital" Initiative (World Bank 2025) [19] highlights the persistent gender gap in internet use. Women in low- and middle-income countries are 15% less likely than men to use mobile internet. It outlines women-focused strategies including:

- Private investment in infrastructure with gender-specific Key performance indicators
- Last-mile safe connectivity hubs;
- Affordable devices and financing;
- Digital safety measures;
- Digital skills training for underserved women.

Table 1: Government Initiatives and its' impact on women farmer of India

Initiative & Year	Ministry/ Implementing Agency	Objective	Key Features	Impact on Women Farmers
Digital India Programme (2015)	Ministry of Electronics & Information Technology (MeitY)	Transform India into a digitally empowered society and knowledge economy	Broadband highways, mobile connectivity, CSCs, e-Governance, digital literacy	Improves access to agricultural advisories, online markets, and financial services for rural women
BharatNet Project (2011)	Department of Telecommunications (DoT) under MeitY	Provide high-speed broadband to all 250,000 Gram Panchayats	Optical fibre network, public Wi-Fi hotspots, PPP model	Facilitates women's access to market prices, weather data, and e-learning
Pradhan Mantri Gramin Digital Saksharta Abhiyan (PMGDISHA) (2017)	MeitY	Provide digital literacy to 60 million rural households	Training in device use, online services, digital payments	Equips women with skills for e-banking, online agri-input purchases, and e-NAM
Common Service Centres (CSCs) Scheme (2006)	CSC e-Governance Services India Ltd. (MeitY)	Deliver digital services in rural areas	Agriculture advisories, telemedicine, e-governance services	Empowers women as Village Level Entrepreneurs; special projects like *Stree Swabhiman* promote health and economic participation among rural women.
e-NAM (National Agriculture Market) (2016)	Ministry of Agriculture & Farmers Welfare	Create a unified national agri-market	Online trading, real-time market data, multilingual support	Enhances bargaining power and price transparency for women farmers.
Mahila Kisan Sashaktikaran Pariyojana (MKSP) (2011)	Ministry of Rural Development under NRLM	Empower women in agriculture	Digital training on crop/livestock management, capacity building	Directly targets women farmers for ICT-enabled agricultural training
Kisan Call Centres (KCC) & mKisan Portal (2013)	Ministry of Agriculture & Farmers Welfare	Provide agri-advice via phone/SMS	Multilingual expert support, weather alerts, pest control tips	Overcomes mobility barriers; allows at-home access to expert advice
Digital Saksharta Abhiyan (DISHA) (2014–2016)	MeitY	Provide IT training to one person per household	Basic computer and internet training	Helps rural women access e-commerce and online agricultural resources
National Digital Communications Policy (NDCP) 2018	Department of Telecommunications	Universal broadband coverage at 50 Mbps	Gender-inclusive connectivity goals	Recognises rural women's digital gap, promoting targeted connectivity
PM-WANI (2020)	Department of Telecommunications	Expand public Wi-Fi access via local entrepreneurs	License-free Wi-Fi provision, affordable access	Reduces cost barrier for women to access online markets and training
AgriStack (Under Development)	Ministry of Agriculture & Farmers Welfare	Unified farmers' database for targeted services	Linkage to land records, digital platforms	Potential to ensure women's inclusion if gender-sensitive data is maintained

It also introduces the Digital Empowerment and Equity Program (DEEP), launched with partners like the Gates Foundation to accelerate women's digital inclusion. The Government of India have also launched a range of initiatives to bridge the digital divide, with several programmes having a direct or indirect impact on rural women farmers. These efforts aim to improve connectivity, digital literacy, and access to agricultural and financial services, thereby fostering empowerment and sustainable livelihoods. Below in Table 1 a detailed summary of key initiatives and their relevance to women in agriculture is given.

These initiatives collectively create a supportive ecosystem for women's digital participation in agriculture. While flagship programmes such as *Digital India* and *BharatNet* focus on infrastructure, others like *PMGDISHA* and *MKSP* address the capacity-building needs of women farmers. Additionally, market-oriented platforms such as *e-NAM* integrate women producers into formal value chains, allowing them to access better price information and negotiate from a position of strength.

However, the success of these programmes depends on factors such as gender-sensitive outreach, localized language content, and affordable device access.

Policy Recommendations:

1. Infrastructure and Connectivity

- **Universal Broadband Access:** Prioritize coverage for women-centric SHG clusters and agricultural centers to expedite the BharatNet initiative.
- **Gender-Responsive Public Wi-Fi:** Expand *PM-WANI* hotspots in rural markets, agri-cooperatives, and community centres where women farmers gather.
- **Device Access Schemes:** Subsidized smartphones and tablets for registered women farmers under schemes like *Kisan Credit Card* or MKSP. In Odisha, the Swayam Sampurna Farmer Producer Organization (FPO) comprised entirely of women members across 139 villages-leverages digital tools like e-Farm and Farmer. Chat to enable data-driven farming and real-time crop advisory, Community Resource Persons (CRPs), all women, lead this digital revolution, boosting productivity and bargaining power.

2. Capacity Building and Digital Literacy

- **Localized, gender-sensitive training:** Expand on PMGDISHA by adding agricultural information in regional languages and adding voice-activated navigation for users with poor reading levels
- **Community digital champions:** Train women as *Village Digital Sakhis* to provide peer-to-peer support and encourage adoption.
- **Integration with agricultural extension:** Ensure every extension programme includes a digital skill module tailored for women farmers.

3. Access to digital agricultural services

- **Inclusive Market Platforms:** Strengthen *e-NAM* and other agri-tech portals with women-focused onboarding, simplified transaction interfaces, and credit linkages.
- **Weather and Advisory Services**: Customize SMS and IVR-based updates to include crop-specific, location-based advice targeted at women farmers.
- **Financial Inclusion via Digital Tools**: Link women to UPI, digital wallets, and mobile banking through SHGs and Farmer Producer Organisations (FPOs).

4. Policy and Governance Measures

- **Gender-Disaggregated Data in AgriStack**: Maintain accurate, updated databases on women farmers to ensure targeted benefits.
- **Incentives for Agri-Tech Startups**: Offer grants to startups developing affordable, women-centric digital farming solutions.
- **Inter-Ministerial Convergence**: Align policies of MeitY, Ministry of Agriculture, Ministry of Rural Development, and NABARD for integrated digital inclusion strategies.

5. Social and Cultural Inclusion

- **Awareness Campaigns**: Promote the value of women's digital participation through community radio, folk media, and women's cooperatives.
- **Family and Community Engagement**: Train male family members to support women's ICT usage, countering patriarchal resistance.
- **Safe Digital Spaces**: Ensure cyber safety training, grievance redressal, and women-friendly online environments.

Conclusion

Digital inclusion empowers women, making it a key pillar of sustainable agriculture in India. Women farmers' productivity, income, and climate resilience improve when they have access to ICT tools, mobile-based market information, digital banking services, and online agricultural extension platforms. These advantages are threatened by gender inequalities in digital access due to economics, literacy, and socio-cultural norms. Targeted, context-specific interventions like MKSP, Digital India, and have bridged the divide. Scalability and sustainability are improved via partnerships with private sector innovators, self-help organizations, and foreign development agencies. Future plans must incorporate gender-sensitive KPIs, invest in rural broadband infrastructure, promote regional language content, and involve women in agri-tech solution creation to change. Empowering women through digital channels boosts rural economic growth and creates inclusive, climate-resilient, and sustainable agricultural systems, making India more egalitarian and food-secure.

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