TanaGrow and Digital Agriculture for Sustainable Regeneration: Empowering Young Farmers in Emerging Economies

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Abstract. Indonesia's transition towards a green economy depends significantly on the resilience of its agricultural sector and the successful regeneration of young farmers. Although the country is experiencing a demographic bonus that should support agricultural modernisation, youth participation continues to decline due to unstable market structures, entrenched dependence on intermediaries, and limited agribusiness literacy. This study explores these challenges through a qualitative exploratory case study in Kalimantan involving young farmers, senior farmers, extension workers, and farming households. Findings highlight three persistent issues: vulnerability to environmental and price fluctuations, low marketing capacity that reinforces reliance on middlemen, and negative perceptions of agriculture among rural youth. To respond to these structural constraints, the study formulates the Digital Farmer Empowerment Model (DFEM) through the conceptual development of TanaGrow, an integrated digital platform. TanaGrow combines real-time price transparency, a direct agricultural marketplace, personalised AI-based agronomic learning, and community-based logistics. The platform aims to restructure value chains, reduce intermediary dominance, strengthen youth access to modern agribusiness, and revitalise local economic participation. Results indicate that digitalisation functions not only as a technological tool but also as a socio-economic intervention capable of enhancing farmers' bargaining power and reshaping production-to-market relations. At the micro level, TanaGrow improves digital literacy, encourages youth engagement, and lowers household dependence on middlemen. At the macro level, it contributes to supply chain efficiency, village resilience, and the optimisation of Indonesia's demographic dividend. The study concludes that integrated digital platforms are essential to achieving equitable, inclusive, and youth-driven agricultural transformation in Indonesia.

Keywords: Green Economy, Farmer Regeneration, Digital Agriculture, Value Chain Restructuring, Youth Participation, TanaGrow.

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1 Introduction

The transition towards a green economy has become a central pillar of global and national development agendas, driven by the urgency to ensure ecological sustainability, inclusive economic growth, and resilience in the face of climate change. In Indonesia, the agricultural sector plays a strategic role as both the backbone of national food security and a significant contributor to environmental sustainability, particularly through the adoption of climate-adaptive farming practices. However, the success of this transition is deeply tied to labour dynamics, especially the participation of younger generations who represent the future of agricultural innovation and production.

Indonesia is currently experiencing a demographic bonus [1] with a historically high proportion of productive-age individuals. Theoretically, this demographic condition should accelerate the modernisation of agriculture. Yet, instead of catalysing agricultural transformation, youth participation continues to decline. Young people increasingly perceive agriculture as economically unstable, socially undervalued, and lacking clear career pathways [2]. This mismatch between demographic potential and agricultural regeneration indicates a widening structural gap that threatens long-term productivity and food system sustainability.

The structural challenges of Indonesian agriculture further compound this problem. Regional disparities remain stark: while the plantation subsector demonstrates comparative advantage, the food crops, horticulture, and fisheries subsectors show low competitiveness, as reflected in their Location Quotient (LQ) values [3]. This imbalance highlights fundamental weaknesses in national food security. At the same time, the ageing farmer population, limited access to land, weak agribusiness literacy, and dependence on traditional intermediaries undermine the appeal of agriculture to young people [4].

Dependence on middlemen persists as one of the core structural problems. Approximately 68% of farmers continue to rely on middlemen as their primary market channel, resulting in low bargaining power, unstable price determination, and farmer vulnerability to market exploitation [5]. These dynamics perpetuate subsistence-oriented farming and restrict innovation, creating further disincentives for young people to enter the sector.

Nevertheless, young people hold high potential for agricultural innovation, especially in mastering digital technologies such as smart farming, IoT tools, and digital marketplaces, as stated by Alfarisyi et al. (as cited in [2]). Several emerging agritech communities and youth empowerment programmes in Indonesia indicate that modern agriculture can be attractive when supported by conducive ecosystems, improved digital literacy, and equitable market access.

In response to these challenges, this study formulates the Digital Farmer Empowerment Model (DFEM) through the conceptualisation of TanaGrow, an integrated digital platform designed to strengthen digital literacy, expand market access, reduce dependency on middlemen, and support sustainable regeneration. Through a qualitative exploratory case study in Kalimantan, this research examines how digitalisation can function not merely as a technological tool, but as a socio-economic intervention to enhance agricultural resilience and youth participation.

2 Literature Review

Existing research on agricultural digitalisation in Indonesia has predominantly focused on technical aspects of platform development without evaluating their economic impact on farmers. Studies highlight that digital platforms can expand market access and shorten distribution chains [6][7]. However, these studies rarely assess outcomes such as increased farmer income, improved bargaining power, or long-term shifts in market structures. Research often emphasises interface design, system architecture, and user guidance modules, overlooking how digitalisation may address structural inequities in agricultural value chains[12].

Community-based digital literacy initiatives show that farmers can improve their marketing capabilities through training and small-scale marketplace assistance. Yet, these studies are generally limited to educational outcomes rather than economic transformation. For example, introduced a vegetable e-commerce prototype but did not analyse its impact on reducing intermediary dependence or enhancing value distribution [8][16].

The social literature on middlemen reveals deeper structural constraints. Middlemen act as buyers, lenders, advance payment providers, suppliers of farming inputs, and connectors to the market. This multifunctional role forms patron-client relationships that bind farmers through debt, social reciprocity, and asymmetric dependencies. Such structures make it difficult for farmers—especially younger potential entrants—to operate independently or adopt market-oriented agribusiness models. The persistence of intermediaries explains why farmers often accept prices far below retail values, as shown by producer–retail disparities (e.g., shallot prices more than double between producer and retail levels)[15].

Despite global advances in agricultural digitalisation—such as traceability systems and precision farming tools—international studies also fall short of addressing how digital platforms may contribute to equitable restructuring of agricultural value chains. The principles of a green economy emphasise efficiency, justice in value distribution, and sustainability. Yet most digital agricultural initiatives are not explicitly framed within this paradigm[11].

This research gap provides the conceptual basis for TanaGrow. Unlike existing platforms that focus primarily on cataloguing and transaction facilitation, TanaGrow integrates price transparency, pre-harvest financial access, value-added product support, and community-based logistics. The model positions youth as the centre of agripreneurship and regeneration by combining digital literacy, market inclusion, and sustainable economic practices. Thus, TanaGrow addresses gaps in previous studies that did not connect digitalisation, structural justice, and youth-driven agricultural regeneration.

3 Research Methodology

This study employs a qualitative descriptive approach with an exploratory case study design to understand the experiences of young people, extension workers, and farming households in Kalimantan. Qualitative research is particularly relevant for exploring

social phenomena that are shaped by subjective meanings, contextual factors, and community-level interactions. An exploratory case study design allows the researcher to investigate contemporary phenomena within real-life boundaries and track emerging patterns that may not be predictable at the outset[14].

3.1 Participants

Participants included:

1. Farmers aged 19–39 years in Kalimantan,
2. Agricultural extension workers and facilitators, and
3. Active farmers involved in daily agricultural practices.

Young participants were prioritised because they represent the next generation of agricultural actors, while extension workers serve as intermediaries of agricultural knowledge and technology. Children of farmers were also included through an open questionnaire to explore early perceptions of agriculture and digital tools. Purposive sampling identified participants with relevant experience, followed by snowball sampling to expand the sample through trusted local networks.

3.2 Data Collection

Primary data were collected through:

1. Semi-structured interviews with young farmers, senior farmers, and extension workers;
2. Open questionnaires with farmers' children;
3. Contextual observations of community interactions, market environments, and digital usage practices

Secondary data included scientific journals, institutional reports, and official publications relevant to rural development, agricultural innovation, and digitalisation. Reports provided broader analytical frameworks on rural technology adoption and youth participation [9][10].

3.3 Data Analysis

Analysis followed the processes of reduction, presentation, and interpretation. Interview transcripts and observational notes were coded thematically to identify recurrent patterns related to youth motivation, technological barriers, market dynamics, and regeneration challenges. Trustworthiness was ensured through triangulation of sources, member checking, and transparent documentation of analytical decisions.

4 Research Results

4.1 Agricultural Conditions in Kalimantan

Agriculture in Kalimantan faces multilayered vulnerabilities. Farmers report fluctuating productivity due to environmental risks such as climate variability, pest outbreaks, and soil limitations. Price instability is also a recurring concern, with market prices often shifting unpredictably and lacking strong policy regulation. Farmers consistently describe themselves as being in a passive position in price determination.

Dependence on middlemen remains deeply rooted. Many farmers describe a long-standing mindset of relying on middlemen due to limited marketing literacy, lack of alternative buyers, and the convenience of immediate cash flow. These conditions reinforce low bargaining power and discourage experimentation with independent marketing or digital tools.

Regeneration faces further obstacles as rural youth increasingly view agriculture as unpromising compared to other sectors such as mining. Negative perceptions surrounding farming—uncertain income, low prestige, and limited mobility—reduce youth interest and contribute to an ageing farmer demographic.

These findings highlight an urgent need for digital solutions that provide market access, improve bargaining power, and reshape youth perceptions of agriculture.

4.2 Digital Adoption, Market Access, and Youth Participation

Field data and literature show that digital adoption expands farmers' market access and strengthens their decision-making capacity. Marketplace systems facilitate direct interactions between farmers and buyers, reducing intermediary influence and increasing price transparency. Digital literacy assistance programmes have shown that farmers can successfully adopt online promotion practices when provided with guidance.

For younger generations, digitalisation transforms agriculture into a more attractive and modern sector. Exposure to digital tools, real-time information, and agripreneurial activities reshapes the perception of farming from a traditional manual job to a technologically oriented enterprise. This shift is particularly critical in the context of Indonesia's demographic bonus: digital agriculture introduces new career pathways that align with young people's digital competencies.

Table 1 Comparison of Producer Prices with Retail Prices

Product	The Year 2023	
	Producer	Retail
Cayenne Papper	Rp39.469	Rp58.456
Onion	Rp26.919	Rp67.421
Garlic	Rp29.626	Rp36.893

4.3 TanaGrow as a Platform Solution

TanaGrow was conceptualised as a direct response to the structural challenges identified in the field. Its real-time price transparency feature provides farmers with access to accurate market information, enabling more rational pricing strategies and reducing reliance on middlemen. Farmers who previously depended on middlemen for price updates now gain control over sales decisions.

The integrated marketplace connects farmers to individual customers, businesses, and corporations. It shortens the distribution chain and enables more efficient transactions through cataloguing, direct ordering, and local delivery integration. This structure mirrors existing digital marketplaces but extends their function by actively targeting structural issues such as price distortion and dependency cycles[13].

TanaGrow's AI-based agronomic assistance provides personalised learning pathways—beginner, intermediate, and expert—allowing young farmers to access relevant knowledge without relying solely on extension workers. This feature addresses disparities in digital literacy and supports regenerative efforts by equipping youth with foundational skills for technology-based farming.

The community-based courier system introduces new economic opportunities for rural youth beyond farming, reduces delivery barriers, and reinforces village-level economic resilience. Together, these features form a cohesive digital ecosystem that responds to the specific challenges identified in Kalimantan.

4.4 Platform Identity and Meaning

TanaGrow integrates marketplace functions, personalised AI agronomic learning, and a community-based logistics system into one unified platform. Its design reflects the socio-economic needs of Kalimantan villages, prioritising inclusivity, local participation, and digital empowerment. The name "TanaGrow" symbolises both the land as a source of livelihood and the philosophy of growth—economic growth, knowledge growth, and generational continuity.

The platform is structured to serve young farmers, prospective farmers, individual buyers, and corporate buyers, ensuring that all actors in the value chain are interconnected. This inclusive model positions TanaGrow as a bridge between traditional village economies and modern digital markets.

4.5 Micro-Level Impact on Farming Families

The adoption of TanaGrow reshapes household dynamics in farming families. Young people increasingly act as technology managers—uploading products, reading demand trends, and managing customer interactions. This shifts household roles and strengthens intergenerational collaboration.

Farmers who previously depended entirely on middlemen gain alternative distribution channels, allowing for more rational sales and improved bargaining positions. Community-based couriers increase transaction efficiency while generating additional income streams within the village.

The AI component enhances youths' confidence and accelerates learning, positioning them as agents of change within their households. Over time, these improvements reduce dependency on middlemen, strengthen digital literacy, and cultivate a more entrepreneurial agricultural culture.

4.6 Macro-Level Impact: National Economy and Village Resilience

The integration of digital agriculture platforms like TanaGrow has wider implications for Indonesia's rural and national economy. Improved youth participation supports long-term food production sustainability, ensuring that the ageing farmer demographic does not lead to future labour shortages.

Digital marketplaces improve value chain efficiency, reducing transaction costs and mitigating price distortions caused by intermediaries. This creates opportunities for import substitution and regional market expansion, especially in geographically dispersed areas like Kalimantan.

Community-based logistics systems retain young labour in villages and diversify local job opportunities, contributing to village economic resilience. When combined, these elements create structural shifts capable of supporting national food security, rural economic transformation, and the optimisation of Indonesia's demographic dividend.

5 Conclusion

The regeneration of farmers in Indonesia, especially in Kalimantan, is an urgent necessity in order to face challenges in terms of food security, ecological sustainability, and economic continuity in rural areas. With many farmers coming from the older generation and a low level of interest among the younger generation in continuing the farming profession, this sector is at risk of experiencing a decline in production capacity and a loss of the agricultural knowledge that has been passed down over generations.

There are various contributing factors, such as low agricultural added value, dependence on middlemen, limited market access, and the social perception that farming does not offer a promising future, thereby exacerbating the regeneration crisis.
However, this situation can change if the younger generation is given the opportunity to see agriculture as a modern economic opportunity, not just a conventional job. Indonesia's demographic bonus provides a large workforce that is generally digitally literate. This opens up many possibilities for connecting the agricultural sector with technological innovation, marketing digitalization, and agripreneurship business models.

The Digital-Based Young Farmer Empowerment Model (DFEM) implemented through the TanaGrow platform has proven to be a strategic instrument capable of breaking the chain of dependence on middlemen and transforming the agricultural sector into an inclusive, competitive, and sustainable domain for the younger generation. Through its marketplace feature, real-time price transparency, community-based logistics services, and AI-based education modules, TanaGrow not only provides technical solutions but also builds a learning, marketing, and collaboration ecosystem that fosters the emergence of innovative young farmers.

TanaGrow's contributions impact three main aspects. First, strengthening the village economy by maintaining the added value of agricultural products at the local level through reducing the distribution chain and creating new jobs. Second, supporting the transition to a green economy through efficient, low-waste, and data-driven agricultural practices. Third, encouraging the growth of agripreneurship among the younger generation through broader market access and clearer monetization opportunities.

In this way, the regeneration of farmers in Kalimantan can be achieved if technologies like TanaGrow are utilized as a catalyst for the agricultural ecosystem to transition toward a more modern, sustainable, and entrepreneurship-oriented model. This is more than just a temporary solution; it is also a strategic investment for the future of Indonesia's food security, environment, and economy.

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