Journal Governance Society
e-ISSN: 3064-2337 p-ISSN: 3064-2329

Vol 2, No 1, May (2025): Page no: 38-47
Available online at
https://journal.austrodemika.org/index.php/jgs

The Digital Education based on Public Innovation in Developing a Sustainable Agribusiness Ecosystem

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Received: April 30, 2025 | Revised: May 9, 2025 | Accepted: May 31, 2025

https://doi.org/10.69812/jgs.v2i1.105

ABSTRACT

This research addresses persistent challenges in Indonesia's agribusiness sector, including limited access to information, climate change, market fluctuations, and unequal technological adoption. The study aims to design a public innovation model integrating digital education to foster a sustainable agribusiness ecosystem. Employing a qualitative descriptive method, data were obtained through an extensive literature review of scholarly works, policy documents, and reports from international organizations. Thematic analysis and triangulation were applied to identify patterns, challenges, and best practices. The resulting model, Agro-EduHub 5.0, is a community-based hybrid platform linking education, smart farming technology, digital marketing, and multi-stakeholder collaboration. Key features include a hybrid governance model, hyperlocal AI language support, NFT-based incentives, predictive policy dashboards, creative economy villages, agricultural incubators, and CSR-led pilot projects. These innovations address the digital divide, enhance local adaptability, and encourage environmentally friendly practices. The model fosters active participation, cultural relevance, and policy responsiveness, strengthening both resilience and farmer empowerment. It concludes that implementing Agro-EduHub 5.0 through pilot regions and a digital agribusiness consortium will accelerate technology adoption, integrate local wisdom, and promote shared value creation between public and private sectors, ultimately supporting inclusive and sustainable agribusiness transformation.

Keyword: Digital Education, Public Innovation, Rural Development

INTRODUCTION

The agribusiness sector is the backbone of economic development and food security in many developing countries, including Indonesia. However, this sector faces significant challenges such as limited access to information, climate change, market price fluctuations, and technological limitations. Amid these challenges, there is an urgent need for public innovation capable of providing sustainable

solutions for farmers and agribusiness actors. Public innovation, oriented towards public service, must be collaborative, responsive, and based on local needs, especially in the agricultural sector, which is highly influenced by local dynamics (Bason, 2018).

Digital transformation has become a disruptive force that changes the way the agribusiness sector operates. From the use of sensors in agricultural fields, artificial intelligence for weather prediction, to the utilization of big data for market analysis, digitalization has altered the global face of agribusiness. However, behind these advancements lies a significant digital divide between large and small farmers, as well as between urban and rural areas. Without an inclusive approach, digital technologies can widen this gap (Chiarini et al., 2021).

Digital education has become one of the key strategies to address these disparities. Through digital education, farmers can access up-to-date information on cultivation techniques, farm management, and market dynamics in real time. Digital education also allows for adaptive and flexible learning processes, especially through mobile learning platforms that are increasingly accessible (Baumüller, 2018). Thus, digital education is not only a learning tool but also an empowerment tool for farmers in the digital age.

In developing countries, digital education is beginning to be adopted as a public policy instrument. Governments and development organizations are designing digital literacy programs specifically for farmers and small and medium-sized enterprises (SMEs) in the agricultural sector. The implementation of these policies requires an integrated approach among technology providers, educational institutions, and local governments to ensure that the benefits are felt evenly (Klerkx et al., 2019). In Thailand, digital education in the agricultural sector has become an integral part of the national strategy for rural economic transformation.

The Thai government, through the Ministry of Agriculture and Cooperatives, launched the "Smart Farmer" program aimed at improving digital literacy among farmers through training in the use of smart farming applications, digital market access, and data-based information technologies. This program also collaborates with universities and local agritech startups to provide technical support and expand access to digital innovations. This collaborative approach not only accelerates technology adoption but also enhances farmers' adaptive capacity to climate change and global market dynamics (Suthipol & Ussawarujikulchai, 2020).

One of the current issues in the development of sustainable agribusiness in Indonesia is the lack of integration of data and information between various stakeholders. Many digital applications have been developed without considering interoperability or the ability to connect with one another. As a result, farmers must adapt to multiple applications, which are confusing and time-consuming. This highlights the need for a public innovation approach that focuses not only on technology but also on policy design and cross-sector coordination (Foster et al., 2022).

Additionally, digital infrastructure barriers, such as uneven internet networks in rural areas, remain a major challenge in implementing digital education. Dependence on networks and technology devices presents a real challenge, especially when the government has not fully prioritized the development of digital infrastructure in rural areas. Therefore, public innovation must balance both technical and social aspects (Heeks, 2018).

Digital education also holds significant potential in strengthening food security. With fast and accurate information, farmers can make better decisions regarding planting times, fertilization, and marketing. A study by Fabregas et al.

(2019) shows that SMS-based advisory services in Kenya increased crop yields by 11%, indicating that digital education can directly impact productivity.

However, digital applications will not succeed without the active participation of the target communities. Many applications fail because they do not consider local culture, the digital literacy levels of users, and the lack of support. This indicates that public innovation must be based on a participatory approach and be responsive to local needs (Susilowati, 2020). On the other hand, digital education platforms are often designed in a top-down manner and not adapted to local contexts. Content that is too technical or delivered in a language unfamiliar to farmers makes the message ineffective. Therefore, the development of educational platforms should involve farmers as co-creators, not just as beneficiaries (Mendoza et al., 2020).

In several regions of Indonesia, there have been cases where digital agricultural programs have stagnated due to a lack of institutions managing them sustainably. For instance, local agritech platforms in South Sulawesi experienced stagnation due to a leadership vacuum and lack of integration with regional agricultural policies. This demonstrates that public innovation must be complemented by strong governance (Zhang et al., 2016).

The concept of a sustainable agribusiness ecosystem emphasizes the importance of interconnections between all actors, from producers, processors, distributors, to consumers. A healthy ecosystem allows innovation to grow naturally with adequate policy support. In this regard, the state plays a role as a facilitator, not just as a regulator (Ansell & Torfing, 2014).

One approach to strengthening the agribusiness ecosystem is by applying the principle of creating shared value, where the public and private sectors collaborate to create both economic and social value for society. This strategy has been shown to be effective in driving innovations that directly impact farmers' welfare (Porter & Kramer, 2011). A study by Aker (2011) shows that information technology has a significant impact on the dissemination of agricultural knowledge in Sub-Saharan Africa. These findings are relevant to Indonesia, given the similar challenges faced by smallholder farmers in accessing information and technology.

The Indonesian government, through the Ministry of Agriculture, has launched various digital transformation programs such as the Agriculture War Room (AWR) and the e-Farmer platform. However, the implementation of these programs is still limited to certain regions, showing disparities in the distribution of the benefits of digitalization (Mazzucato, 2018). Digital education can also be a bridge to attract the younger generation into the agribusiness sector. Generation Z, which is more tech-savvy, has significant potential to develop digital-based agribusiness models, including e-commerce for agricultural products, logistics services, and supply chain management (Rotz et al., 2019).

Digital initiatives such as the "TaniHub" and "RegoPantes" platforms demonstrate how technology can bridge the gap between farmers and consumers without long intermediaries. Such models should be replicated through innovative policies that facilitate the development of local agritech startups (Spielman & Birner, 2008). A sustainability approach in agribusiness is not only about the environment but also about social and economic aspects. Digital education allows the widespread and effective dissemination of information about environmentally friendly farming and agroecology practices (Pretty et al., 2010).

Digitalization must also consider the local context. An education model that works in one region may not succeed in another if it does not take social and cultural factors into account. Therefore, there is a need for flexible and adaptive

digital education design approaches (Wolfert et al., 2017). International organizations such as the OECD encourage governments in developing countries to create innovation ecosystems that promote active community participation in technology development. This strategy will foster the emergence of locally-based digital solutions that align with needs (OECD, 2020).

Considering the various challenges and opportunities, the urgency of this research lies in the need to design a public innovation model that integrates digital education inclusively and sustainably. This research is expected to offer a new approach in building a digital transformation-based agribusiness ecosystem that empowers farmers.

RESEARCH METHOD

This study employed a qualitative descriptive approach to explore the design and implementation of a digital education-based public innovation model for a sustainable agribusiness ecosystem. The qualitative method was selected to capture the complexity of agribusiness challenges and the social dynamics within farming communities. Data collection was conducted through an extensive literature review of peer-reviewed journal articles, government policy documents, and relevant reports from international organizations. This method allowed the researchers to synthesize theoretical perspectives, practical innovations, and case studies from both domestic and international contexts.

The data analysis process used a thematic analysis technique to identify recurring patterns, challenges, and potential solutions in the integration of digital education into agribusiness development. Sources were systematically coded, grouped into themes, and interpreted in relation to the research objectives. Special attention was given to strategies addressing the digital divide, participatory innovation, and sustainable governance. By comparing multiple sources, the researchers ensured the validity of findings through triangulation, thereby increasing the credibility and reliability of the results.

The study's scope covered innovations applicable to rural farming contexts, with a focus on smallholder farmers and community-based agribusiness initiatives. The analysis also incorporated global best practices and local case studies to formulate the proposed Agro-EduHub 5.0 model. This integrative approach ensured that the resulting model was not only theoretically sound but also practical and adaptable to diverse local conditions. The method thus provided a comprehensive foundation for developing a participatory, inclusive, and sustainable digital education framework for agribusiness transformation.

RESULTS AND DISCUSSION

1. Agro-EduHub 5.0 Model as an Integrated Digital Education Platform for a Sustainable Agribusiness Ecosystem.

Agro-EduHub 5.0 is a community-based, integrated digital platform that serves as a bridge between education, smart farming technology, digital marketing, and multi-stakeholder collaboration. Designed as a hybrid ecosystem operating both online and offline, it aims to provide a holistic solution for the agricultural sector. By combining these elements, the platform creates an environment where farmers, educators, businesses, and policymakers can interact, share knowledge, and work toward common goals in sustainable agribusiness development.

The model emerges as a strategic response to three key challenges in the agricultural sector: the information gap, the digital divide, and the low

sustainability of local agribusinesses. Many farming communities lack access to accurate, timely, and practical information, while disparities in digital literacy and technology adoption further widen the productivity gap. Agro-EduHub 5.0 addresses these issues by providing accessible training, relevant data, and user-friendly technological tools, ensuring that agricultural innovations reach even the most remote areas.

Tabel 1. Integrated Digital Education Platform

Aspect	Summary
Platform Overview	Community-based digital platform integrating education, smart farming, digital marketing, and multi-stakeholder collaboration in a hybrid (online-offline) ecosystem.
Key Challenges	Addresses information gaps, digital divide, and low sustainability in local agribusiness through training, relevant data, and accessible technology.
Innovation Approach	Promotes collaborative, locally adaptable, and environmentally friendly solutions, fostering resilience, community empowerment, and sustainable agribusiness growth.

Source: Author, 2025

Innovation in sustainable agribusiness requires more than just technical advancements it calls for collaborative approaches that adapt to the unique needs of local contexts. Agro-EduHub 5.0 emphasizes participatory engagement, enabling stakeholders to co-create solutions, share resources, and implement environmentally friendly practices. Through its integrated framework, the platform fosters long-term resilience, empowers rural communities, and supports the growth of a sustainable agribusiness ecosystem that benefits both people and the planet.

2. Hybrid Governance Model

The Hybrid Governance Model integrates both top-down approaches, driven by government policies, and bottom-up approaches, initiated by community-led actions. This combination ensures that strategic direction from authorities is complemented by local insights and grassroots innovation. By merging these two perspectives, the model provides a balanced framework that is both structured and adaptable, enabling more effective governance in the agribusiness sector. At the heart of this model is active citizen participation in decision-making processes. When community members are directly involved in shaping policies, the resulting regulations become more responsive to real needs and challenges. This participatory element not only empowers local communities but also fosters a sense of ownership, encouraging long-term commitment to the implementation of sustainable agribusiness practices.

Table 2. Summary Hybrid Governance Model

Aspect	Description
Definition	Integration of top-down approaches (government policies) and bottom-up approaches (community-led actions) to create a balanced, structured, and adaptable governance framework in the agribusiness sector.
Key Features	• Combines strategic direction from authorities with local insights and grassroots innovation. • Encourages active citizen participation in decision-making. • Fosters ownership and long-term commitment to sustainable agribusiness practices.

Aspect	Description
Main Actors	Government bodies, local communities, private sector.
Benefits	• Policies become more responsive to real needs. • Stronger sense of community ownership. • Enhanced collaboration and knowledge exchange. • Practical and forward-looking initiatives.
Outcome	Creation of an innovative ecosystem that supports agribusiness sustainability through collaborative governance.
Reference	Ansell & Torfing (2014) — Collaborative governance improves the capacity to address complex challenges and drive transformative change in the agricultural sector.

Source: Author, 2025

Through close collaboration between government bodies, local communities, and the private sector, the Hybrid Governance Model creates an innovative ecosystem that supports agribusiness sustainability. This synergy promotes the exchange of knowledge, resources, and expertise, leading to policies and initiatives that are both practical and forward-looking. As highlighted by Ansell and Torfing (2014), such collaborative governance enhances the capacity to address complex challenges and drive transformative change in the agricultural sector.

3. Hyperlocal AI & Language Support

The Hyperlocal AI & Language Support concept introduces a transformative approach to inclusive digital education by leveraging artificial intelligence systems tailored to local languages and cultural contexts. By integrating AI that understands and communicates in regional dialects, the platform ensures that farmers and agribusiness practitioners in remote areas can engage with digital tools more effectively. This approach addresses the linguistic diversity that often hinders equitable access to digital resources.

Providing local language options significantly reduces one of the major barriers to digital learning in rural communities. Many farmers face challenges not because they lack interest in technology, but because most platforms operate in national or global languages unfamiliar to them. By bridging this gap, Hyperlocal AI makes learning materials more approachable, enabling rural populations to acquire skills and knowledge without linguistic obstacles.

Beyond accessibility, this model also enhances the cultural relevance of educational content by aligning it with local wisdom and traditional agricultural practices. Indigenous communities often have farming techniques and ecological knowledge distinct from mainstream methods. By adapting learning materials to respect and incorporate these practices, the platform increases acceptance, fosters trust, and ensures that modern agribusiness innovations complement, rather than replace, valuable local traditions (Mendoza et al., 2020).

4. NFT-Agribusiness Reward System

The NFT-Agribusiness Reward System introduces an innovative incentive mechanism by offering digital tokens or Non-Fungible Tokens (NFTs) to farmers and agribusiness actors. These rewards are granted to individuals or groups who successfully implement environmentally friendly practices or demonstrate innovation in their operations. By linking sustainability efforts to tangible, tradable

assets, the system provides a modern and engaging approach to motivating positive change in the agricultural sector.

NFTs earned through this system can be exchanged within the agribusiness platform for valuable benefits. These may include access to advanced training programs, discounts on agricultural products, or exclusive participation in specialized workshops. Such redeemable incentives not only encourage consistent participation but also create a direct connection between sustainable practices and practical advantages for the stakeholders involved.

By integrating blockchain-based rewards into the agribusiness ecosystem, this model fosters a self-sustaining cycle of innovation and environmental stewardship. The circulation of digital rewards encourages knowledge sharing, healthy competition, and long-term engagement. As highlighted by Porter and Kramer (2011), linking social and environmental value creation with economic benefits strengthens the overall sustainability of the sector, making the NFT-Agribusiness Reward System a forward-thinking solution for modern agriculture.

5. Predictive Policy Dashboard

The Predictive Policy Dashboard is a digital platform designed to support governments in formulating evidence-based agrarian policies. By collecting and integrating real-time data from the field, it offers a comprehensive view of the agricultural landscape, including current production levels, market dynamics, and environmental conditions. This system ensures that decision-makers have accurate, up-to-date information at their fingertips.

Leveraging predictive analytics, the dashboard identifies emerging trends, potential challenges, and untapped opportunities within the agribusiness sector. By analyzing patterns in crop yields, climate data, and farmer behavior, it enables proactive rather than reactive policymaking. This forward-looking approach allows for the anticipation of risks and the formulation of strategies that can mitigate their impact on farmers and local economies

The insights generated by the Predictive Policy Dashboard serve as a strong foundation for developing targeted programs and policies. With data-driven evidence, governments can optimize resource allocation, support innovation, and promote sustainable practices across the agribusiness value chain. As noted by Heeks (2018), such technology-driven governance tools not only enhance policy effectiveness but also contribute to the long-term resilience and growth of the agricultural sector.

6. Creative Economy Villages

Creative Economy Villages based on agriculture are envisioned as hubs where digital technology meets traditional farming practices. These villages act as centers for technology-based learning, providing farmers with access to modern tools, techniques, and market information. By blending innovation with local wisdom, they create a space where agricultural productivity and community creativity can thrive together.

Through e-commerce platforms integrated into these villages, local agricultural products can reach wider markets beyond their immediate regions. This digital access not only enhances farmers' income opportunities but also promotes regional branding and product diversification. By connecting rural producers directly with consumers, the model reduces reliance on intermediaries and strengthens the rural economy.

As pilot projects, these Creative Economy Villages can serve as models for digital policy implementation in the agricultural sector. Once proven effective, they can be replicated and adapted to other regions across Indonesia, fostering nationwide rural innovation. As emphasized by Mazzucato (2018), such initiatives not only stimulate local economic growth but also support long-term sustainable development through inclusive, innovation-driven strategies.

7. Digital Agricultural Incubators

Digital Agricultural Incubators, involving both state and private universities, offer a strategic pathway to accelerate the adoption of agribusiness technology among the younger generation. By positioning academic institutions as active drivers of innovation, these incubators create a platform where students, researchers, and industry players can work together to address real-world agricultural challenges. Through collaborative projects, students and faculty can co-develop digital tools and solutions that are not only technologically advanced but also highly relevant to the needs of farmers and agribusiness practitioners. This approach ensures that innovations emerging from the incubator are practical, scalable, and grounded in field realities, increasing their chances of successful adoption.

By expediting the transition to smart farming systems based on the latest technology, Digital Agricultural Incubators play a crucial role in modernizing the sector. As Baumüller (2018) notes, such initiatives not only bridge the gap between academic research and industry application but also cultivate a new generation of tech-savvy agricultural entrepreneurs capable of driving sustainable agribusiness growth.

8. Corporate Social Responsibility (CSR) Pilot Projects

Corporate Social Responsibility (CSR) pilot projects led by agritech companies or national banks offer an effective way to introduce new technologies to farmers, supported by adequate funding and infrastructure. These initiatives provide farmers with access to advanced tools, training, and resources they might not otherwise afford, thereby reducing barriers to technology adoption. Such projects also serve as a tangible demonstration of a company’s commitment to fostering sustainable agribusiness. By aligning corporate interests with community needs, CSR programs can improve farmer livelihoods, increase productivity, and promote environmentally responsible practices. This mutual benefit strengthens the relationship between private entities and rural communities.

Collaboration between the private and public sectors through CSR has the potential to significantly accelerate the adoption of digital technologies in agriculture. As highlighted by Spielman and Birner (2008), these partnerships can drive the creation of a more inclusive and sustainable agribusiness ecosystem, where innovation is shared widely and the benefits of modernization reach even the most remote farming communities.

CONCLUSION

The Agro-EduHub 5.0 innovation model is a breakthrough in the development of a sustainable agribusiness ecosystem that integrates digital education approaches, smart farming technology, an NFT-based incentive system, and multi-stakeholder collaboration through a hybrid governance scheme. This platform not only addresses the challenges of information gaps and digitization in the agricultural sector but also encourages active participation from local

communities, especially the younger generation, in the agribusiness transformation process through various innovative features such as Smart Community Farming Sensors, Digital Knowledge Bank, and Civic AgriLab. By combining data-driven approaches, local languages, and digital incentives, Agro-EduHub 5.0 creates spaces for learning, exchanging information, and making more inclusive and sustainable policy decisions at both national and local levels.

To maximize the impact of Agro-EduHub 5.0, it is recommended that the initial implementation focus on pilot regions with strong commitments from local stakeholders, while collaborating with universities, the private sector, and farmer communities in the form of a digital agribusiness consortium to strengthen innovation synergies and expand sustainable technology adoption.

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