STRENGTHENING COST STRUCTURE AND REVENUE STREAM STRATEGIES BASED ON THE BUSINESS MODEL CANVAS IN DRYLAND FARMING SYSTEMS IN ALOR

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Abstract

Dryland farming in archipelagic regions such as Alor Regency faces structural challenges, including limited water availability, high production costs, and low productivity. These conditions necessitate adaptive and technology-based business model innovations. This study aims to analyze strategies to strengthen the cost structure and revenue stream through a Business Model Canvas (BMC) approach, supported by smart farming and renewable energy. The research was conducted using a community-based applied research method and a single-case study design involving the Batu Nirwala farmer group over four months. The analytical framework used included BMC analysis, before–and–after impact analysis, and qualitative thematic analysis. The results show that integrating solar power systems and automated precision fertigation can reduce energy costs to nearly zero, increase crop productivity, expand productive land by 80%, and promote income diversification through the development of derivative products and technology-based services. The implementation of these technologies also strengthens farmers' institutional capacity and enhances the scalability of the business model in similar agroclimatic regions. This study contributes to the development of a technology-based sustainable agricultural business model framework in dryland areas and offers strategic implications for regional policy and agribusiness entrepreneurship development.

Keywords: Business Model Canvas, Cost Structure, Revenue Stream, Smart Farming, Dryland Agriculture

INTRODUCTION

Agriculture is a dominant sector supporting the economic structure of semi-arid regions such as Alor Regency, East Nusa Tenggara (NTT). However, traditional cultivation practices that continue to rely on manual irrigation, a high dependence on chemical fertilizers, and limited use of technology have resulted in low production efficiency, high cost structures, and minimal contribution to increasing farmers' income. The extreme agroclimatic conditions, characterized by limited water availability, further weaken the competitiveness of the local agricultural sector (Undana & PNK, 2024). Therefore, an alternative agricultural business model is required—one that can sustainably increase productivity and adapt to climate variability.

The Business Model Canvas (BMC) approach is relevant as a strategic framework for designing business models centered on value creation, resource efficiency, and holistic strengthening of revenue structures (Hartatik & Baroto, 2017). However, studies on its application within technology-based dryland agriculture remain limited, particularly in marginal agroecological contexts and among smallholder farming communities. Previous research has largely focused on MSMEs, creative industries, and service enterprises, whereas discussions of BMC in the context of precision agriculture and renewable-energy-based farming systems have been underexplored.

This study addresses this gap by integrating BMC analysis with the implementation of smart farming systems based on automated circular farming, solar energy (PLTS), and the Internet of Things (IoT) within a farmer group. This system enables efficient water distribution, optimized plant nutrition through organic biofertilizers, and real-time monitoring of land conditions. Technological implementation has resulted in an expansion of cultivated land by up to 80%, an increase in cropping intensity from once to three times annually, and a reduction in energy-related operational costs from IDR 1,200,000 per month to nearly zero. Additionally, crop productivity increased by up to 4.5 times, followed by improved market penetration (Impact Report, 2024).

This integration not only strengthens the BMC elements both technically and economically but also generates social impacts, including enhanced technological literacy among farmers and a paradigm shift from conventional practices to agritech-based farming. Furthermore, the use of renewable energy and zero-waste farming systems contributes positively to soil quality improvement and carbon emission reduction, thereby supporting sustainable agricultural development goals.

The central problem examined in this study arises from the fact that traditional agricultural practices in semi-arid regions like Alor face structural limitations, including scarce water resources, high operational costs, low productivity, and dependence on external inputs such as chemical fertilizers and fossil-based energy. These conditions lead to inefficient cost structures and unstable farmer incomes, thereby weakening the competitiveness of local agribusiness. Meanwhile, the application of the Business Model Canvas (BMC) in designing modern technology-based agricultural strategies remains uncommon, particularly in smallholder dryland farming systems. Consequently, this study seeks to address how cost structure and revenue stream strengthening strategies can be formulated through the BMC framework, how renewable-energy-based smart farming and IoT technologies contribute to reinforcing these business model elements, and what strategic implications arise in economic, social, and environmental dimensions within dryland agricultural systems.

This study aims to comprehensively analyze the application of the Business Model Canvas framework in formulating strategies to strengthen cost structure and revenue stream in the dryland farming system in Alor through the integration of smart farming technologies based on renewable energy and the Internet of Things. Specifically, this study evaluates the effectiveness of automated circular farming in improving production efficiency, reducing operational costs, and expanding agribusiness income opportunities for farming communities. In addition, the study seeks to identify the strategic contributions of PLTS-based energy systems, IoT technologies, and biofertilizers in optimizing farmers' business model components, as well as to analyze their impacts on productivity, farmers' economic welfare, technological literacy, and environmental sustainability. Thus, the results of this study are expected to produce a formulation of smart agricultural business strategies that can be replicated and sustainably applied across other dryland regions.

This research provides theoretical contributions by developing a new perspective on the application of the Business Model Canvas in technology-driven agriculture, particularly in regions with limited natural resources. Practically, the findings generate applicable and replicable business model strategies for farmer groups to optimize cost structures and enhance revenue streams through the integration of smart farming technologies, enabling their adoption in community agribusiness planning. Moreover, this study offers strategic contributions to policymakers through evidence-based recommendations for developing smart agricultural policies that support renewable energy adoption and agricultural digitalization. By demonstrating tangible impacts on productivity improvement, operational efficiency, institutional strengthening of farmer groups, and opportunities for developing teaching farms and regional replication models, this study serves as a reference for strengthening sustainable agricultural systems and promoting regional economic development driven by innovative technologies.

REVIEW OF LITERATURE

Business Model Canvas (BMC)

The Business Model Canvas (BMC) is a conceptual framework developed by Osterwalder and Pigneur (2010) to systematically describe, analyze, and design business models through nine interrelated components. It functions as a strategic tool to visualize the alignment between value creation, value delivery, and value capture within an organizational entity. In the context of modern agribusiness, the BMC enables firms or farmer groups to formulate resource management strategies, develop value propositions that respond to market needs, expand partnership networks, and optimize cost structures and revenue streams in response to environmental challenges and climate variability.

Nine Elements of BMC and Its Relevance in Agribusiness

According to Osterwalder and Pigneur (2010), the Business Model Canvas comprises nine elements that illustrate how an organization creates, delivers, and captures value, and its relevance has been reinforced by recent studies on innovation-driven and technology-based business model development (Foss & Saebi, 2018; Joyce & Paquin, 2016). Five elements reflect market orientation: (1) customer segments, representing target beneficiaries or primary customers; (2) value propositions, the unique value offered, such as enhanced productivity or sustainable agricultural products; (3) channels, referring to mechanisms for delivering value through physical or digital distribution; (4) customer relationships, encompassing retention strategies and customer loyalty building; and (5) revenue streams, which include income derived from primary products, derivative products, and technology-based services. Santosa and Putra (2021) demonstrated that the implementation of the BMC in agribusiness communities improves marketing strategy clarity and income diversification, while Aksoy and Yenigun (2021) confirmed that BMC integration enhances strategic planning and the value positioning of agricultural products in the market.

Operational Structure and Cost Components in BMC

The remaining four elements reflect the structure of activities and resources within the business: (6) key resources, including the physical, financial, intellectual, and human assets required to create value; (7) key activities, which encompass essential operations such as production, distribution, technology application, and data management; (8) key partnerships, referring to networks formed with government institutions, technology providers, educational institutions, and agricultural cooperatives to minimize risks and strengthen operational capacity; and (9) cost structure, which includes both fixed and variable costs arising from operational activities. Martinez-Diaz et al. (2021) emphasize that optimizing key resources and key activities in digital agribusiness systems can reduce cost structures by up to 35%, while Bacco et al. (2020) highlight that business models supported by strategic key partnerships and renewable energy adoption enhance operational efficiency and environmental sustainability. Furthermore, Santoro et al. (2021) assert that integrating digital technologies, resource management strategies, and cost structure adjustments enables the emergence of new business opportunities and strengthens adaptation capacity to climate change and market dynamics.

Cost Structure Optimization through Technology Integration and Process Efficiency

Optimizing the cost structure in modern agricultural business models requires not only reducing expenditures but also restructuring business processes through technological integration to increase operational efficiency. In dryland agricultural systems, the adoption of Internet of Things (IoT)-based smart farming, renewable energy through solar power systems, circular farming mechanisms, and biofertilizer applications significantly reduces energy, irrigation, and labor costs. Consistent with findings by Ferreira et al. (2023), agricultural digitalization can reduce input costs by up to 45% and improve resource management efficiency by 70%. Precision irrigation and fertilizer automation shorten daily work duration from eight hours to one hour and reduce reliance on manual labor—a major driver of fixed operational costs in traditional agriculture, as identified by Oyinlola et al. (2022). Within the BMC framework, these technologies strengthen key resources and key activities while lowering variable costs through autonomous energy systems and optimized water use.

Process Efficiency and Sustainable Production Cycles

Process efficiency is a key component of cost structure transformation, particularly through the application of sustainable production models such as zero-waste farming and increased cropping intensity—from once to three times per year—without proportionally increasing input costs. This aligns with Martinez-Diaz et al. (2021), who demonstrate that precision automation systems and sensor-based land management technologies can reduce operating costs by 31% at the community farming scale. In addition to technical efficiency, cost structure optimization is reinforced by BMC-based business strategies that include diversified financing sources and strategic partnerships (Santoro et al., 2021). Thus, technology integration and streamlined operational processes serve not only as cost-control mechanisms but also as catalysts for developing sustainable and competitive agribusiness communities.

Revenue Stream Diversification through Business Model Innovation and Technology Integration

The revenue stream component in the BMC represents the mechanisms through which income is generated from the value proposition offered to customers (Osterwalder & Pigneur, 2010). In modern agribusiness, revenue strategies extend beyond the sale of primary agricultural products to include product diversification, agronomic services, and digital technology applications. Aksoy and Yenigun (2021) note that innovation-based business models in agriculture can increase income potential by 38% through value chain expansion and improved market access. In this context, revenue can be generated from primary crops, derivative products such as biofertilizers and organic feed, technology services including IoT–solar system installation and smart farming training, and digital platforms for direct marketing and contract-based partnerships. Maredia et al. (2021) argue that revenue diversification through precision agriculture enhances financial stability and reduces dependence on single-crop outcomes.

Strengthened Revenue Streams through Renewable Energy and Automated Systems

The adoption of autonomous energy systems and automated farming processes plays an essential role in strengthening revenue streams by enabling increased cropping intensity and consistent production cycles. Studies by Ferreira et al. (2023) and Bacco et al. (2020) demonstrate that precision technologies and renewable energy systems support multi-season production, improve yield volume, and enhance product quality consistency, thereby increasing competitive advantage in the market. Integrating BMC with smart farming also opens new revenue opportunities through consulting services, field demonstration activities, and subscription-based technical service models (Martinez-Diaz et al., 2021). As such, the revenue stream is positioned not merely as the outcome of business activities but as a strategic component of technology-driven and sustainability-oriented entrepreneurship, essential for building resilient agribusiness systems adaptable to climate change and replicable in other marginal regions.

Integrating BMC with Smart Farming and Renewable Energy Systems

Integrating the BMC with smart farming approaches enables the development of agricultural business models that prioritize efficiency, climate resilience, and replicability. Wolfert et al. (2017) emphasize that the use of IoT technologies, agricultural sensors, and automation systems significantly enhances precision in production decision-making and reduces resource waste. Meanwhile, solar-powered irrigation systems have proven effective in reducing energy costs (Rahman et al., 2023) and extending the operational lifespan of farming equipment. In dryland regions such as Alor, circular farming practices that utilize biofertilizer from internal agricultural waste reinforce the production cycle and reduce dependence on chemical fertilizers, thereby strengthening the BMC elements of key resources, key activities, cost structure, and value propositions. The integration of technology and sustainability-based strategies also facilitates the development of business models that function as teaching farms and foundations for regional replication.

RESEARCH METHOD

Research Approach

This study employs a community-based applied research (CBAR) approach, which emphasizes the direct application of research outputs within the local community context. This approach is selected to ensure that the study not only generates academic insights but also provides strategic, implementable solutions for farmers operating in dryland agricultural systems. CBAR facilitates active participation from community members—including farmers, agricultural extension workers, and local stakeholders—in problem identification, business model formulation, technology implementation, and impact evaluation (Reason & Bradbury, 2019). The study further adopts an intrinsic case study design focused on the Batu Nirwala Farmer Group in Alor Regency, representing a community-based dryland farming system facing climatic challenges, resource limitations, and restricted access to technology.

The research utilizes a descriptive–qualitative method supported by data triangulation through direct observations, semi-structured interviews, document analysis, and participatory validation. This approach is integrated with a comparative analysis of farming performance before and after the implementation of the technology-based business model to map improvements in cost structure and revenue streams. Additionally, the study critically examines the relevance of applying the Business Model Canvas (BMC) to design a smart farming and renewable-energy-based agricultural business model. Impact assessment incorporates quantitative indicators (productivity, operational costs, cropping intensity, and market absorption) and qualitative indicators (technology adoption, capacity enhancement, and institutional effectiveness).

Research Location and Subjects

The study was conducted with the Batu Nirwala Farmer Group located in Alor Barat Daya District, Alor Regency, East Nusa Tenggara Province—a region characterized by semi-arid agroclimatic conditions and limited surface water availability. Research subjects consisted of 15 active farmers, 3 technical facilitators, and representatives from local government and higher education institutions involved in the implementation of circular farming technology. Subjects were selected through purposive sampling based on their direct involvement in the business model execution, technology adoption, and their experience in dryland farming systems. The field context is considered representative for assessing the effectiveness of BMC implementation in community-based agriculture operating under resource constraints.

Data Collection Techniques

Data collection was carried out using four primary techniques applied simultaneously. Participatory observation was conducted over four months to observe farming activities, including cultivation practices, the application of IoT-based automated irrigation, the integration of biofertilizer through circular farming, and product marketing mechanisms. Field observations were performed directly by the research team and technical experts, allowing experience-based analysis of operational changes and efficiency improvements. This technique was complemented by semi-structured interviews with implementing farmers, agricultural extension workers, village officials, and smart farming technicians to explore experiential knowledge, perceptions of technology sustainability, and adaptation dynamics.

The approach was further strengthened through document review, including farmer group performance reports, impact reports, records of operational costs and crop productivity before and after technology implementation, and model replication documents. Subsequently, analytical findings were validated through Focus Group Discussions (FGDs) to ensure collective agreement on BMC element mapping and business model strengthening strategies. Data validity was ensured through source triangulation—integrating observational findings, respondent statements, and documented data—ensuring that the information used is technically accurate and contextually acceptable from the perspective of the local community.

Data Analysis Techniques

Data analysis was conducted through three structured and integrative stages. The first stage involved analyzing the business model structure using the Business Model Canvas (BMC) through a canvas-mapping workshop involving farmers, technical facilitators, and business analysts. This process identified changes in the business model strategy before and after the smart farming intervention, enabling a participatory re-mapping of the nine BMC elements to obtain interpretations responsive to dryland agricultural conditions. This analysis allowed assessment of how operational changes affected key elements such as value proposition, key activities, key resources, cost structure, and revenue streams in the community farming business model.

The second stage, a comparative impact analysis (before–after analysis), evaluated the effectiveness of technology implementation using quantitative indicators. These include reduced irrigation time from 8 hours to 1 hour per day, expansion of productive land area by up to 80%, increased planting frequency from once to three times per year, increased harvest productivity from 6.43 tons to 28.88 tons, reduced energy costs from Rp1,200,000 per month to nearly zero, and improved market penetration from 0.00085% to 0.00383%. Data were analyzed using linear comparison and directional value interpretation to assess the effect of technology-based strategies on economic value creation.

The third stage involved strategic analysis using narrative and innovative business model approaches, employing thematic analysis as proposed by Braun and Clarke (2021). This analysis assessed the implications of the business model implementation for economic sustainability, institutional capacity strengthening, and regional replication potential. The combination of structural, numerical-comparative, and qualitative-narrative approaches enabled the study to generate conclusions that are empirically robust, strategically relevant, and suitable for application in the development of technology-driven agribusiness models in dryland regions.

Table 1.
Comparison of Business Model Canvas Elements Before and After Technology Implementation

BMC Elements	Before Technology Implementation	After Smart Farming & Circular Farming Implementation
1. Customer Segments	Limited local marketing (neighbors/small collectors); no value-added segmentation.	Expanded segmentation: premium local markets, potential modern retail, educational partners (teaching farms), and technology institutions.
2. Value Proposition	Conventional agricultural products with no quality differentiation.	Environmentally friendly products supported by water- and energy-efficient technology; added services such as technology demonstrations and consultation.
3. Channels	Direct sales to traditional collectors; no digital access.	Distribution channels through BUMDes partnerships, basic digital marketing, and community-based agribusiness networks.
4. Customer Relationships	Transactional, with no long-term engagement.	Collaborative approach: technology education, digital extension services, and sustainability-oriented business partnerships.
5. Revenue Streams	Solely from primary crop sales; seasonal and unstable.	Diversified income: primary crops, biofertilizer products, technology rental, IoT–solar PV installation services, training, and teaching farm programs.
6. Key Resources	Land, manual labor, limited water, minimal technology.	Solar PV systems, IoT devices, biofertilizer, automation systems, digital data resources, skilled human resources, and university support.
7. Key Activities	Manual irrigation, traditional cultivation, no digital monitoring.	Automated irrigation (8 hours → 1 hour), moisture monitoring, precision fertilization, model replication, and technology education.
8. Key Partnerships	Local suppliers and basic agricultural extension services.	Strategic partnerships with universities, local government, IoT–solar PV technology providers, modern farmer communities, and social investors.
9. Cost Structure	High water and energy costs, labor-intensive operations, no efficiency (Rp1.2 million/month energy cost).	Very low operational costs (near-zero energy expenses), significant labor efficiency (8 hours → 1 hour), improved productivity-to-cost ratio.

RESULTS AND DISCUSSION

Business Model Transformation Based on the BMC Framework

The remapping of the Business Model Canvas demonstrates that the implementation of smart farming and circular farming technologies has substantially transformed the farmer group's business orientation from a conventional, product-based system into a technology-driven and innovation-oriented agribusiness model. This shift is evident in seven of the nine BMC elements that underwent significant changes following the technological intervention, particularly in value propositions, key activities, key resources, cost structure, and revenue streams. Prior to technology adoption, the business model operated traditionally—manual, highly dependent on weather conditions, and constrained by limited water availability. Following the intervention, the model evolved into a data-driven production system supported by digital monitoring, energy self-sufficiency, and governance structures centered on efficiency and sustainability. This phenomenon aligns with Aksoy & Yenigun (2021), who argue that technology can act as a catalyst in repositioning agricultural business models toward value-added orientation and economic resilience.

This transformation not only enhances operational efficiency but also expands the value proposition from merely offering agricultural products to providing integrated technological solutions, educational services, and field-based demonstration plots (smart farming demonstration sites). The integration of service-based agriculture broadens revenue streams and strengthens the competitiveness of local commodities. These findings reinforce the assertions of Santoro et al. (2021), who note that the adoption of technology in primary sectors can shift local commodity-based economies toward innovation-driven agribusiness models.

Table 2.
Business Model Canvas Analysis of Technology-Enabled Dryland Farming Systems

BMC Elements	Analysis Results (Post-Implementation of Smart Farming & Solar-Powered Systems)
Customer Segments	• Local farmers (Alor & NTT) • Consumers of agricultural products • Local government (food security initiatives) • Vocational institutions & agricultural research bodies
Value Propositions	• Smart and water-efficient farming systems • Sustainable agriculture supported by renewable energy • Productivity increase up to 348% • Low-cost organic biofertilizer • Supports food security in dryland regions
Channels	• Social media and digital marketing • Cooperatives/BUMDes • Agricultural festivals and events • Eco-edutourism and field visits
Customer Relationships	• Community-based farmer training center • On-site technical assistance • Educational tourism and agricultural product-based retail experiences

BMC Elements	Analysis Results (Post-Implementation of Smart Farming & Solar-Powered Systems)
Revenue Streams	• Sales of agricultural products • Sales of biofertilizer • Smart farming technology consulting services • Potential government project partnerships and industrial CSR initiatives
Key Resources	• Strategic location with high solar irradiation • Internet connectivity and technical support • Multidisciplinary expertise (engineering, agriculture, business) • Solar energy (PLTS) and IoT-based agricultural systems
Key Activities	• Research and development of circular farming technologies • Production and testing of biofertilizer • Installation and operation of PLTS and IoT systems • Training and dissemination of innovations
Key Partners	• Local government and Ministry of Education/Science & Technology • Universities • Agricultural vocational schools & local farmer communities
Cost Structure	• Costs of technology development and fabrication (PLTS, IoT, bioreactors) • Installation and maintenance costs • Training and field extension costs

Strengthening Cost Structure through Technological Efficiency and Process Automation

The implementation of smart farming technologies and renewable energy has generated a significant impact on the cost structure of the farming system. Evaluation results show a reduction in irrigation time from an average of 8 hours to just 1 hour per day, alongside the use of solar power systems (PLTS) which decreased monthly energy expenses from Rp1,200,000 to nearly zero. Labor efficiency also increased by up to 87.5%, while water consumption was substantially reduced through IoT-based precision irrigation. The use of biofertilizers produced from recycled agricultural waste further reduced fertilizer costs by 45% and strengthened the adoption of zero-waste farming practices.

These findings are consistent with Ferreira et al. (2023), who demonstrated that automation and digitalization in agriculture can reduce input costs by up to 45% and increase resource-use efficiency in marginal lands. Therefore, strengthening the cost structure is not merely a technical outcome but also part of reconstructing the broader business strategy, aligning with the concept of cost leadership in modern agribusiness. The integration of technology into the cost structure also has the potential to serve as an indicator of investment readiness for green financing and carbon credit–based funding mechanisms.

Revenue Stream Diversification Strategies through Business Model Innovation

Diversifying income sources is essential for enhancing financial resilience in dryland regions. Prior to the intervention, income was derived solely from seasonal crop sales. After technology implementation, the revenue stream expanded into a multi-dimensional model, encompassing revenue from primary crop production, organic biofertilizer sales, smart farming system rentals, technology installation services, training and field visits (teaching farm), and direct digital-based marketing opportunities.

The study indicates an increase in market penetration from 0.00085% to 0.00383% of total regional market demand, along with a rise in harvest productivity from 6.43 tons to 28.88 tons per cycle. These developments support the theory proposed by Maredia et al. (2021), which emphasizes the importance of revenue diversification as a risk mitigation strategy in community-based agribusiness. Thus, the post-intervention BMC is not merely an operational representation but also a strategic framework for developing innovation-driven farming enterprises enriched by technology-based services.

Implications for Strengthening Farmer Institutions and Model Replication

The implementation of a BMC-based business model has influenced organizational behavior within the farmer group, shifting their orientation from production-driven to innovation- and collaboration-driven (collaborative innovation farming). Institutional capacity increased through strategic partnerships with universities, local government, technology providers, and business partners. The farmer group demonstrated improved managerial capabilities, greater technological adaptability, and a deeper understanding of sustainability as a foundational business principle.

The findings show that this model is suitable for replication in other dryland regions provided that initial technical assistance, access to renewable energy, and an education- and partnership-oriented business model are established. This aligns with Martinez-Diaz et al. (2021), who assert that the success of community-based agribusiness innovations is determined by the adaptability of the system rather than the sophistication of the technology alone.

Overall, the implementation of a technology-driven BMC demonstrates that modernizing dryland agriculture extends beyond enhancing technical performance—it encompasses a comprehensive transformation of business strategy. The integration of cost efficiency (cost structure) and expanded income generation (revenue stream) within the business model framework reflects increased economic self-sufficiency among farming communities and readiness to transition toward modern agribusiness capable of adapting to climate change and the challenges of marginal environments.

CONCLUSION

This study demonstrates that the implementation of a Business Model Canvas (BMC) integrated with smart farming and circular farming technologies can transform traditional farming models in dryland regions into innovative and adaptive agribusiness systems. The adoption of IoT-based automated irrigation, energy self-sufficiency through solar power systems (PLTS), and the integrated application of biofertilizers resulted in improved operational efficiency, strengthened cost structure, and diversified revenue streams. The analysis shows a reduction in irrigation labor time from 8 hours to 1 hour per day, an expansion of productive land by up to 80%, an increase in planting intensity from once to three times per year, a more than 350% increase in harvest productivity, and a reduction in energy costs to nearly zero.

From a business model perspective, there has been a shift in the value proposition—from merely selling agricultural products to providing technological solutions and educational services. The farmer group no longer acts solely as a producer but has evolved into an innovative actor offering smart farming system installation services, technical consultation, biofertilizer provision, and the development of a teaching farm. This study affirms that the BMC can function not only as a business analysis tool but also as an instrument for reconstructing technology-driven entrepreneurial strategies in community-based agriculture. Therefore, the newly developed business model in this research is suitable for replication in other marginal regions with similar agroclimatic characteristics.

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