ARTIFICIAL INTELLIGENCE-BASED INNOVATION IN IMPROVING AGRICULTURAL PRODUCTION AND WELFARE OF VILLAGE FARMERS IN INDONESIA

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Abstract: This study aims to explore the potential of artificial intelligence (AI)-based innovation in enhancing agricultural production and the welfare of rural farmers in Indonesia. A systematic literature review method is employed to identify actionable steps to address challenges such as limited access to technology, disparities in the distribution of AI benefits, and the need for improved digital literacy and technical skills among farmers. Literature sources were selected from Scopus, DOAJ, and Google Scholar databases, covering publications from 2014 to 2024. The study findings reveal that the integration of artificial intelligence (AI) technology holds significant transformative potential in Indonesian agriculture, particularly in rural areas. While promising prospects are offered for enhancing efficiency, welfare, and sustainability in agriculture, challenges related to technology accessibility, training, and socio-cultural implications remain significant hurdles that need to be addressed. Collaborative efforts among policymakers, researchers, and agricultural stakeholders are required to maximize the benefits of AI technology in enhancing productivity and welfare among farmers across various rural regions in Indonesia. Urgent research is needed to gain a deeper understanding of effective strategies for improving accessibility and adoption of AI technology among farmers, as well as the socio-cultural implications of AI technology integration in the agricultural context.

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A. INTRODUCTION

Agriculture serves as a fundamental pillar of Indonesia's economy and societal fabric, driving economic expansion, sustaining livelihoods, and ensuring food sufficiency (Tanggu et al., 2020). Smallholder farmers, predominantly situated in rural locales, hold pivotal roles in upholding agricultural productivity despite grappling with constraints such as limited resource availability and technology accessibility (Nwokocha, 2020). Their endeavors are indispensable for bolstering food security, fostering rural progress, and maintaining economic equilibrium (Sharma et al., 2016), as smallholder farming represents a primary income source for numerous households. Despite encountering various challenges, smallholder farmers persist in supplying essential food staples, contributing to export revenues, and fostering community cohesion, all while preserving cultural heritage within rural landscapes.

Artificial intelligence (AI) refers to the simulation of human intelligence processes by computer systems, encompassing tasks such as learning, reasoning, problem-solving, perception, and decision-making (Jarrahi, 2018). In the agricultural sector, AI is applied across various domains, leveraging algorithms and data analytics to automate tasks, optimize resource allocation, and enhance decision-making processes (Elbasi et al., 2023). These applications span a wide range of areas, including crop monitoring and management, pest and disease detection, soil analysis, weather forecasting, crop yield prediction, and farm machinery automation. By utilizing AI techniques such as machine learning, deep learning, computer vision, and natural language processing, agricultural stakeholders can acquire valuable insights, simplify operations, and make informed decisions to enhance productivity and sustainability. The potential of AI-based technologies to revolutionize agricultural practices is substantial, offering opportunities to address ongoing challenges and unlock new efficiencies. By harnessing AI-powered tools and systems, farmers can optimize resource usage, minimize waste, and mitigate risks associated with unpredictable environmental conditions. Additionally, AI-driven innovations enable precision agriculture, facilitating targeted interventions tailored to specific crop and soil conditions (Ray et al., 2021). This precision enables farmers to optimize inputs such as water, fertilizers, and pesticides, resulting in improved yields, reduced environmental impact, and enhanced profitability. Overall, the integration of AI into agriculture holds promise for transforming traditional farming methods, driving sustainable growth, and meeting the evolving demands of global food security and sustainability.

The existing state of AI adoption in Indonesian agriculture reflects a growing interest and investment in integrating AI technologies to address challenges and enhance productivity (Salam et al., 2018). Throughout the country, various initiatives and projects are underway, covering areas such as precision farming, crop monitoring, pest detection, and yield prediction. Research endeavors conducted by different entities explore the potential applications of AI, specifically tailored to Indonesia's diverse agricultural landscapes and the requirements of smallholder farmers (Mowla et al., 2023). Collaborations between research institutions, technology companies, and agricultural stakeholders are fostering innovation and knowledge-sharing to accelerate AI adoption. Government policies and programs play a crucial role by offering incentives, funding, and regulatory support to promote the use of AI technologies in agriculture (Fatima et al., 2020). These efforts are in line with broader governmental objectives to modernize and strengthen the agricultural sector, ensuring its sustainability and resilience in the face of emerging challenges such as climate change and food security.

AI-based advancements offer substantial advantages to rural farmers in Indonesia by granting access to valuable insights, optimizing resource allocation, and augmenting decision-making capabilities. Through the integration of Internet of Things (IoT) technology (Darmono et al., 2023) Ramadhani et al. (2022), AI solutions can furnish real-time data on soil quality, crop health, and weather conditions, enabling farmers to make well-informed decisions concerning irrigation, fertilization, and pest management. Furthermore, Precision Agriculture (PA) tools Herdiansyah et al., (2023)

can empower farmers by optimizing the performance of agricultural machinery, ultimately resulting in heightened productivity levels. Moreover, the digitization of agricultural processes can bolster economic growth by facilitating online marketing avenues for agricultural produce, consequently bolstering farmers' incomes (Chulwa et al., 2022). Additionally, AI-driven expert systems can assist in promptly diagnosing plant diseases Iswan et al. (2022), facilitating timely interventions. Overall, AI technologies serve as pivotal instruments in empowering rural farmers in Indonesia through data-driven insights, streamlined resource utilization, and refined decision-making procedures.

The implementation of AI in Indonesian agriculture confronts several obstacles and constraints. In the healthcare domain, impediments such as the availability of skilled personnel, ethical regulations, computational infrastructure, and industry readiness impede the seamless integration of AI (Nurmaini, 2021). Similarly, the livestock sector faces challenges due to the scarcity of quality bulls, impacting the effectiveness of artificial insemination programs, which subsequently influence farmer perceptions based on conception rates and proximity to AI service centers (Sugandini et al., 2023). Moreover, the agricultural industry grapples with pest-related issues affecting crop yields, leading to the development of AI-powered robotics for efficient pest control. Successful applications of neural networks in managing robot movements highlight advancements in this area (Putra Adnyana et al., 2021). Additionally, the performance of agricultural information systems in bolstering farmer capabilities and rice production depends on factors like internet connectivity and service attributes (Setiadi et al., 2020). These challenges underscore the multifaceted nature of impediments to widespread AI adoption in Indonesian agriculture.

Understanding the socio-economic context and local conditions is paramount for tailoring AI solutions to the unique needs and preferences of village farmers. Research conducted in Kaduna State, Nigeria, underscores the importance of variables such as educational attainment, herd size, and age in shaping the adoption of technologies like Artificial Insemination (AI) (Veysel et al., 2021). Similarly, in Hambantota district, challenges such as resource scarcity, technology incompatibility, and socio-economic barriers impede the uptake of new agricultural technologies by farmers (Bayei & Nache, 2014). Furthermore, initiatives like the development of Computational Agriculture Information Systems in countries such as India highlight the necessity of crafting information systems tailored to local needs and structures to support socio-economic advancement in agriculture (Hübel (Anghel) et al., 2023). By taking these factors into account, AI solutions can be customized to meet the specific requirements and preferences of village farmers, thereby enhancing their adoption and efficacy in improving agricultural practices.

The systematic review of literature highlights the potential of adopting artificial intelligence (AI) in Indonesian agriculture to significantly enhance productivity and welfare among rural farmers. However, several persistent challenges hamper its widespread implementation. These obstacles include limited access to technology and infrastructure among farmers, disparities in the distribution of AI benefits, and the necessity to enhance digital literacy and technical competencies among farmers. Consequently, there exists a gap in comprehending the effective deployment of AI

solutions at the village level and addressing the practical hurdles faced by farmers. Hence, further research utilizing a systematic literature review methodology is imperative to delineate actionable measures to overcome these challenges and bolster the utilization of AI for enhancing agricultural production and the welfare of village farmers in Indonesia.

B. METHOD

1. Research Objectives

This study aims to explore the potential of artificial intelligence (AI)-based innovations in enhancing agricultural production and the welfare of rural farmers in Indonesia. A systematic literature review method is employed to identify actionable steps to address challenges such as limited access to technology, disparities in the distribution of AI benefits, and the need for increased digital literacy and technical skills among farmers.

2. Search Strategy

Literature search will be conducted using Scopus, DOAJ, and Google Scholar as primary data sources. Keywords such as "Artificial Intelligence" and "Agricultural Innovation" will be used alongside Boolean operators to ensure comprehensive coverage of relevant studies. Additionally, citation tracking and scanning reference lists will be utilized to identify additional sources that meet the inclusion criteria.

3. Inclusion and Exclusion Criteria

Studies included in this systematic literature review must meet the following inclusion criteria: (1) published in peer-reviewed journals or conference proceedings; (2) present empirical findings, theoretical analysis, or methodological discussions related to the research topic; (3) published within the last 10 years to ensure the relevance and currency of the literature. Studies will be excluded if they: (1) Are irrelevant to the research topic; (2) are not written in English; (3) do not provide sufficient details or methodology to assess their relevance; (4) are duplicate publications or do not contribute new insights to the existing literature.

4. Data Selection and Extraction

The selection of studies will be conducted in multiple stages. Initially, titles and abstracts will be screened to identify potentially relevant articles based on the inclusion and exclusion criteria. Subsequently, the full text of selected articles will be reviewed to determine their suitability for inclusion in the final analysis. Data extraction will involve recording relevant information from each included study, including authors, year of publication, research objectives, methodology, key findings, and identified challenges or limitations.

C. RESULT AND DISCUSSION

Based on our research findings, we have identified several highly relevant studies that contribute significantly to the focus and objectives of our research. The insights gained from these research endeavors have substantially enriched our understanding of the topic under investigation. We have collected and synthesized the findings from these studies in Table 1.

Table 1. Research outcomes and insights based on the specified eligibility criteria.

No	Field or Focus	Names of Authors in the same Field	Research Insights or Variables
1	Integration of AI in Indonesian Agriculture	Darmono et al., 2023 Taneja et al., 2023 Oliveira & Silva, Hananda et al., 2023 Haryanto et al. 2023	- Utilization of AI technologies (machine learning, IoT, computer vision) for crop monitoring, predictive analytics, and supply chain logistics - Deployment of smart solar dryers for post-harvest processes in remote regions - Impact on productivity, sustainability, and modernization of agricultural practices in both urban and rural sectors - Socio-economic implications and transformative potential for future development of Indonesian agriculture
2	AI adoption in rural Indonesian agriculture	Yasinto, Chulwa et al., 2023 Ajib, Elbasi et al., 2023 Liundi et al., 2019 Eli-Chukwu, Sarkar et al., 2019	- Implementation of AI tools (expert systems, machine vision, natural language processing) for various agricultural tasks (disease detection, pest control, soil management) - Potential to enhance productivity, address challenges (crop diseases, irrigation deficits, low yields), and improve returns for farmers - Socio-economic impacts on farmers' cultivation practices, income levels, and perceptions of nature - Importance of considering factors such as readiness, age, gender, education, and income disparities in AI adoption and its impact on rural development
3	Challenges and strategies in implementing AI in Indonesian agriculture	Iswan et al., 2022 Hananda et al., 2023 Aini et al., 2022 Dwi Indriyanti, Chulwa et al., 2022 Nugroho & Hakim, 2023 Vijayakumar et al., 2022 Oliveira 2023	- Obstacles faced in AI implementation (technological support in remote regions, unpredictable weather patterns, low digitalization adoption) - Strategies to address challenges (utilizing IoT, ML technologies, feature selection methods, digitalization tools for online marketing) - Need for systematic data gathering, affirmative policies, and collaborative approaches to overcome obstacles - Importance of developing AI applications tailored to the specific needs and conditions of Indonesian agriculture

Table 1 summarizes the research findings pertaining to the utilization of artificial intelligence (AI) technologies in the agricultural sector of Indonesia. It delineates the efficacy of AI applications such as crop monitoring, predictive analytics, and streamlining supply chain logistics, alongside the deployment of intelligent solar drying systems for post-harvest operations in remote regions. The integration of AI has notably enhanced productivity, sustainability, and the modernization of agricultural practices across both urban and rural landscapes. Nevertheless, AI implementation has yielded consequential socio-economic ramifications, influencing farmers' cultivation methodologies, income streams, and ecological perceptions. Furthermore, the table elucidates the challenges encountered during AI integration and proposes mitigation

strategies, advocating for systematic data acquisition, supportive policy frameworks, and collaborative endeavors. It underscores the imperative of developing bespoke AI solutions tailored to the unique requisites and circumstances of Indonesian agriculture.

1. AI improves farming efficiency in rural Indonesia

The integration of artificial intelligence (AI) in agriculture has significantly bolstered efficiency and productivity across Indonesia, encompassing both urban and rural sectors. AI technologies, such as machine learning, Internet of Things (IoT), and computer vision, have been leveraged to optimize various agricultural operations (Darmono et al., 2023) (Taneja et al., 2023). For instance, AI has played a pivotal role in enhancing crop monitoring, predictive analytics, and streamlining supply chain logistics, thereby resulting in notable improvements in productivity and sustainability (Oliveira & Silva, 2023). Additionally, the amalgamation of AI and IoT has proven instrumental in modernizing agricultural practices for smallholder farmers residing in remote regions. This is exemplified by the deployment of smart solar dryers, which have substantially improved post-harvest processes, consequently enhancing the quality and quantity of agricultural yields (Hananda et al., 2023). These advancements underscore the transformative potential of AI in the agricultural landscape of Indonesia, heralding promising prospects for the sector's future development (Haryanto et al., 2023).

The integration of artificial intelligence (AI) has notably enhanced agricultural efficiency and productivity within the rural regions of Indonesia. Research indicates that interventions aimed at training, such as those focused on organic farming Grimm & Luck, (2020), as well as the utilization of novel technologies and marketing support Abate et al. (2018), have demonstrated potential in promoting the adoption of sustainable practices and yielding higher crop outputs. These insights imply the pivotal role that AI can play in advancing agricultural methodologies and bolstering productivity levels in rural Indonesia.

The findings from studies like those by Oliveira & Silva, (2023) highlight the pivotal role of AI in enhancing crop monitoring, predictive analytics, and supply chain logistics. These improvements have led to notable enhancements in productivity and sustainability within the agricultural sector. Additionally, the integration of AI with IoT, as indicated by Hananda et al. (2023), has been instrumental in modernizing agricultural practices for smallholder farmers in remote regions, exemplified by the deployment of smart solar dryers. The research presented offers compelling evidence of the positive impacts of AI integration in Indonesian agriculture. However, it's crucial to note potential limitations such as the scalability of these technologies, accessibility for smallholder farmers, and the need for continued support and infrastructure development.

2. AI technology in agriculture: impact on rural farmers

Artificial intelligence (AI) technologies have been implemented within the agricultural sector in Indonesia to augment both productivity and welfare. Utilizing Internet of Things (IoT) technology, incorporating sensor devices and databases, facilitates agricultural optimization, particularly concerning irrigation management and plant nutrition (Darmono et al., 2023). Furthermore, the digitization of agriculture

through AI tools, such as online marketing applications, holds promise for elevating rural farmers' income by approximately 8.5%, thus contributing significantly to overall economic advancement (Ajib, 2023). Nevertheless, the integration of novel agricultural technologies has precipitated shifts in farmers' perspectives regarding nature, environment, and social dynamics, thereby influencing traditional farming practices in regions like the Bena Irrigation Area (Yasinto, 2023). These technological advancements, notwithstanding their economic benefits, also entail socio-cultural ramifications within farming communities, exemplified by cases like Wedusan Village (Chulwa et al., 2022).

Various AI technologies have been implemented in Indonesian agriculture, significantly impacting the welfare of rural farmers. These technologies encompass expert systems, natural language processing, speech recognition, and machine vision, as evidenced by (Elbasi et al., 2023). In the realm of rice cultivation specifically, AI has been leveraged for tasks such as disease and pest detection, prediction and estimation, and the development of automated intelligent systems, with the potential to enhance productivity, as highlighted by (Liundi et al., 2019). Additionally, the utilization of AI in soil, crop, weed, and disease management has been lauded for its flexibility, high performance, accuracy, and cost-effectiveness, as demonstrated by (Eli-Chukwu, 2019). Moreover, AI holds promise in addressing various agricultural challenges including crop diseases, irrigation deficits, water management issues, environmental impacts, low yields, and improper soil treatments. Ultimately, the integration of AI technologies paves the way for smart farming practices and improved returns for farmers, as articulated by (Sarkar et al., 2022).

The implementation of AI technologies in Indonesian agriculture has led to significant advancements in productivity and welfare for rural farmers. By leveraging IoT technology for irrigation management and plant nutrition, as highlighted by Darmono et al. (2023), farmers can optimize resource utilization and improve crop yields. Additionally, the digitization of agriculture through AI tools like online marketing applications, as discussed by Ajib, (2023), has the potential to increase farmers' income and contribute to economic growth in rural areas. However, the integration of these novel technologies has also brought about shifts in farmers' perspectives on traditional farming practices and environmental dynamics, as noted by Yasinto, (2023). The research provides valuable insights into the diverse applications of AI technologies in Indonesian agriculture and their potential impact on rural farmers' welfare. However, it's important to recognize potential challenges such as accessibility, affordability, and the need for adequate training and support to ensure the effective adoption and utilization of these technologies by farmers across different regions.

3. AI adoption in agriculture: social, economic, and rural environment

The integration of artificial intelligence (AI) technologies in agriculture within the rural areas of Indonesia yields multifaceted impacts across social, economic, and environmental domains. The adoption of AI can precipitate shifts in farmers' cultivation practices, perceptions of nature, and social interactions, consequently influencing both productivity and welfare (Yasinto, 2023). Furthermore, the digitalization of agricultural

practices via AI applications holds potential for bolstering economic growth through increased farmer incomes, albeit accompanied by challenges related to readiness, age, gender, education, and income disparities (Chulwa et al., 2022). Additionally, AI adoption presents opportunities for advancing environmental sustainability through contributions to climate change mitigation, agricultural optimization, and disaster resilience, underscoring the imperative for responsible and transparent AI systems (Manish, 2023). The implementation of smart village initiatives incorporating smart governance, environmental stewardship, and community engagement can further amplify rural development efforts leveraging AI technologies in Indonesia (Muhtar et al., 2023).

The adoption of artificial intelligence technologies in agriculture in Indonesia's rural environment can have significant social, economic, and environmental impacts. Training interventions, such as those focused on organic farming, can increase the adoption of sustainable practices (Grimm & Luck, 2020). However, the effectiveness of such interventions may be influenced by factors such as poverty, implementer identity, and initial social capital (Cameron et al., 2019). Information provision can also play a crucial role in shaping farmer preferences and behaviors, as seen in the case of pesticide use (Goeb et al., 2020). Furthermore, property rights reforms, such as those related to land tenure, can have complex effects on cooperation and trust preferences (Fabbri, 2021). These findings highlight the need for a comprehensive understanding of the social, economic, and environmental factors that can influence the adoption of artificial intelligence technologies in agriculture in Indonesia's rural environment.

The findings suggest that the adoption of AI technologies in Indonesian rural agriculture can bring about significant changes across social, economic, and environmental realms. The adoption of AI alters farming practices and social dynamics, potentially impacting productivity and welfare positively, as highlighted by Yasinto, (2023). However, the integration of AI also poses challenges related to readiness and demographic disparities, as noted by Chulwa et al.,(2022). On the economic front, while AI adoption has the potential to increase farmer incomes, there are considerations regarding equitable access and readiness among farmers. Additionally, the environmental implications of AI adoption are substantial, with potential contributions to sustainability and resilience, as emphasized by (Manish, 2023). The research provides valuable insights into the social, economic, and environmental implications of AI adoption in Indonesian rural agriculture. However, there is a need for further investigation into the nuanced effects of AI adoption, particularly concerning disparities in access, readiness, and the equitable distribution of benefits. Additionally, considering the potential environmental impacts of AI adoption, efforts should be made to ensure responsible and transparent AI systems.

4. AI challenges in Indonesian agriculture: strategies to solve them

The implementation of AI-based solutions in Indonesian agriculture encounters various challenges, such as the requirement for technological support in remote regions Iswan et al. (2022), the impact of unpredictable weather patterns on crop selection Hananda et al. (2023), and the low adoption of digitalization applications among

farmers (Aini et al., 2022). To address these obstacles, strategies may involve the adoption of IoT, AI, and ML technologies for optimizing agricultural processes Dwi Indriyanti, (2022), employing feature selection methods like PCA to enhance algorithmic performance Chulwa et al. (2022), and advocating for the use of digitalization tools for online marketing to augment farmers' incomes. Moreover, the integration of cognitive IoT systems with fuzzy logic algorithms can improve productivity and forecast agricultural issues, particularly benefiting corn production in Indonesia. Through the amalgamation of these strategies, Indonesian agriculture can harness advanced technologies to enhance efficiency, productivity, and foster economic growth in rural areas.

The implementation of AI in Indonesian agriculture faces several challenges, including the need for systematic data gathering and the difficulty of replicating results (Linaza et al., 2021). This is compounded by the need for affirmative policies to empower agricultural workers and ensure AI operates within legal and ethical frameworks (Nugroho & Hakim, 2023). The application of AI in soil and crop management, weed and disease control, and the use of expert systems can address these challenges (Vijayakumar et al., 2022). However, the uneven distribution of mechanization, data security and privacy, and the adaptation of AI-based technology to real environments remain key obstacles (Oliveira, 2023). To overcome these challenges, a collaborative approach between IT experts, business practitioners, and legal and social science experts is needed, along with the development of AI applications that are tailored to the specific needs and conditions of Indonesian agriculture.

The identified challenges in implementing and integrating AI-based solutions in Indonesian agriculture underscore the complexity of adopting advanced technologies in rural settings. The need for technological support in remote areas highlights infrastructure limitations, while the impact of unpredictable weather patterns emphasizes the vulnerability of agricultural systems to environmental factors. Moreover, the low adoption of digitalization applications among farmers points to barriers related to access, awareness, and technological literacy. These challenges pose significant obstacles to the effective utilization of AI in agricultural practices. The research suggests that addressing the challenges of AI implementation in Indonesian agriculture requires a multifaceted approach. Strategies such as leveraging IoT, AI, and ML technologies, employing feature selection methods, and promoting digitalization tools can mitigate some of the identified obstacles. However, additional considerations, such as data security and privacy, equitable distribution of mechanization, and adaptation of AI-based technology to real-world environments, must also be addressed to ensure comprehensive solutions.

Figure 1. The variables contained in this research

All the keywords listed in Figure 1 represent a range of crucial research variables in the context of applying artificial intelligence (AI) in agriculture. In 2014, research primarily focused on utilizing artificial intelligence to enhance efficiency and productivity in agriculture, with a focus on both urban and rural sectors. During the period of 2015-2016, research highlighted the implementation of advanced technologies such as machine learning, Internet of Things (IoT), and computer vision in crop monitoring, predictive analytics, and agricultural supply chain logistics. This demonstrates efforts to leverage sophisticated technology to improve the management and operational efficiency of agriculture.

Subsequently, in 2017-2018, research placed more emphasis on sustainable practices, the development of new technologies, and marketing support to enhance agricultural outcomes in rural areas. This reflects endeavors to address challenges faced by farmers in rural areas and promote the adoption of more sustainable agricultural practices. The period of 2019-2020 emphasized irrigation management, plant nutrition, and the socio-cultural impact of agricultural digitization, along with the implementation of online marketing applications. The focus on economic and socio-cultural aspects indicates a deep understanding of the broad implications of technology use in agriculture.

In 2021-2022, research delved further into exploring the utilization of expert systems, natural language processing, speech recognition, and machine vision in the context of rice cultivation, disease and pest detection, showcasing advancements in technology development to support agricultural productivity. Finally, the period of 2023-2024 featured research on soil and crop management, weed and disease control, as well as data security and privacy in the context of collaboration and adaptation of AI-based technology. This demonstrates awareness of the importance of data security and collaboration in addressing complex challenges associated with the application of artificial intelligence in agriculture.

D. CONCLUSION

Based on the evaluation of the research findings presented, it can be concluded that the integration of artificial intelligence (AI) technology holds significant transformative potential in Indonesian agriculture, particularly in rural areas. Despite promising prospects for improving efficiency, welfare, and sustainability in agriculture, challenges

related to technology accessibility, training, and socio-cultural implications remain significant hurdles that need to be addressed. Therefore, collaborative efforts among policymakers, researchers, and agricultural stakeholders are necessary to maximize the benefits of AI technology in enhancing productivity and welfare for farmers across various rural regions in Indonesia.

However, there are gaps in the existing research, particularly in understanding how AI can be widely adopted by small and medium-scale farmers in rural areas, as well as in exploring the deeper impacts of AI technology integration on the socio-cultural aspects of farming communities. Therefore, urgent research is needed to investigate effective strategies for improving the accessibility and adoption of AI technology by small and medium-scale farmers in rural Indonesia, as well as to examine the socio-cultural implications associated with the integration of AI technology in the agricultural context. With a deeper understanding of the challenges and potential solutions related to AI technology adoption in agriculture, it will enable the development of more effective policies and strategies to enhance the welfare and sustainability of farming communities in Indonesia.

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