



A Phenomenological Study of Rural Farmers' Experiences and Perceptions of Digital Technology Adoption in Agriculture

Mukhlis Lubis^{1*}, Ali Wardana²

¹Sekolah Tinggi Agama Islam Negeri Mandailing Natal, Indonesia

²IAI Diniyyah Pekanbaru, Indonesia

¹mukhlislubis@gmail.com*

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ABSTRACT

The integration of digital technology in agriculture has revolutionized farming practices, offering solutions to increase productivity and sustainability. However, the adoption of these technologies in rural communities remains underexplored, particularly in terms of farmers' subjective experiences and the social-cultural context of technology use. While previous research has focused on the technical and economic impacts, there is a gap in understanding the deeper, lived experiences of farmers engaging with these tools. This study uses a phenomenological approach to explore how farmers perceive and adapt to digital technologies in agriculture, addressing the gap in understanding their emotional, social, and cultural interactions with these tools. Through in-depth interviews with 15 purposively selected farmers from rural agricultural communities who had prior experience using digital agricultural technologies, key themes were identified regarding the empowerment and challenges faced in adopting digital tools. Participants were selected based on their active involvement in farming and their experience with digital platforms and applications used for agricultural activities. To enhance the trustworthiness of the findings, member checking and peer debriefing procedures were employed throughout the data analysis process. The results show that while digital tools enhance productivity, access barriers and digital literacy issues hinder widespread adoption, underscoring the importance of addressing social and cultural factors in technology deployment. These findings contribute to a more holistic understanding of agricultural technology adoption and suggest the need for future research focused on long-term impacts and the role of social networks in facilitating digital inclusion in rural communities.



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INTRODUCTION

The integration of digital technology in agriculture has become a significant trend in recent years, as farming communities worldwide strive to improve productivity, reduce costs, and enhance sustainability (Chamdimba & Chinkondengi, 2025; Mujtaba, 2025). Agricultural technologies, such as farm management software, precision farming tools, and climate prediction apps, are transforming traditional farming practices, offering solutions to long-standing challenges in resource management, crop planning, and pest control. However, these technological advancements are not universally accessible or easy to implement, particularly in rural communities where digital literacy and infrastructure may be limited. As agriculture faces increasing pressures from climate change, food security concerns, and economic instability, the role of digital technology in shaping the future of farming is more critical than ever.

The relevance of exploring farmers' experiences with digital technology lies in understanding the human aspect of this technological shift. While quantitative studies have highlighted the efficiency gains and economic benefits of digital tools in agriculture, less attention has been given to how farmers personally perceive, interpret, and adapt to these technologies in their everyday agricultural practices (Li et al., 2024). These experiences encompass not only the practical implications of using technology but also the emotional, social, and cultural dimensions of adopting new practices. As farmers engage with digital tools, they encounter both opportunities and challenges that affect their daily lives, work

., routines, and relationships with their communities. Understanding these lived experiences is essential, as it provides insights into how technology is perceived, accepted, and integrated within the fabric of rural life.

The need for a deeper exploration of these subjective experiences is rooted in the limitations of existing research, which often overlooks the personal and cultural contexts of technology adoption. Phenomenology, with its focus on lived experience, offers an invaluable approach to capturing the essence of these experiences (Moya & Camacho, 2021). By examining how farmers make sense of and navigate the complexities of digital technology, phenomenological research can uncover the meanings that individuals attach to their experiences and the broader social and cultural factors that influence their perceptions. This approach is particularly important as it acknowledges the diversity of experiences within farming communities and highlights the importance of understanding technology adoption not only as a technical process but as a deeply personal and context-dependent journey.

Research on the experiences of individuals in specific phenomena has become a vital area of study, particularly in the context of technology adoption and its impact on various aspects of life. Understanding how people experience and make sense of new technologies is crucial in fields such as education, healthcare, and agriculture. In the realm of agriculture, the adoption of digital tools has profound implications, not only for increasing productivity but also for reshaping farmers' social and cultural environments (Vesnic-Alujevic, 2021). Despite the importance of this issue, much of the existing literature has primarily focused on the technical aspects of digital tools and their measurable effects on agricultural outcomes, such as crop yields and economic efficiency. The subjective experiences of farmers how they perceive, navigate, and adapt to these technologies remain underexplored.

One of the significant challenges in capturing the depth of these experiences lies in the limitations of traditional quantitative methods. While surveys and statistical analyses can quantify the impact of digital tools on productivity, they fail to capture the richness of personal experiences and the meanings farmers attach to their interactions with technology. These methods are often unable to account for the emotional, social, and contextual factors that shape how technology is perceived and used. As a result, much of the existing research has overlooked the nuanced and multidimensional nature of technology adoption (Kozinets, 2023). For example, understanding how farmers feel about the new tools, the social pressures they may face, or the way technology affects their relationship with the land and community cannot be fully captured by numbers alone.

This gap in understanding highlights the inadequacy of many previous research methods in addressing the complexity of technology adoption in agriculture. Phenomenological approaches, with their focus on lived experience, offer a more suitable framework for exploring these dimensions (Patel et al., 2022). By delving into the subjective experiences of farmers, phenomenology provides a deeper insight into how individuals interpret and engage with digital tools, uncovering the essence of their experiences. This approach allows for a more comprehensive understanding of the phenomenon, one that encompasses not only the observable outcomes but also the underlying meanings, challenges, and transformations experienced by farmers.

In the context of agricultural technology adoption, much of the existing research has focused on practical, quantitative approaches to measure the impact of digital tools on productivity and efficiency. These studies often use surveys, statistical models, and data analytics to evaluate outcomes such as yield improvements, cost reductions, and resource optimization. While these approaches provide valuable insights into the effectiveness of digital tools, they fall short of capturing the deeper, subjective experiences of farmers the meanings they attach to the technologies they use and the personal, social, and cultural factors that influence their adoption process. This limitation results in a relatively narrow understanding of the phenomenon, one that overlooks the emotional and contextual dimensions of technology integration in agriculture.

The gap in the literature arises from the insufficient exploration of the lived experiences of farmers as they engage with digital technologies (Selvaggi et al., 2025). Despite the practical insights offered by quantitative methods, these studies fail to address critical questions regarding how farmers perceive, interpret, and navigate the complexities of digital tools within their daily lives and

communities (Mutesi et al., 2025). For instance, how do farmers understand the implications of technology for their traditional practices? What challenges do they face in adopting these tools, and how do they negotiate the tensions between technological innovation and cultural traditions? These questions require a more nuanced approach that goes beyond numerical data and instead focuses on the personal, contextual meanings that shape farmers' experiences.

To address these gaps, a phenomenological approach is essential. Phenomenology allows for an in-depth exploration of the essence of farmers' experiences, offering a holistic understanding of how digital technologies are perceived and integrated into agricultural practices. By focusing on the subjective experiences of farmers, phenomenology can uncover the meanings that individuals attach to these technologies, providing insights into the broader social, emotional, and cultural contexts that influence their adoption. This method offers a unique opportunity to explore the complex interplay between technology and the lived realities of farmers, thereby enriching our understanding of the phenomenon in ways that traditional, quantitative methods cannot.

Previous research on the adoption of digital technology in agriculture has predominantly focused on the practical aspects, such as technological efficiency and productivity gains. Studies have explored how digital tools like farm management software and climate prediction apps have enhanced the agricultural process, often using quantitative methods to measure outcomes such as crop yields and resource optimization (Shao & Marwa, 2025). However, these studies have not fully addressed the subjective experiences of farmers, which are critical in understanding how technology is integrated into their daily lives. The literature on technology adoption in rural settings, such as that by (Rosenblad et al., 2024), Therefore, the subjective experiences of farmers how they make sense of, negotiate, and integrate digital technologies into their daily lives remain insufficiently explored..

To address the gaps identified in the previous section, this study adopts a phenomenological approach, focusing on the lived experiences of farmers as they engage with digital tools in agriculture. Phenomenology is particularly suited for this study as it allows for a deep exploration of the meaning and essence of the farmers' experiences, offering insights into how they perceive and make sense of the technologies they use (Kendrick & Early, 2025). This method will help uncover the challenges, opportunities, and transformations that occur when farmers integrate technology into their practices, providing a richer, more comprehensive understanding of the phenomenon. By focusing on individual experiences, this study seeks to answer the research questions posed in the Knowledge Gap section, which have yet to be fully explored in existing literature.

This article is structured as follows: the introduction presents the context of digital technology adoption in agriculture and the need for understanding farmers' experiences. The next section discusses the phenomenological approach used in the study, followed by a detailed description of the data collection and analysis process (Herawati & Raehana, 2024). The findings are presented and analyzed thematically, highlighting key insights into farmers' perceptions and experiences. Finally, the article concludes with a discussion of the implications of these findings and recommendations for future research in the field.

RESEARCH METHODS

Study Design

This study was designed using a phenomenological approach to explore the subjective experiences of farmers in adopting digital technology within agriculture. Phenomenology was chosen because it allows for an in-depth exploration of the lived experiences of participants, focusing on how they make sense of and interpret their world (Lutz & Knox, 2014; McNabb, 2015). This approach is particularly relevant to the research question as it seeks to understand the meaning behind the farmers' interactions with digital tools and the impact of these technologies on their agricultural practices and daily lives. The phenomenological design emphasizes the essence of lived experiences and the meanings that participants assign to them, thus providing a rich, detailed perspective on the phenomenon being studied. In this study, an interpretative phenomenological analysis (IPA) was employed, which focuses on how participants interpret and make sense of their experiences. IPA is

particularly suitable for this research as it allows for an in-depth examination of individual perceptions within their social and cultural contexts. The use of IPA also enabled the researchers to examine not only what participants experienced, but also how they interpreted the adoption of digital technology in relation to their farming routines, economic decisions, and rural community practices.

Participants

Participants were selected through purposive sampling to ensure that they had relevant experiences with the adoption of digital technology in agriculture. The inclusion criteria included farmers who have actively integrated digital tools into their farming practices and are willing to share their personal experiences regarding the use of technology. Participants were required to be over the age of 18 and engaged in farming for at least one growing season using digital technology. Exclusion criteria included individuals without direct experience using technology in agriculture or those unable to communicate in the study's language (Hillman & Radel, 2018; Migdal, 2018). Recruitment was conducted through local farmer groups, agricultural extension networks, and community leaders who helped identify farmers meeting the inclusion criteria. Potential participants were first contacted through these networks and were provided with a brief explanation of the study objectives, participation requirements, confidentiality procedures, and their right to withdraw at any stage. Farmers who expressed interest were then contacted directly by the research team to confirm eligibility and schedule interviews. Participation was entirely voluntary, and no participant was pressured by community leaders or extension officers to join the study. A total of 15 participants were involved in this study, with a mix of males and females ranging in age from 30 to 65 years. These participants were from rural agricultural communities where digital tools are being increasingly integrated into traditional farming methods. The diversity in gender, age, and farming experience provided a comprehensive perspective on the phenomenon under study.

Data Collection

Data were collected through semi-structured in-depth interviews, which allowed participants to express their experiences and reflections in their own words. Interviews were conducted in person at the participants' homes or farms to ensure a comfortable and familiar environment, which encouraged open and honest discussions. Each interview lasted between 60 and 90 minutes, depending on the depth of the conversation (Carreiras & Castro, 2012; Iosifides, 2016). A standardized interview guide was used, containing open-ended questions designed to explore the participants' personal experiences with digital technology in agriculture, as well as the social and economic implications of these experiences. The interview guide was adapted from established protocols used in similar studies (Author, Year), with slight modifications to tailor the questions to the specific context of agriculture and technology. All interviews were audio-recorded with participants' consent and transcribed verbatim for analysis.

Data Analysis

Data were analyzed using interpretative phenomenological analysis (IPA), a method that allows for the identification of themes that reflect the core experiences of participants. The analysis was conducted in several stages (Daly, 2007; Longhofer et al., 2012). First, the interview transcripts were read multiple times to gain a comprehensive understanding of the data. Next, key themes were identified by coding relevant passages that reflected the participants' experiences with digital technology. These themes were then categorized into broader topics, such as "Adoption of Technology," "Economic and Social Impact," and "Challenges of Digital Integration." The final step involved interpreting the meanings of these themes in the context of the participants' lived experiences and the broader agricultural and technological landscape (Fife, 2020; Kawamura, 2020). NVivo software was used to assist with organizing and coding the data, though the analysis remained focused on the meaning-making process rather than the software itself. To enhance credibility, several strategies were employed, including repeated reading of transcripts, reflexive memo writing, peer debriefing among the research team, and comparison of emerging themes across participants. Selected participants were also invited to review brief summaries of the interpreted themes to confirm whether the findings reflected their experiences accurately. An audit trail was maintained by documenting coding decisions, theme development, and analytical reflections throughout the research process. These procedures strengthened the trustworthiness, dependability, and confirmability of the findings.

RESULTS

The Experience of Adopting Digital Technology in Agriculture

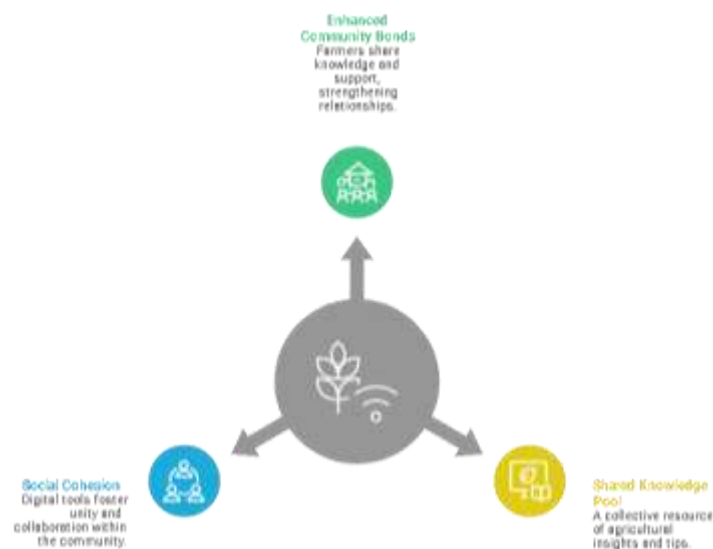
The integration of digital technology in agriculture has significantly altered the way farmers engage with their work. Many participants in the study described their initial exposure to technology as a transformative experience that opened new possibilities for increasing productivity. For instance, one farmer from a rural village shared, "When I first used the smartphone app for planting schedules, it felt like a whole new world opened up to me. I could plan my crops better and avoid mistakes I made in the past." This statement illustrates that digital tools were not merely perceived as technical instruments, but as resources that changed farmers' confidence in planning and decision-making. Similar views were expressed by other participants, who emphasized that access to planting schedules, weather information, and crop management guidance helped them reduce uncertainty in daily farming activities. [Insert additional participant quotation here to support this theme, e.g., a quotation on improved planning, reduced uncertainty, or better decision-making.]. Digitalization in agriculture allowed farmers to have better control over their operations and reduced uncertainties in the farming process, which previously relied heavily on traditional methods and guesswork.

However, the adoption of these technologies was not without its challenges. Several farmers mentioned the steep learning curve involved in adopting these new systems. As one participant noted, "At first, it was overwhelming. I didn't know where to start, but once I understood the basics, it became easier to use." This highlights the importance of training and support in ensuring that farmers can fully leverage the potential of digital tools. While the experience was largely positive, the difficulty in acquiring technical knowledge and the need for constant adaptation were recurring themes in the data.

Social and Economic Changes Resulting from Digital Integration

Alongside the technological advancements, farmers also reported significant changes in their social and economic lives. The integration of digital tools has created new dynamics within farming communities. As one farmer expressed, "The whole village started using the same technology, and now we have a shared knowledge pool. We exchange ideas and tips, and it has brought us closer together." This sense of community and shared learning was a key benefit reported by several participants, indicating that digital technology has facilitated not only agricultural improvements but also social cohesion.

Digital Technology's Impact on Farming Communities



On the economic front, the perceived benefits were substantial, with many farmers noting increased yields and reduced costs. One participant stated, "I saved a lot of money on fertilizers by using the digital tool that helps me calculate the exact amount needed." This practical application of

technology in reducing costs was a common thread, with digital platforms providing clear economic advantages through optimized resource allocation. However, it was also clear that access to these tools was not uniform, with some farmers expressing concerns about the affordability of smartphones and internet services. A farmer from a more economically disadvantaged area mentioned, "We don't have the money to invest in smartphones and data plans. This technology is out of reach for some of us."

Challenges in Accessing and Implementing Digital Technology

Despite the benefits, the challenges of accessibility and implementation were significant barriers for some farmers. These barriers were particularly evident in regions with limited infrastructure, where internet connectivity remained unreliable. As one farmer pointed out, "Sometimes the internet cuts out, and I can't access the app. It's frustrating because I rely on it for my daily tasks." The lack of reliable internet access in rural areas was a recurrent theme, with participants stressing the need for better connectivity and more affordable digital tools to ensure that all farmers could benefit from these innovations.

Moreover, there was a stark contrast in the level of digital literacy across the study population. While some farmers were quick to embrace digital tools and incorporate them into their daily routines, others struggled to understand and use the technology effectively. One participant noted, "Some of us don't even know how to use a smartphone, let alone these apps. We need better training programs to help us." This highlights the digital divide that exists even within rural farming communities, where generational gaps and varying levels of education play a significant role in the adoption process.

Essential Conclusion

The findings of this study reveal that while digital technology has brought about significant improvements in agricultural productivity and efficiency, the experience of adopting these technologies is not universal. The participant quotations show that digital technology improved planning, reduced uncertainty, encouraged community learning, and supported cost efficiency. At the same time, the evidence also indicates that adoption was constrained by limited affordability, unstable internet connectivity, and uneven digital literacy. Farmers who have access to the necessary resources and training have benefited greatly from these innovations, experiencing increased productivity and social cohesion. However, those in more economically disadvantaged or isolated areas face considerable challenges in accessing and implementing digital tools. The study underscores the importance of addressing barriers to access, providing training, and ensuring that the benefits of digital agriculture are equitably distributed across all farming communities.

DISCUSSION

Summary of Key Findings

The main findings of this study revealed that farmers' experiences with digital technology in agriculture are shaped by both positive and negative aspects. While digital tools offer significant improvements in productivity, efficiency, and decision-making, they also introduce challenges related to access, technical skills, and integration with traditional farming practices. Importantly, these findings suggest that agricultural digitalization should not be understood as a uniformly beneficial process, because its outcomes depend heavily on the availability of infrastructure, digital literacy, economic capacity, and local socio-cultural conditions.

Contribution to Research Questions

This study contributes to answering the central research question by providing an in-depth understanding of the subjective experiences of farmers in adopting digital technology. The findings illustrate that, while digital tools can enhance agricultural practices, the adoption process is far from straightforward (Evans et al., 2025). The study highlights that farmers' perceptions of digital tools are influenced by their personal, social, and cultural contexts, showing that the meaning they attach to these tools goes beyond mere functionality. Farmers often express a sense of empowerment through better control over their farming decisions, but they also face challenges in terms of access, digital literacy, and the compatibility of new technologies with established agricultural traditions (Lin & Liu, 2025).

This nuanced understanding underscores the importance of considering the socio-cultural context when examining technology adoption in rural settings.

Connection to Existing Literature and Theory

The results of this study align with and expand upon existing research in technology adoption. Previous studies, such as those by (Msila, 2022), have highlighted the positive impact of digital tools on agricultural productivity, but they have not fully explored the lived experiences of farmers. This study extends the work of (Kang & Shang, 2025), who found that technology adoption leads to increased efficiency but failed to address the emotional and social aspects of the process. Our findings complement these studies by emphasizing the emotional and social dimensions that shape how farmers engage with digital tools (He et al., 2025). However, the findings also diverge from studies that assume digital technology adoption naturally leads to agricultural empowerment. While some research emphasizes the capacity of digital platforms, farm management software, and climate prediction applications to improve decision-making and productivity, the present study shows that such benefits are unevenly distributed. Farmers who have stronger digital skills, better infrastructure, and greater financial resources are more likely to benefit from digital tools, whereas farmers with limited access may experience digitalization as an additional burden rather than as empowerment. Specifically, the challenges faced by farmers in rural areas such as limited access to technology and the need for training are consistent with the broader literature on digital divides (Anggriani et al., 2025). However, this study goes further by showing how these challenges influence not only the practical use of technology but also its social acceptance and integration into the farmers' daily lives. By exploring these deeper dimensions, the study aligns with the theoretical framework of innovation diffusion, which suggests that the successful adoption of new technologies is not solely dependent on technical feasibility but also on the alignment with users' values, practices, and social contexts.

Implications of the Findings

The findings of this study have significant implications both for the academic understanding of technology adoption in agriculture and for practical applications in rural farming communities (Dela Cruz et al., 2025). From a theoretical perspective, the study deepens our understanding of the socio-cultural dynamics that influence how digital tools are adopted and integrated into agricultural practices. It shows that adoption is not just a technological shift but also a social process, influenced by farmers' values, traditional practices, and social networks (He et al., 2025). These findings imply that digital agriculture policies should avoid assuming that technology alone can solve structural problems in rural farming communities. Without attention to infrastructure gaps, unequal access to training, affordability, and local cultural practices, digitalization may widen rather than reduce rural inequalities. For practitioners, the findings highlight the need for tailored training programs that not only focus on the technical aspects of digital tools but also address the emotional and social challenges farmers face. Given that many farmers in rural communities experience barriers related to digital literacy and access, initiatives aimed at bridging the digital divide could facilitate more equitable technology adoption. Additionally, the integration of digital tools into traditional agricultural practices needs to consider the cultural contexts in which these tools are deployed (Silva, 2025). This study suggests that understanding farmers' lived experiences is crucial in designing policies and technologies that align with local needs and practices.

Limitations of the Study

While this study offers valuable insights into farmers' experiences with digital technology, there are several limitations that should be considered when generalizing the findings. First, the study focuses on a specific rural population, which may not be representative of all farmers globally or even regionally (Raivio et al., 2023). The experiences of farmers in areas with better access to technology or different socio-economic conditions may differ significantly (Arino et al., 2025). Additionally, the study's qualitative nature limits the generalizability of the findings to larger populations. While the phenomenological approach provides deep insights into individual experiences, it does not allow for broader statistical generalization. Future research could explore a more diverse set of participants across different regions to assess whether these findings hold true in other agricultural contexts.

Future Research Directions

Building on the insights from this study, future research could explore the long-term impact of digital technology adoption on farmers' livelihoods and their communities. Longitudinal studies could track how experiences evolve over time as farmers gain more familiarity and expertise with digital tools. Additionally, further research could investigate the role of social networks in facilitating or hindering technology adoption, as the social aspect of learning and sharing knowledge was a significant theme in this study (Heryanto et al., 2024). Another area for future exploration could be the role of policy in supporting or obstructing digital adoption in rural areas, particularly in developing countries where infrastructure challenges remain prevalent (Abdulkareem & Mohd Ramli, 2022). Future studies should also compare farmers across different levels of digital access to examine how inequality shapes the benefits and risks of agricultural digitalization. Such comparative research would help clarify whether digital tools reduce rural marginalization or, under certain conditions, intensify existing social and economic divides. These studies could contribute to a deeper understanding of the broader implications of digital transformation in agriculture.

CONCLUSION

This study explored the subjective experiences of farmers in adopting digital technology within agriculture, addressing the gap in understanding how technology impacts their lives beyond productivity metrics. The findings revealed that while digital tools enhance agricultural practices, they also introduce challenges related to access, technical skills, and integration with traditional farming methods. Farmers expressed both empowerment and frustration, underscoring the importance of considering the social and cultural context of technology adoption. This research contributes to the existing literature by highlighting the emotional, social, and contextual factors that influence technology adoption, which had been overlooked in previous studies. The practical implications of these findings are particularly relevant for farmer training programs. Training should not only introduce farmers to digital applications but also provide continuous, hands-on assistance that is adapted to farmers' levels of digital literacy, local language use, and existing farming routines. Extension officers, agricultural trainers, and local farmer groups should be involved as facilitators to ensure that digital tools are explained through practical demonstrations, peer learning, and problem-solving activities based on farmers' real agricultural needs. Such training should also address farmers' concerns, including fear of technological failure, uncertainty about costs, and difficulties in integrating digital tools with traditional farming knowledge. In terms of rural digital inclusion policy, the findings suggest the need for more targeted support for infrastructure, affordability, and community-based access. Policymakers should prioritize reliable internet connectivity in farming areas, affordable access to smartphones or digital devices, and locally relevant digital platforms that respond to farmers' production, market, and climate-related needs. Rural digital inclusion policies should also integrate agricultural extension services with digital literacy initiatives so that technology adoption is not treated merely as the distribution of tools, but as a long-term process of capacity building and social adaptation. Future research should examine the long-term effects of digital technology on farming communities, especially how digital tools reshape farmers' social networks, decision-making practices, market participation, and relationships with local institutions. Further studies could also evaluate the effectiveness of specific farmer training models and rural digital inclusion policies in improving equitable access to agricultural technology. Expanding this research could provide valuable insights for policymakers and practitioners looking to support digital inclusion in rural areas.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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