



Digital Extension Services and Their Role in Accelerating Agricultural Technology Adoption

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Agricultural extension plays a vital role in transferring scientific knowledge and innovations from research institutions to farmers. However, conventional extension systems often face challenges such as limited manpower, delayed information delivery, and inadequate outreach. In recent years, digital extension services have emerged as an effective alternative to overcome these constraints. Digital tools such as mobile phones, agricultural applications, call centers, and social media platforms enable timely, cost-effective, and location-specific dissemination of agricultural information. This article examines the role of digital extension services in accelerating agricultural technology adoption among farmers. It highlights how digital platforms enhance awareness, improve access to information, and support informed decision-making related to improved agricultural practices. Despite their potential, issues such as digital illiteracy, poor internet connectivity, and lack of localized content limit their effectiveness. The study concludes that strengthening digital infrastructure, enhancing farmers' digital skills, and integrating digital tools with traditional extension approaches are essential to maximize technology adoption and promote sustainable agricultural development.

Keywords: Digital extension services, technology adoption, ICT in agriculture, mobile advisory, agricultural innovation

Introduction

Agriculture continues to be the primary source of livelihood for a large proportion of the rural population in developing countries. The growth and sustainability of the agricultural sector largely depend on the effective dissemination of scientific knowledge and modern technologies to farmers. Agricultural extension services act as a bridge between research institutions and farmers by facilitating the transfer of improved technologies and practices. Traditional extension systems, although effective, are constrained by limitations such as inadequate extension personnel, high operational costs, and limited farmer reach. These challenges have created a need for alternative extension approaches. With rapid advancements in information and communication technologies (ICTs), digital extension services have emerged as a promising tool to strengthen extension delivery systems. Digital extension services provide farmers with timely access to agricultural information related to crop production, pest and disease management, weather forecasts, and market prices. These services play a significant role in accelerating the adoption of improved agricultural technologies by reducing information gaps and enhancing farmers' decision-making abilities.

Theoretical Framework of Technology Adoption

The adoption of agricultural technologies is a complex process influenced by individual, social, and institutional factors. Several theories explain how and why farmers adopt new technologies. Among these, the Diffusion of Innovations Theory proposed by Rogers (2003)

is widely used in agricultural extension research. According to this theory, adoption is a process that involves five stages: knowledge, persuasion, decision, implementation, and confirmation. Digital extension services play a critical role in the early stages of the adoption process by creating awareness and enhancing farmers' knowledge about new technologies. Mobile advisories, videos, and digital content help reduce uncertainty and perceived risk associated with innovations. By facilitating continuous access to information and expert guidance, digital extension services positively influence farmers' attitudes and accelerate the adoption process.

Types of Digital Extension Services Used in Agriculture

Digital extension services are delivered through various ICT tools and platforms, each serving a specific purpose in agricultural information dissemination.

Mobile-Based Advisory Services

Mobile phones are the most widely used digital tools in agricultural extension. SMS and voice messages provide farmers with timely information on crop management practices, pest and disease control, and weather forecasts. These services are cost-effective and accessible even in remote areas.

Agricultural Mobile Applications

Agricultural apps provide comprehensive information on improved technologies, input use, crop calendars, and market prices. Many apps also include images, videos, and interactive features that enhance farmers' understanding of recommended practices.

Kisan Call Centers

Kisan Call Centers offer farmers direct access to agricultural experts through toll-free numbers. Farmers can seek solutions to their problems in real time, which improves confidence in adopting new technologies.

Social Media and Online Platforms

Social media platforms such as WhatsApp, YouTube, and Facebook are increasingly used for agricultural knowledge sharing. Farmer groups and digital communities promote peer learning and experience exchange, which positively influence technology adoption behavior.

Concept of Digital Extension Services

Digital extension services refer to the use of ICT-based tools and platforms to deliver agricultural information and advisory services to farmers. These services include mobile phone-based SMS and voice advisories, agricultural mobile applications, Kisan Call Centers, social media platforms, online portals, and digital learning modules. Unlike conventional extension methods, digital extension services offer real-time and interactive communication. Farmers can access information anytime and anywhere, reducing dependence on physical visits by extension workers. Digital platforms also allow customization of advisory messages based on crop type, location, and growth stage, making extension services more relevant and farmer-centric.

Technology Adoption in Agriculture

Technology adoption in agriculture refers to the process through which farmers become aware of, evaluate, and implement improved agricultural practices. Adoption is influenced by several factors such as socio-economic characteristics, education level, farm size, risk perception, and access to extension services. Extension systems play a crucial role in facilitating technology adoption by increasing farmers' awareness and confidence in new technologies. Digital extension services enhance this process by providing continuous access to information, reinforcing learning, and enabling faster diffusion of innovations among farming communities.

Role of Digital Extension Services in Technology Adoption

Digital extension services significantly contribute to accelerating agricultural technology adoption. Mobile-based advisories provide timely information on crop management practices, pest outbreaks, and weather conditions, enabling farmers to take preventive and corrective

measures. Agricultural mobile applications offer visual content, decision-support tools, and step-by-step guidance that simplify complex technologies. Social media platforms and digital farmer groups encourage peer learning and experience sharing, which increases farmers' trust in new technologies. Digital extension also improves feedback mechanisms by allowing farmers to interact directly with experts, thereby enhancing the effectiveness of advisory services. As a result, farmers are more likely to adopt improved seeds, nutrient management practices, integrated pest management, and water-saving technologies.

Impact of Digital Extension Services on Farmers' Decision-Making:

Access to timely and accurate information significantly influences farmers' decision-making processes. Digital extension services empower farmers by providing them with real-time data on weather conditions, pest outbreaks, and market trends. This enables farmers to make informed decisions related to input use, crop selection, and harvesting time. Digital advisory services also reduce dependency on informal and unreliable information sources. By improving farmers' confidence in scientific recommendations, digital extension services encourage the adoption of improved technologies and sustainable farming practices.

Policy Support and Government Initiatives:

The promotion of digital extension services is supported by various government initiatives aimed at strengthening agricultural information systems. Programs such as Digital India, mKisan, e-NAM, and Kisan Call Centers emphasize the use of ICTs in agriculture. These initiatives aim to enhance farmers' access to information, improve market linkages, and promote transparency in agricultural transactions. Policy support plays a crucial role in scaling up digital extension services and ensuring their integration with existing extension frameworks.

Constraints in the Use of Digital Extension Services:

Despite their advantages, digital extension services face several challenges. Limited digital literacy among farmers, particularly older farmers, restricts effective utilization of digital tools. Poor internet connectivity, unreliable electricity supply, and high cost of smartphones further constrain access in rural areas. Additionally, lack of localized and language-specific content reduces the relevance of digital advisories. Some farmers also express concerns regarding the credibility and accuracy of digital information. Addressing these constraints requires focused capacity-building programs, development of user-friendly digital platforms, and integration of digital extension services with traditional face-to-face extension methods.

Future Prospects of Digital Extension Services

The future of agricultural extension lies in the effective integration of digital tools with conventional extension methods. Emerging technologies such as artificial intelligence, big data analytics, and remote sensing have the potential to further enhance digital advisory services. Customized and location-specific advisories, delivered through user-friendly platforms, can significantly improve technology adoption rates. Strengthening digital literacy among farmers and extension personnel will be critical in realizing the full potential of digital extension services.

Conclusion

Digital extension services have emerged as an important component of modern agricultural extension systems. They play a significant role in accelerating technology adoption by improving access to information, enhancing farmers' knowledge, and supporting timely decision-making. Although digital extension services cannot completely replace conventional extension approaches, their integration can greatly enhance extension effectiveness and outreach. Strengthening digital infrastructure, promoting digital literacy, and developing farmer-oriented content will further increase the impact of digital extension services on sustainable agricultural development.

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