Innovative Agricultural Financing Models to Enhance Farmers' Access to Sustainable Credit and Investment

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ABSTRACT

Farmers' access to sustainable finance remains a persistent structural barrier to agribusiness development in many developing countries. In Indonesia, conventional credit schemes often fail to align with the seasonal nature and risk profile of agriculture, limiting productivity and financial inclusion among smallholder farmers. This study aims to evaluate innovative financing models that can improve access to credit and sustainable investment in three agrarian regions: Kulon Progo, Jember, and Tanah Datar. Using a qualitative multiple case study approach, the research examines the design and implementation of value chain financing, blended finance mechanisms, and digital lending platforms within varying local agricultural contexts. The findings reveal that value chain financing in Kulon Progo significantly reduced non-performing loan rates to 1.2%; digital lending in Jember reached over 3,200 young farmers; and blended finance in Tanah Datar contributed to a 26% increase in household income. These results highlight the importance of coordination among agribusiness actors, financial institutions, and enabling policy frameworks. The study contributes practical insights for policymakers by identifying key success factors such as adaptive regulation, improved digital infrastructure, and institutional partnerships needed to scale inclusive financing models and enhance the resilience of Indonesia's smallholder farmers.

Keywords*: Agricultural Credit Innovation, Agricultural Finance, Digital Lending, Financial Inclusion, Fintech, Value Chain Financing.*

ABSTRAK

Akses petani terhadap pembiayaan berkelanjutan masih menjadi hambatan struktural yang terus-menerus bagi pengembangan agribisnis di banyak negara berkembang. Di Indonesia, skema kredit konvensional seringkali tidak selaras dengan sifat musiman dan profil risiko pertanian, sehingga membatasi produktivitas dan inklusi keuangan di kalangan petani kecil. Studi ini bertujuan untuk mengevaluasi model pembiayaan inovatif yang dapat meningkatkan akses terhadap kredit dan investasi berkelanjutan di tiga wilayah agraris: Kulon Progo, Jember, dan Tanah Datar. Dengan menggunakan pendekatan studi kasus ganda kualitatif, penelitian ini mengkaji desain dan implementasi pembiayaan rantai nilai, mekanisme pembiayaan campuran, dan platform pinjaman digital dalam berbagai konteks pertanian lokal. Temuan penelitian ini mengungkapkan bahwa pembiayaan rantai nilai di Kulon Progo secara signifikan mengurangi tingkat kredit macet menjadi 1,2%; pinjaman digital di Jember menjangkau lebih dari 3.200 petani muda; dan pembiayaan campuran di Tanah Datar berkontribusi pada peningkatan pendapatan

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rumah tangga sebesar 26%. Hasil ini menyoroti pentingnya koordinasi antar pelaku agribisnis, lembaga keuangan, dan kerangka kebijakan yang mendukung. Studi ini memberikan wawasan praktis bagi para pembuat kebijakan dengan mengidentifikasi faktor-faktor kunci keberhasilan seperti regulasi adaptif, peningkatan infrastruktur digital, dan kemitraan kelembagaan yang diperlukan untuk memperluas model pembiayaan inklusif dan meningkatkan ketahanan petani kecil di Indonesia.

***Kata kunci**: Inovasi Kredit Pertanian, Pembiayaan Pertanian, Pinjaman Digital, Inklusi Keuangan, Fintech, Pembiayaan Rantai Nilai.*

INTRODUCTION

The agricultural sector plays a crucial role in supporting food security, job creation, and national economic growth, especially in developing countries such as Indonesia (Pawlak & Kołodziejczak, 2020). However, limited access to adequate and sustainable financing continues to be a major obstacle to agribusiness development (Barua, 2020). According to GrowAsia (2024), more than 70% of smallholders in Southeast Asia do not have direct access to formal financial services, and only 10% of them receive financing from banking institutions. This inequality is exacerbated by the high risks of the agricultural sector due to dependence on climate, fluctuations in commodity prices, and the lack of collateral, which makes the financial sector reluctant to channel credit to this sector. Sustainable financing, defined as financial mechanisms that ensure long-term economic viability, social inclusion, and environmental resilience for farmers, is critical yet challenging to implement in this context (Havemann et al., 2022; Mapanje et al., 2023; Oprisan et al., 2023).

Conventional agricultural financing models, which are top-down and based on fixed asset collateral, have proven to be incompatible with the characteristics of smallholder farming, which is risk-intensive but offers low market certainty. In this context, there is an urgent need to design innovative, inclusive, and risk-based agricultural financing models (Jayalath et al., 2024). Innovations such as value chain financing, blended finance, agricultural crowdfunding, and digital lending platforms are starting to show potential in bridging the financing gap (Havemann et al., 2022; Kurdyś-Kujawska et al., 2025). For example, Canton (2021) states that the FAO report indicates that integrating digital financial technology with value chain-based financing schemes can increase capital allocation efficiency by up to 30% in the horticultural agriculture sector (Wang et al., 2024). However, according to Annosi et al. (2022), while these innovations show promise, a significant research gap remains in understanding how these models can be effectively implemented in diverse socio-economic and institutional contexts, particularly in Indonesia's agrarian regions with varying levels of infrastructure and farmer capacity. This gap is further compounded by limited empirical evidence on the scalability and sustainability of these models in addressing structural barriers such as low financial literacy and weak regulatory frameworks (Rizaldy, 2024; Zahra et al., 2025). Despite growing experimentation, there remains a limited empirical understanding of how innovative financing models can be adapted to Indonesia's diverse agrarian landscape, highlighting the urgent need for contextualized financial reforms to support smallholder resilience and inclusion.

In Indonesia, several initiatives, such as the People's Business Credit (*Kredit Usaha Rakyat*/KUR) for the Agricultural Sector, agribusiness-based peer-to-peer lending platforms, and collaborations between farmer cooperatives and agrotechnology companies, have been piloted with varying results. For instance, KUR has disbursed over IDR 100 trillion to the agricultural sector since 2015; however, only 20% of smallholder farmers have benefited, largely due to stringent collateral requirements and limited outreach in remote areas (de Brauw et al., 2020; Saepudin, 2021). However, the sustainability and scalability of these models are still limited by the weak supporting ecosystem, including regulatory frameworks, institutional capacity, and financial literacy

of farmers. This study aims to address this research gap by identifying and evaluating innovative agricultural financing models that enhance farmers' access to sustainable credit and investment, with a focus on their implementation in three distinct agrarian regions in Indonesia: Kulon Progo (Yogyakarta), Jember (East Java), and Tanah Datar (West Sumatra).

This study aims to identify and evaluate innovative agricultural financing models that enhance smallholder farmers' access to sustainable credit and investment, and to assess their implementation in three distinct agrarian regions in Indonesia Kulon Progo (Yogyakarta), Jember (East Java), and Tanah Datar (West Sumatra) with a focus on their effectiveness, scalability, and sustainability in improving farmers' economic resilience within diverse socio-economic and institutional contexts. This study employs a multiple case study approach to explore the linkages between the design of financing schemes, the actors involved, and their impact on the economic resilience of farmers in these regions. By analyzing diverse economic, social, and institutional characteristics, the research seeks to not only contribute to the agrifinance literature but also provide practical recommendations for policymakers and agribusiness actors in building a more inclusive and resilient agricultural finance system. Agricultural financing refers to the provision of funds, credit, and investment aimed at supporting activities throughout the agricultural value chain, spanning from primary production to yield processing, distribution, and marketing. The unique characteristics of the farming sector, such as seasonality, dependence on climate factors, and market risks, make the need for funding distinct from that of other economic sectors. Therefore, the approach to agricultural financing cannot be standardized and requires the design of financial instruments that are adaptive to the risk profile of farming businesses.

LITERATURE REVIEW

Financial Inclusion and Risk-Based Agricultural Financing

The persistent exclusion of smallholder farmers from formal financial systems in Indonesia can be critically examined through the lens of financial inclusion theory, which emphasizes the importance of accessible, affordable, and appropriate financial services in promoting economic stability and poverty alleviation (Demirgüç-Kunt et al., 2018). According to this theory, financial inclusion is not only about access but also about the usage and quality of financial services tailored to the users' needs. In rural agrarian contexts, low levels of financial literacy, lack of documentation, and weak institutional infrastructure contribute to financial exclusion (Herdinata & Pranatasari, 2020). These conditions are especially prevalent in regions such as Java and Sumatra, where formal land ownership and digital access vary significantly, rendering conventional financial models ineffective.

Complementing this perspective is the risk-based agricultural financing approach, which advocates for the design of financial products that align with the high-risk, low-collateral nature of agriculture (Jayalath et al., 2024). Unlike traditional credit systems that rely on physical collateral and static credit scoring, risk-based financing incorporates dynamic indicators such as climate risk, crop cycles, and market volatility to structure loans and insurance products that are more responsive to the realities of farming. Models such as value chain financing and digital credit platforms operationalize this approach by using non-traditional forms of data (e.g., supply chain contracts, satellite imagery, and mobile phone activity) to assess borrower risk and ensure more inclusive lending (Ülgen, 2017; Krishnan et al., 2020).

Thus, integrating financial inclusion theory with risk-based financing provides a robust conceptual framework for understanding and evaluating the implementation of innovative financing models in Indonesia's agricultural sector. This theoretical foundation helps explain both the causes of exclusion and the mechanisms through which tailored financial innovations can promote inclusion, productivity, and resilience among smallholder farmers.

Challenges in Agricultural Financing

Access to sustainable finance remains a persistent structural challenge in the development of agribusiness within developing countries. According to Andersen et al. (2019), traditional credit schemes often neglect agriculture's seasonality, climate risks, and lack of collateral, limiting productivity and financial inclusion (Andersen et al., 2019). Collateral-based lending and limited rural banking outreach exclude over 60% of Indonesian smallholders from formal finance (Saepudin, 2021; Guja, 2022). The high risk of default due to unpredictable weather and commodity price volatility further discourages financial institutions from engaging with the sector (Sun et al., 2022). This creates a financing gap that restricts farmers' ability to invest in productivity-enhancing inputs, such as quality seeds or modern irrigation systems, perpetuating cycles of low output and poverty (Pawlak & Kołodziejczak, 2020). According to a report by the International Fund for Agricultural Development (IFAD), agricultural credit disbursement constitutes only 3–10% of total credit portfolios in developing countries, underscoring the need for innovative solutions tailored to the sector's risk profile (Basiru et al., 2023).

The theoretical lens of financial inclusion sheds light on why these challenges persist. Financial inclusion theory emphasizes equitable access to affordable financial services to enhance economic resilience. Yet, smallholder farmers in Indonesia face barriers such as low financial literacy and inadequate credit risk assessment models (Herdinata & Pranatasari, 2020). These barriers are particularly pronounced in regions with diverse socio-economic conditions, such as Java and Sumatra, where institutional support varies significantly. For instance, the lack of formal land titles among smallholders complicates credit eligibility, as banks rely heavily on collateral-based lending (Zahra et al., 2025). Addressing these challenges requires rethinking traditional financing approaches to better align with the agricultural sector's unique needs and local contexts (Lubis & Kamilah, 2025).

Innovative Financing Models

Value chain financing aligns the interests of stakeholders across the agricultural supply chain to facilitate credit access and mitigate risk (Canton, 2021). In Indonesia, cooperatives partner with agribusinesses to secure input loans via supply chain contracts (Saepudin, 2021). Blended finance has also emerged as a viable strategy, combining public and private investment to mobilize capital for agricultural development (Dey & Mishra, 2022). This approach not only addresses funding gaps but also shares risks among stakeholders, encouraging investment in high-risk sectors such as agriculture (Fund, 2020). For example, blended finance initiatives in Indonesia, such as partnerships between local governments and international donors, have supported organic farming projects by providing first-loss capital to attract private investors (Rizaldy, 2024). These models enhance capital allocation efficiency, with studies showing up to 30% improvement in resource use in horticultural value chains (Wang et al., 2024).

Digital lending platforms represent another transformative innovation. By utilizing alternative data sources, such as satellite imagery and mobile phone usage patterns, these platforms enhance credit assessments for farmers who lack formal credit histories (Ülgen, 2017). In Indonesia, platforms like TaniFund and Crowde have accelerated credit access for young and women farmers in regions such as Jember, utilising data-driven algorithms to assess creditworthiness (Wijaya & Amna, 2025). However, the scalability of these models in Indonesia is limited by uneven digital infrastructure and regulatory gaps, which hinder widespread adoption (Hao et al., 2024). The financial inclusion framework highlights the potential of these innovations to bridge access gaps; however, their success depends on aligning technological solutions with local institutional capacities (Krishnan et al., 2020).

Enabling Factors and Barriers

The successful implementation of innovative financing models relies on a supportive ecosystem. According to Ramirez and Hernandez (2016), institutional partnerships between financial institutions, agribusinesses, and technology providers are critical for developing comprehensive solutions that address the multifaceted needs of smallholder farmers, as demonstrated by Morocco's Tamwil El Fellah initiative. In Indonesia, collaborations between farmer cooperatives, fintech platforms, and local governments have facilitated tailored financial products, such as input financing in Kulon Progo's value chain schemes (Abiragiye, 2023). Digital infrastructure, including access to spatial data and mobile networks, is another key enabler, enabling accurate credit scoring and risk mitigation through tools such as parametric insurance (Masliani et al., 2024). Supportive fiscal policies, such as interest subsidies and credit guarantees, further incentivize financial institutions to engage with the agricultural sector, particularly in underserved regions like Tanah Datar (Rizaldy, 2024).

Despite these advancements, significant barriers persist. Low digital literacy among farmers, as highlighted by Liew et al. (2020), limits the adoption of fintech solutions, with many Indonesian farmers struggling to navigate digital platforms or understand loan terms. Infrastructure deficits, such as unreliable internet access in rural Sumatra, exacerbate this issue, hindering real-time data collection and credit monitoring (Smidt & Jokonya, 2022). Regulatory barriers also pose challenges, as Indonesia lacks specific guidelines for agricultural fintech, creating uncertainty for investors and risks for farmers (Tambunan & Yassir, 2023). These barriers align with financial inclusion theory, which stresses the need for capacity-building and regulatory reform to ensure equitable access to financial services (Herdinata & Pranatasari, 2020). Addressing these challenges requires flexible regulatory frameworks and strategic investments in digital and institutional infrastructure to foster sustainable agricultural finance in Indonesia.

RESEARCH METHOD

This study uses a qualitative approach with an exploratory case study design to gain an in-depth understanding of innovative agricultural financing models and the dynamics of their implementation at the field level. This approach was chosen because the nature of the phenomenon studied is complex, contextual, and involves various actors in the agribusiness ecosystem. The case study was conducted in three agrarian regions in Indonesia that represent a diversity of geographical, socio-economic, and institutional structures, namely Kulon Progo Regency (Yogyakarta), Jember Regency (East Java), and Tanah Datar Regency (West Sumatra). The selection of locations was purposively based on the criteria of active involvement in innovative agricultural financing programs, the existence of functional farming institutions, and the availability of secondary data and accessibility to the main speakers. These regions were selected to capture variations in agribusiness ecosystems, with Kulon Progo recognised for its strong cooperatives, Jember for its fintech adoption, and Tanah Datar for its community-based organic farming initiatives.

Data collection was conducted through three primary techniques: in-depth interviews, focus group discussions, and document studies. Interviews were conducted with various stakeholders, including farmers receiving financing, farmer cooperative managers, representatives of financial institutions (banks and fintech companies), partner agribusiness companies, and local government officials responsible for the agricultural and economic sectors. A total of 45 key informants were selected using the snowball sampling method, starting with cooperative leaders and fintech representatives who then recommended additional informants based on their roles in financing programs. This approach ensured representation of diverse perspectives, with informants selected based on their direct involvement in financing schemes, expertise in agribusiness, or policymaking authority.

Data analysis was carried out thematically using coding and pattern-matching techniques to identify key themes related to the type of financing model, operational

mechanisms, supporting and inhibiting factors, and the impact on credit accessibility and sustainability for farmers. The validity of the data is maintained through source triangulation and member checking techniques, where the findings are reconfirmed to key informants to ensure the accuracy and credibility of the interpretation. To address potential biases, such as over-reliance on vocal informants or subjective interpretation, the research team cross-verified interview data with documentation and conducted regular debriefings to refine coding consistency. This research also adheres to the ethical principles of qualitative research, including obtaining informed consent, maintaining the confidentiality of respondent identities, and ensuring the transparency of data use. Thus, this methodology is designed to produce a comprehensive and contextual picture of innovative agricultural financing practices that can be replicated or adapted in other agrarian regions of Indonesia, contributing to both academic insights and practical policy recommendations.

RESULTS

The results of in-depth case studies in three research areas reveal that three innovative agricultural financing models have shown concrete contributions in expanding farmers' access to sustainable financing, namely Value Chain Financing (VCF), digital lending based on agricultural fintech, and blended finance schemes through multi-actor synergy. These models differ significantly in their institutional architecture, financing flows, risk mitigation mechanisms, and economic effects on farmers. The relative success of each model, as evidenced by data from cooperative reports, fintech platforms, and project evaluations, is influenced by local conditions such as farmer organization strength, technological infrastructure, and public-private partnerships (Gargano et al., 2021; Smidt & Jokonya, 2022).

In Kulon Progo Regency, the implementation of the VCF scheme occurs within an agribusiness ecosystem that has been consolidated through institutionally strong farmer cooperatives. A partnership was built between the cooperative "Tani Mandiri Sejahtera" and PT Agro Sukses Mandiri, a company processing chili and processed horticultural products. The financing scheme is carried out through an indirect supplier financing approach, where cooperatives act as intermediaries that provide production inputs (seeds, fertilizers, pesticides) on credit to farmers (Abiragiye, 2023). The source of funding comes from state-owned banks, which distribute funds to cooperatives based on collateral provided through supply contracts (forward contracts) between the cooperatives and partner companies. Farmers pay their credit obligations after the crop is harvested by the company at an agreed-upon price at the beginning of the growing season (Akram-Lodhi et al., 2021). Based on cooperative reports from 2022–2023, this model involved 1,200 farmers across 15 villages, with a total credit disbursement of IDR 15 billion for chili and vegetable cultivation (Saepudin, 2021). This model has been proven to significantly reduce credit risk, as seen from the Non-Performing Loan (NPL) figure, which decreased by 1.2% in 2023, far below the national average of NPL in the agricultural sector, which reached 4.6% (Safitri, 2024). Additionally, the market guarantee provided by partner companies creates high production incentives for farmers (Ayvaz-Çavdaroğlu et al., 2021). On average, cooperative-assisted farmers experienced an increase in productivity of 17.8% (from 8 tons/ha to 9.4 tons/ha for chili) and an increase in net income of 23% (from IDR 25 million to IDR 30.75 million per season), as recorded in cooperative financial statements for the 2022–2023 planting seasons. The success of this model is also influenced by the efficiency of input distribution, technical supervision by cooperative extension workers, and the adoption of Good Agricultural Practices (GAP) principles required in partnership contracts.

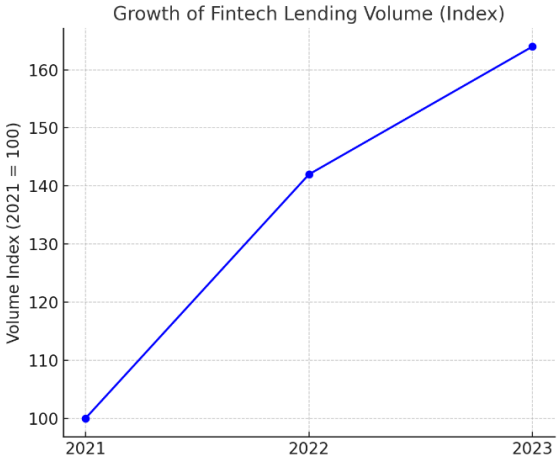

Figure 1. Growth in Fintech financing volume during 2021–2023

The two platforms that were the focus of the study were TaniFund and Crowde, which utilize algorithmic technology in credit scoring, incorporating alternative data such as input purchase records, harvest history, and satellite-based spatial data (NDVI, rainfall, and soil temperature). This fintech bridges the gap between retail investors (crowd investors) and farmers who need planting capital, offering a short-term loan of 4-6 months with a profit-sharing scheme (Alt & Huch, 2022). During the 2021–2023 period, TaniFund and Crowde disbursed IDR 22 billion to 3,200 farmers in Jember, primarily in horticulture and food crops, according to platform reports (Hao et al., 2024). One of the main advantages of this model is the speed of disbursement of funds, which takes an average of 5–7 business days, compared to the conventional banking process, which takes up to 2–3 weeks. As shown in Figure 1, the volume of financing increased by 64% over this period, reflecting high demand among young farmers. However, the limitations of digital literacy and farmers' financial management are the main challenges (Liew et al., 2020). Many farmers, particularly those over 40 years old, reported difficulties in navigating digital applications. According to focus group discussions in 2023, 35% of the 150 surveyed farmers in Jember cited challenges in understanding loan terms. This leads to relatively high variation in default rates, ranging from 5% to 8%, especially in the first growing season when new technologies are onboarded without intensive training.

The study found that partnership programs involving local governments, Village-Owned Enterprises (*Badan Usaha Milik Desa*/BUMDes), and international donor institutions (e.g., IFC and the Kehati Foundation) were one of the ways blended finance schemes have been implemented in Tanah Datar Regency. Public funds are used as first-loss capital to mitigate initial investment risks and attract private sector participation in financing community organic farming projects. The project targets 500 farmers in the organic rice and horticulture sectors, with flexible financing mechanisms distributed through village-based cooperatives. The funds, totalling IDR 8 billion from 2021 to 2023, were used to build drip irrigation systems, compost houses, and provide organic GAP training, according to project evaluation reports (Rizaldy, 2024). Impact evaluations showed that the scheme resulted in an Internal Rate of Return (IRR) of 15.7% in two years, with a farmer retention rate in the programme reaching 91%. Farmers' household incomes increased by an average of 26%, and there was a significant increase in the quality of crops that met export standards. For instance, organic rice yields improved from 4.5 tons/ha to 5.6 tons/ha, and 60% of produce met international organic certification standards, as documented by the Kehati Foundation in 2023. The success of this program cannot be separated from the participatory approach in planning, as well as the existence of continuous technical assistance from donor institutions. However, long-term sustainability depends on transitioning financing from donors to the private sector and BUMDes, with only 20% of funds currently sourced from private investors, as noted in project reports.

Assessing the effectiveness of the agricultural financing model is a strategic aspect in efforts to strengthen national food security, improve farmers' welfare, and encourage rural economic transformation. The three models, VCF, digital lending, and blended finance, were evaluated based on three key indicators derived from field data collected between March and August 2023. The indicators are accessibility to financing for marginalized smallholders, economic sustainability through productivity and income growth, and resilience to agricultural risks such as price fluctuations and crop failures, as documented in cooperative records, fintech platform reports, and project evaluations (Basiru et al., 2023). Figure 2 illustrates the models' resilience by comparing NPL rates across the three regions and the national average. The data for this figure were sourced from cooperative financial statements, fintech platform reports, and Bank Indonesia's 2023 agricultural sector credit statistics (Safitri, 2024).

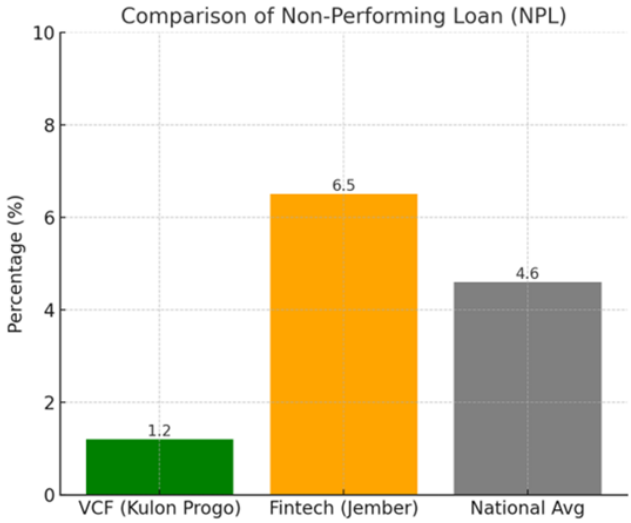

Figure 2. Comparison of NPLs between VCFs, Fintechs, and National Averages

In Kulon Progo, the VCF model significantly enhanced accessibility by connecting 1,200 farmers to formal credit through the "Tani Mandiri Sejahtera" cooperative, bypassing traditional collateral requirements. Cooperative records from 2022–2023 indicate that 85% of participating farmers, previously excluded from banking services due to a lack of land titles, accessed credit through supply contracts with PT Agro Sukses Mandiri, with 90% reporting improved access to quality inputs, such as superior seeds and organic fertilisers (Saepudin, 2021). The model's economic sustainability is evident in the 17.8% increase in productivity (from 8 tons/ha to 9.4 tons/ha for chili) and a 23% rise in net income (from IDR 25 million to IDR 30.75 million per season), based on cooperative financial statements. As shown in Figure 2, the VCF model achieved an NPL rate of 1.2% in 2023, significantly lower than the national average of 4.6%, reflecting its resilience to risks through forward contracts that stabilize commodity prices (Ayvaz-Çavdaroğlu et al., 2021). This low NPL rate was supported by technical supervision and GAP training provided by cooperative extension workers.

In Jember, the digital lending model reached non-bankable farmers, particularly young and female farmers, with 3,200 beneficiaries accessing IDR 22 billion in loans through TaniFund and Crowde platforms from 2021 to 2023. Platform reports show that 70% of borrowers were under 35 years old and 25% were women, addressing a critical gap in financial inclusion for these groups, with funds primarily used for horticulture and food crop cultivation (Wijaya & Amna, 2025). The model's rapid disbursement (5–7 business days) and 30% lower transaction costs compared to banks enhanced accessibility. However, fintech platform data indicate a default rate of 5–8%, with 35% of 150 surveyed farmers reporting difficulties navigating digital applications, as noted in focus group discussions conducted in 2023 (Hao et al., 2024). Figure 2 highlights that the digital

lending model's NPL rate, while higher than VCF, remains below the national average, suggesting moderate resilience to risks due to satellite-based credit scoring using NDVI and rainfall data. The higher default rate was attributed to limited training during the initial onboarding phase, affecting 40% of first-season borrowers, according to platform feedback reports.

In Tanah Datar, the blended finance model achieved high accessibility by targeting 500 organic farmers through partnerships among local governments, BUMDes cooperatives, and donors such as the IFC and the Kehati Foundation. Project evaluation reports from 2021–2023 show that 91% of farmers remained in the program, with IDR 8 billion disbursed for drip irrigation, compost houses, and organic GAP training, enabling access for farmers without formal collateral (Rizaldy, 2024). Household incomes increased by 26% (from IDR 15 million to IDR 18.9 million annually), and 60% of produce met international organic certification standards, with organic rice yields improving from 4.5 tons/ha to 5.6 tons/ha. The model achieved an Internal Return Rate (IRR) of 15.7% over two years, as documented by the Kehati Foundation in 2023, and Figure 2 shows its NPL rate of 2.1%, reflecting strong resilience due to community-based risk-sharing through BUMDes (Havemann et al., 2022). However, only 20% of funds were sourced from private investors, indicating reliance on donor support.

A comparative analysis across the three regions, as illustrated in Figure 2, reveals distinct strengths: VCF in Kulon Progo had the lowest NPL rate (1.2%) due to strong cooperative structures and market guarantees, digital lending in Jember reached the most diverse beneficiaries (70% young farmers), and blended finance in Tanah Datar achieved the highest income growth (26%) and crop quality improvements (60% export-standard produce). Data from focus group discussions and project reports indicate that VCF benefited from established institutions (85% cooperative coverage). In comparison, digital lending faced challenges with digital literacy (35% of farmers struggled), and blended finance was constrained by donor dependency (80% public/donor funds) (Masliani et al., 2024). These findings highlight that accessibility is highest in digital lending, sustainability in blended finance, and resilience in VCF, though each model's effectiveness varies by regional context (Zahra et al., 2025).

DISUCSSION

The findings from the case studies in Kulon Progo, Jember, and Tanah Datar highlight the transformative potential of VCF, digital lending, and blended finance in addressing the structural challenges of agricultural financing in Indonesia. According to Belhadi et al. (2025), innovative financing models that align with local agribusiness ecosystems can significantly enhance credit accessibility and economic resilience for smallholder farmers, a trend evident in Kulon Progo's VCF model, which achieved a 1.2% NPL rate and 17.8% productivity increase through strong cooperative structures. The VCF's success in Kulon Progo, driven by forward contracts and input efficiency, contrasts with Jember's digital lending, which reached 3,200 young and women farmers but faced 5–8% default rates due to low digital literacy among 35% of borrowers. This disparity underscores the importance of institutional readiness, as noted by Aaltonen and Turkulainen (2022), who argue that collaborative governance is critical for financing models to thrive in diverse contexts. In Tanah Datar, blended finance's 26% income growth and 15.7% IRR reflect the power of multi-actor synergy, yet its reliance on 80% donor funds raises questions about long-term scalability (Havemann et al., 2022).

The comparative analysis reveals that each financing model targets distinct aspects of financial inclusion. VCF reduces risks through market guarantees, benefiting areas with strong cooperatives like Kulon Progo. Digital lending, though promising in expanding outreach, faces barriers in Jember due to digital literacy, requiring training interventions (Kurdyś-Kujawska et al., 2025). Blended finance in Tanah Datar combines public-private funds, supporting long-term sustainability, yet remains dependent on donors unless incentivized by regulation (Rizaldy, 2024). These patterns align with the financial inclusion framework emphasizing access and capacity-building (Herdinata & Pranatasari,

2020). Local conditions cooperative strength, digital infrastructure, and community engagement critically influence outcomes, as reflected in varied NPL rates (Masliani et al., 2024).

The effectiveness of inclusive financing depends not only on technology or capital but on systemic alignment. Local intermediaries, such as cooperatives and BUMDes, bridge the gap between formal finance and farmers' realities, while digital infrastructure enables precision in risk profiling (Tambunan & Yassir, 2023; Smidt & Jokonya, 2022). Yet, without regulatory certainty, especially in agri-fintech, investors hesitate and farmers remain vulnerable (Abiragiye, 2023). Low financial literacy, affecting 35% of Jember farmers, further complicates access to financial services (Liew et al., 2020). These gaps reveal that isolated solutions are insufficient. Instead, adaptive, multi-actor collaboration is essential, combining state support, education, and donor-backed innovation, as demonstrated by Tanah Datar's blended finance initiative with IFC and the Kehati Foundation (Ramirez & Hernandez, 2016).

The implications of these findings are significant for policymakers and agribusiness actors in Indonesia. Developing flexible regulatory frameworks that support fintech interoperability and consumer protection can enhance the reach of digital lending, particularly for young farmers. Integrating agricultural data systems with land and population databases, as suggested by Masliani et al. (2024), would improve credit scoring accuracy and reduce verification errors. Strategic fiscal incentives, such as first-loss capital schemes, can attract private investment to blended finance, reducing donor dependency in regions like Tanah Datar. Finally, strengthening local institutions through capacity-building programs will ensure models like VCF can be replicated in less developed areas, fostering a more inclusive and resilient agricultural finance ecosystem that supports Indonesia's food security and rural economic transformation.

CONCLUSION

This study affirms that transforming agricultural finance in developing countries like Indonesia requires innovative, adaptive, and locally contextualized approaches. By analyzing diverse case studies from Kulon Progo, Jember, and Tanah Datar, it is revealed that alternative financing models such as value chain financing, digital lending platforms, and blended finance can significantly broaden smallholder access to productive capital, enhance efficiency, and generate sustainable economic incentives. For instance, Kulon Progo's low 1.2% NPL rate, Jember's inclusion of 3,200 women and youth farmers, and Tanah Datar's 26% increase in farmer income demonstrate how context-specific designs can drive success when institutional capacity, digital access, and financing structures are aligned with local realities. A key contribution of this study is its empirical insight into how digital technologies accelerate fund distribution and reduce transaction costs in rural financing. Yet, persistent challenges such as digital literacy gaps and weak consumer protection frameworks demand targeted interventions. Value chain financing supports market certainty through cooperative-led integration, while blended finance leverages risk-sharing to attract private investment. These findings highlight diverse, actionable strategies to improve financial inclusion and strengthen rural economic resilience.

For policymakers, the implications are substantial. Regulatory reforms are needed to enable fintech interoperability, improve agricultural credit scoring through integrated data systems, and incentivize private capital via fiscal tools like interest subsidies. However, the study's focus on three regions limits generalizability, and its qualitative nature may introduce subjectivity. Future research should expand to underrepresented areas such as Eastern Indonesia and apply quantitative impact assessments to validate scalability and effectiveness. Such efforts are crucial to establishing inclusive, technology-driven financing ecosystems that foster long-term agricultural transformation.

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