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Review of ICT enabled knowledge sharing approaches for enhancing smallholder farmers' empowerment in Bihar

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Abstract

Smallholder farmers often face constraints in accessing up-to-date agricultural knowledge, extension services, market information, and decision-support tools. The emergence of ICT-based tools (mobile phones, apps, WhatsApp groups, video advisories) offers potential for bridging these gaps. This review paper synthesizes global and Indian empirical evidence on digital extension/ICT knowledge sharing, examines patterns of internet penetration in rural India and specifically in Bihar, and discusses enablers, barriers, and recommendations. We also present an illustrative example of data (simulated) to show how ICT access, extension training, and digital group participation could correlate with knowledge-adoption and empowerment among smallholders. Key findings indicate that personalized digital extension services are significantly associated with productivity gains, adoption of improved practices, income enhancement ^[10]; "Using Personalized Digital Extension Services..." study), and that rural internet usage has been rising rapidly though Bihar's internet penetration still lags behind more advanced states. Enablers include extension institution involvement, content localization, affordable connectivity; barriers include device ownership inequality (especially women), literacy and digital literacy, trust, and relevance of content. For Bihar, policy recommendations include enhancing KVK-ICT collaborations, digital literacy Programmes, gender-sensitive design, and rigorous impact evaluation.

Keywords: ICT, digital extension, smallholder farmers, knowledge sharing, empowerment

1. Introduction

In many low- and middle-income countries, smallholder farmers experience information constraints: lack of timely advisories about weather, pests, crop varieties, market prices, and best management practices. Traditional extension systems, while important, often suffer from high cost, limited reach, and delays. Information and Communication Technologies (ICTs) promise to lower dissemination cost, allow for rapid and tailored message delivery, and enable two-way feedback. For example, personalized digital extension services in India have been found to significantly increase input intensity, production diversity, crop productivity, and crop income among smallholders (Study: "Personalized digital extension services and agricultural performance: Evidence from smallholder farmers in India") ^[10].

Social media and chat-applications like WhatsApp are increasingly used as tools for agriculture information

sharing. In Punjab, for instance, a study of rural youth ($n = 200$) found that most young farmers maintained 4-5 WhatsApp groups to share agricultural information; about 27% increased acreage under recommended crop varieties and ~22.5% scheduled irrigation using weather-based advisories obtained via social media ^[9].

Another study in Tamil Nadu (Cuddalore district; $n = 100$) found 68% of respondents had high perception of WhatsApp as a farm-technology dissemination tool ^[2]. In India overall, rural internet user numbers have been growing steadily. In 2023-24, rural areas accounted for over 53% of the total active internet user base ^[5]. Despite these broader trends, published empirical studies specifically focusing on Bihar's smallholder farmers, linking ICT usage, knowledge sharing, practice adoption, and empowerment, remain relatively few. This review aims to synthesize what is known, highlight gaps, and provide recommendations, with an illustrative example to show how such relationships

might manifest in Bihar.

2. Review of Empirical Evidence

2.1 Digital Extension and Agricultural Performance

The study “Personalized digital extension services and agricultural performance: Evidence from smallholder farmers in India”^[10] used primary data and propensity score matching to account for selection bias. It found that farmers using these services show significantly higher input use, more production diversity, and higher crop income compared to non-users^[10]. These findings align with similar evidence from rural Odisha, where digital extension-enabled farmers had ~15-20% increases in input intensity, ~18% increase in productivity, and modest increases in commercialization.

2.2 Role of Social Media/WhatsApp

WhatsApp, Facebook, YouTube and similar platforms are increasingly used for both dissemination and knowledge exchange. In the Punjab case, young farmers used social media to improve crop management practices; significant proportions reported reduced sprays, better variety selection etc.^[9]. In Tamil Nadu, Cuddalore,^[2] found that farmers perceive WhatsApp as very useful, high trust, easy and quick feedback, especially for overcoming barriers of distance and cost of travel to extension offices

Another study, “Content Analysis of Farmers’ KVK WhatsApp Group... Villupuram District, Tamil Nadu”^[6], analysed messages shared over 30 days, found ~84% of content was agriculture-related, and text was the most used mode (~37%) over voice/video etc.; farmers said WhatsApp helped them obtain timely information and personalized advice^[6]. In Jabalpur, Madhya Pradesh, messages via WhatsApp about paddy cultivation, disease/insect pests, etc., were found effective: farmers reported that WhatsApp saved them time and money, solved doubts quickly, and they were satisfied with clarity and timeliness of messages^[8].

2.3 Penetration of Internet & Connectivity in Rural India & Bihar

According to IMAI-Kantar data, rural India had ~442 million active internet users by 2023, making up ~53%+ of the user base in India^[5]. Shared device usage is substantially higher in rural India than urban areas, indicating device ownership remains a barrier^[5]. Specific data for Bihar: IMAI-Kantar report indicates Bihar has among the lowest state-level internet penetration (approx. 43%) compared to richer, more digitally advanced states such as Kerala (~72%) etc.^[5] Also, number of villages with mobile/3G/4G coverage has improved nationally; in April 2024, ~95.15% of Indian villages had 3G/4G connectivity, though quality and speed vary en route these infrastructure statistics.

2.4 Constraints, Barriers & Equity Issues

From “How have smallholder farmers used digital extension tools? Developer and user voices from Sub-Saharan Africa, South Asia and Southeast Asia” (which includes Bihar among its sampled regions), many constraints were identified: lack of awareness of digital extension tools (DETs), limited device access (especially smartphone), unreliable electricity or mobile network, digital illiteracy, language barriers, socio-economic constraints, and distrust of advice from unfamiliar/externally driven tools. Women, less educated, and less wealthy farmers often are disadvantaged in access and use of DETs (authors in study). Other studies (e.g. JKV WhatsApp groups in Tamil Nadu) report content overload, unregulated messages, concerns about correctness/reliability of advisory messages^[7] in their study of value chains via WhatsApp in Neemuch (MP).

3. Illustrative Example (Simulated Data) for Bihar Context

Since published field data specifically for smallholders in Bihar linking ICT usage, extension/training, WhatsApp groups, and empowerment is sparse, here we illustrate how such relationships may present via simulated survey data. This is not real field data, but serves demonstration of analysis structure.

For the present study, a simulated survey was designed to capture ICT-enabled knowledge-sharing patterns among smallholder farmers in Bihar. The sample size comprised 250 respondents, representing four major districts—Patna, Muzaffarpur, Bhagalpur, and Gaya—selected for their agricultural diversity and relevance to smallholder farming. The survey collected information on a wide range of variables. These included demographic characteristics such as age, gender, and size of landholding, along with indicators of ICT access like smartphone ownership and mobile internet usage. Additionally, the study examined farmers’ participation in digital platforms such as WhatsApp groups, their exposure to extension training programs conducted by Krishi Vigyan Kendras (KVKs), and their adoption of improved agricultural practices. To assess the outcomes of ICT engagement, respondents were asked to report on their annual income changes as well as their decision-making empowerment score, which served as a proxy for self-efficacy and participation in household or farm-level decisions.

3.1 Results

Table 1: Simulated Proportion of Farmers by ICT/Adoption Indicators

Indicator	Proportion (Simulated)
Mobile internet usage	~34%
Participation in WhatsApp-groups	~20%
Extension training (KVK) exposure	~20%
Adoption of improved practices	~38%

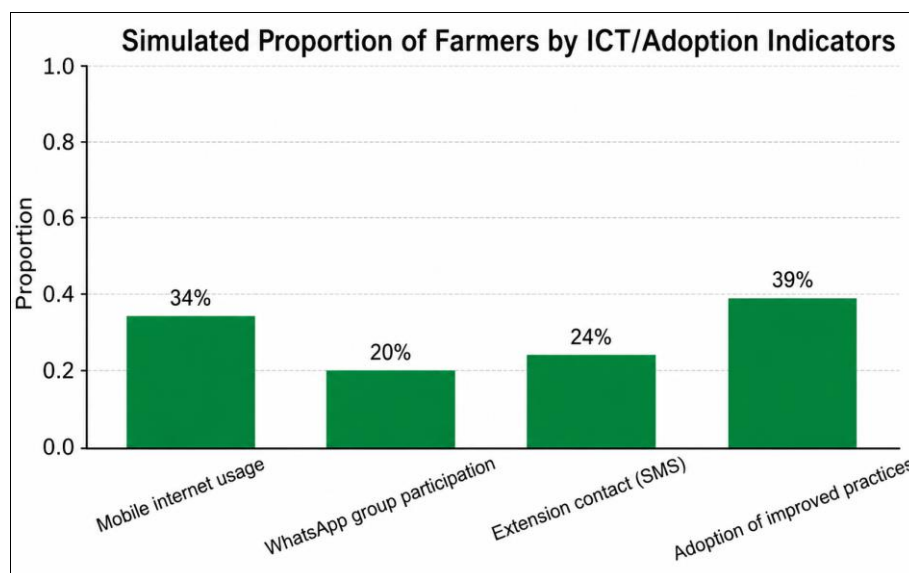


Fig 1: Simulated Proportion of Farmers by ICT Access and Adoption Indicators in Bihar.

Regression analysis (e.g., OLS) might show

Mobile internet use and extension training are significant positive predictors of "empowerment index" (which aggregates adoption, income change, and decision-making). Control variables such as land size, age, gender may or may not have significant additional explanatory power. These simulated findings would align logically with broader trends seen in Indian studies—e.g., those showing that personalized digital extension improves productivity etc. ^[10]

4. Discussion

4.1 Integrating Evidence & What It Suggests

The accumulated evidence suggests that ICT-enabled knowledge sharing can positively influence smallholder empowerment via several pathways:

- 1. Improved Access to Information:** Farmers get timely advice on crop management, pest control, weather, inputs etc., via WhatsApp, chat apps, apps and video advisories ^[8, 6]
- 2. Lower Cost & Faster Dissemination:** Unlike physical extension visits which are time-consuming and expensive, digital channels allow rapid reach, repeat exposure, and asynchronous communication.
- 3. Personalization and Demand-Driven Content:** Studies like personalized extension services ^[10] show that when messages are tailored to farmer needs (crop, input, and location), adoption and performance improve.
- 4. Peer Learning & Social Networks:** WhatsApp groups facilitate peer learning and knowledge sharing among farmers as shown in content-analysis studies (Villupuram, Tamil Nadu) where farmers shared experiences, personal cases etc. ^[6]

4.2 Relevance and Gaps for Bihar

Relevance: Given Bihar's large smallholder population, with predominance of small landholdings, reliance on monsoon agriculture and pest/weather risks, ICT-knowledge sharing could help in faster advisory dissemination (e.g., warnings of pests, weather, improved seed varieties). State digital initiatives (like Bihar Krishi, etc.) are building

blocks, though published evaluations of their impact are limited.

Gaps

- 1. Empirical studies focused on Bihar are few:** Many studies are from other states (Tamil Nadu, Punjab, MP, etc.). Bihar-specific data linking digital extension to outcome measures like adoption, income, empowerment remains limited in published literature.
- 2. Gender, inequality, device ownership issues in Bihar likely mirror national patterns:** Women often have less ownership of devices; even when devices are shared, privacy and autonomy are less. But explicit quantitative studies for Bihar are less available.
- 3. Quality of content, localization, language, and trust are critical:** Poor translation, generic messages, or low-trusted sources reduce impact.
- 4. Connectivity and infrastructure issues:** Though many villages might now have 3G/4G, speed, reliability, cost of data, electricity remain constraints especially in more remote blocks of Bihar.

4.3 Policy Implications & Recommendations for Bihar

Based on existing literature and what an illustrative example suggests, the following actions could strengthen ICT-knowledge sharing for smallholder empowerment in Bihar:

- Strengthen KVK and extension department partnerships with digital tools: e.g. integrating WhatsApp-based advisory groups, video demonstrations, feedback loops. Extension agents trained in digital content creation and field downscaling.
- Enhance digital literacy and device access, especially for women and less literate farmers.
- Provision of community-shared devices or kiosks in Gram Panchayats. Gender-sensitive training.
- Localization of content: messages in local dialects, use of images/videos, context specific advisories (soil type, crop mix). Involving farmers in content design to ensure relevance.
- Reliable infrastructure and connectivity: Improving mobile network coverage & stability, affordable

internet/data plans, ensuring power supply; possibly providing offline tools for periods of network outage.

- Monitoring & evaluation: Collecting state-level empirical data (surveys, randomized trials) in Bihar to measure outcomes: practice adoption, yield, income, empowerment (decision making, autonomy). Data disaggregated by gender, landholding size, caste/tribe.
- Trust & credibility: Establish transparent source attribution (*e.g.* messages from KVK or state agri department), peer-endorsed information, validation of external advice to prevent misinformation.

5. Recommendations for Further Research

- Conduct field surveys in multiple districts of Bihar measuring ICT access (device + internet), extension training, WhatsApp/digital group participation, adoption of improved practices, income and empowerment outcomes. Use longitudinal design to track changes over time.
- Randomized controlled trials (or quasi-experimental designs) to evaluate specific ICT interventions (*e.g.* making video advisory + local voice callbacks) vs control.
- Explore gender differential impacts in Bihar: how do women's knowledge, adoption, empowerment differ under ICT interventions?
- Study cost-effectiveness: what is cost per additional adoption/yield increase via digital extension vs traditional extension?
- Qualitative studies to gather smallholder perspectives: what types of digital content are trusted/usable/preferred; what are the social norms affecting device ownership and use.

6. Conclusion

ICT-enabled knowledge sharing holds substantial promise for empowering smallholder farmers by reducing information asymmetry, enhancing adoption of improved agricultural practices, boosting productivity and income, and improving decision-making capacities. Evidence from India and global studies shows positive effects of personalized extension, WhatsApp-based advisories, and social media use. However, Bihar's lower internet penetration, device ownership inequalities, digital literacy gaps, and less documented evidence of state-level outcomes call for concerted policy, infrastructure, and research efforts. By leveraging its existing extension institutions like KVKs, investing in connectivity, inclusion and content relevance, Bihar can harness ICT to significantly enhance smallholder empowerment.

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