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# Institutional model for social entrepreneurship in rice-based agrotourism

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**ABSTRACT:** Rice field agritourism is a tourist attraction that utilizes natural agricultural landscapes to offer educational experiences related to the agricultural sector. This research aims to develop an ideal rice-based agro-tourism institutional model using a systems approach, employing the Analytical Hierarchy Process (AHP) method. This study was conducted in the Bunga Raya Sub-district, Siak District, Indonesia. AHP analysis revealed that human resources (0.302) and technology (0.229) were the most important factors for successful agritourism development. The study identified an equal weighting of farmers (0.284) and agritourism management (0.291) in stakeholder roles, while technology development (0.253) and local economic growth (0.272) emerged as key objectives. Among the institutional models evaluated, the Local Public Service Agency (LPSA) emerged as the most suitable framework (0.429), followed by the partnership model (0.237), the Destination Management Organization (0.147), cooperatives (0.118), and Community-Based Tourism (0.068). Local Public Service Agencies (LPSAs) with social entrepreneurship initiatives in the rice-based agritourism sector play a strategic role in enhancing the welfare of farmers, contributing to the optimization of tourism potential, promoting local financial independence, and creating sustainable economic opportunities while protecting local natural and cultural resources.
**Keywords:** agrotourism; institutional model; social entrepreneurship; rice farming; analytical hierarchy process; rural development; agricultural economics.

## Modelo institucional de empreendedorismo social no agroturismo à base de arroz

**RESUMO:** O agroturismo em arrozais é uma atração turística sob a forma de um conceito natural que utiliza terrenos agrícolas para proporcionar ensinamentos relacionados com o sector agrícola. Esta investigação tem como objetivo produzir um modelo institucional ideal de agroturismo baseado no arroz com uma abordagem sistémica, utilizando o método Analytical Hierarchy Process (AHP). Este estudo foi efectuado no subdistrito de Bunga Raya, distrito de Siak, Indonésia. A análise AHP revelou que os recursos humanos (0,302) e a tecnologia (0,229) eram os factores mais importantes para o desenvolvimento bem-sucedido do agroturismo. O estudo identificou um peso igual dos agricultores (0,284) e da gestão do agroturismo (0,291) nos papéis das partes interessadas, enquanto o desenvolvimento tecnológico (0,253) e o crescimento económico local (0,272) surgiram como objectivos-chave. Entre os modelos institucionais avaliados, a Agência de Serviços Públicos Locais (LPSA) surgiu como a estrutura mais adequada (0,429), seguida pelo modelo de parceria (0,237), Organização de Gestão de Destinos (0,147), cooperativas (0,118) e Turismo de Base Comunitária (0,068). As Agências de Serviços Públicos Locais (LPSAs) com empreendedorismo social no sector do agroturismo baseado no arroz desempenham um papel estratégico na melhoria do bem-estar dos agricultores e contribuem para otimizar o potencial turístico, a independência financeira local e a criação de oportunidades económicas sustentáveis, protegendo simultaneamente os recursos naturais e culturais locais.
**Palavras-chave:** agroturismo; modelo institucional; empreendedorismo social; cultivo de arroz; processo hierárquico analítico; desenvolvimento rural; economia agrícola.

## 1. INTRODUCTION

Rice paddy farming is a characteristic of traditional life found in countries where the majority of the population considers rice as their primary staple (BRAY, 2023). This indicates that rice fields play an important role for local communities due to their economic, social, and cultural value. However, rice fields are currently facing numerous crises, including the abandonment of rice fields and the loss of agricultural labor in rural areas (WANG et al., 2021). Rice farming represents not only a cornerstone of global food security, feeding over 3.5 billion people worldwide, but also serves as the economic backbone of rural communities in many developing nations (LIANG et al., 2022). Beyond its economic value, rice cultivation embodies centuries of cultural heritage and traditional knowledge systems that shape rural social structures (BRITWUM; DEMONT, 2022). However, the rice farming sector is currently at a critical juncture, facing unprecedented challenges that threaten its sustainability. Recent data reveal alarming trends: a 15-20% reduction in productive farmland across Asian rice-producing regions, a 30% decline in the agricultural workforce over the past decade, and less than 5% of young

people expressing interest in farming careers (TONG et al., 2019). Additionally, climate change impacts, including irregular rainfall patterns and an increasing frequency of extreme weather events, pose significant risks to rice production systems (VINKE et al., 2017).

Siak Regency is the center of rice production in Riau Province and has the potential for paddy fields, one of which is in Bunga Raya District, covering an area of 2,429 ha. This area has the potential to develop natural agro-tourism based on rice paddy plants, which are visually stunning and an attraction for visitors seeking a unique travel experience. The number of tourists visiting Siak Regency in 2019 has decreased due to the COVID-19 pandemic outbreak. In 2018, the number of tourist visits totaled 255,930. In 2019, this number decreased to 191,404 tourists, comprising 191,404 domestic tourists and 1,067 foreign tourists.

Translated with DeepL.com (free version) Rice-based agritourism plays a crucial role in enhancing agricultural economics by providing alternative income streams for farmers, thereby increasing their overall earnings and promoting rural economic development (AMLOY et al., 2024). The emerging paradigm of sustainable agricultural economics represents a holistic approach to addressing the multifaceted challenges confronting contemporary agricultural systems. Rice-based agrotourism emerges as a pivotal strategy for sustainable rural economic development, integrating economic resilience, environmental conservation, and social innovation (WU; LIU, 2024).

This approach enables farmers to diversify their income sources, thereby reducing their reliance on traditional crop yields that are increasingly threatened by climate change and market volatility. Successful initiatives in countries like Japan and Thailand have demonstrated income increases of 40-60% for farmers, while also attracting younger generations to careers in the agricultural sector. Additionally, agritourism creates jobs in the hospitality and local crafts sectors, stimulating local economies. The effectiveness of these initiatives relies on robust institutional frameworks that foster collaboration among stakeholders, including farmers, local governments, and tourism operators. By integrating social entrepreneurship, these frameworks empower communities to develop innovative business models that enhance economic resilience while preserving cultural heritage and agricultural landscapes. Ultimately, rice-based agritourism offers a sustainable pathway for rural development, ensuring the longevity of rice farming traditions in the face of modern challenges (TRAN et al., 2021).

In response to these multifaceted challenges, rice-based agrotourism has emerged as an innovative strategy for revitalization. This approach not only creates alternative income streams but also preserves agricultural landscapes and traditional farming practices (ACHMAD et al., 2022). Success stories from countries like Japan, where rice-based agrotourism has increased farmer incomes by 40% and attracted a new generation to agriculture, demonstrate its potential. Similar initiatives across Southeast Asia have shown promising results in promoting rural development while fostering meaningful cultural exchange between urban and rural communities (KUNJURAMAN et al., 2022). The long-term viability of these initiatives critically depends on robust institutional frameworks and governance mechanisms that can adapt to changing socio-economic contexts.

Social entrepreneurship has emerged as a transformative force in agricultural development (JIA; DESA, 2022). In the context of rice-based agrotourism, social enterprises are revolutionizing traditional farming systems through innovative business models. Recent studies have demonstrated that social enterprise-led agritourism initiatives have increased farmer incomes by 45-60% while preserving cultural heritage in various Asian countries (ZHANG et al., 2023). These enterprises have successfully developed structured business approaches that combine digital marketing platforms, capacity-building programs, and infrastructure development, creating a sustainable ecosystem for agricultural tourism.

The integration of institutional frameworks with social entrepreneurship has shown remarkable results, particularly when facilitated through multi-stakeholder partnerships. For instance, successful rice-based agritourism ventures in Thailand and Vietnam have demonstrated how well-coordinated collaboration between farmers, tourism operators, government agencies, and financial institutions can create sustainable tourism products (PHI DINH et al., 2022). The Community-Based Tourism (CBT) model has evolved from its traditional form, as described by Zielinski et al. (2021), to incorporate digital technologies and modern marketing strategies, while maintaining its core principle of equitable distribution of benefits.

Developing a sustainable rice-based agrotourism model presents several institutional challenges. Fragmented governance often results in inefficient coordination between the agricultural and tourism sectors, limiting their potential synergies (QUARANTA et al., 2016). Additionally, a lack of access to financial resources and investment opportunities constrains the growth of social enterprises in rural areas (DOHERTY et al., 2014). Another challenge is the low level of stakeholder engagement, as many farmers and local communities lack the necessary business skills and knowledge to manage tourism-related activities effectively (LONGART et al., 2017). Furthermore, policy and regulatory barriers, including bureaucratic inefficiencies and inconsistent government policies, often delay the implementation of agrotourism projects (CAO, 2015). To overcome these challenges, it is necessary to develop institutional models that promote multi-stakeholder collaboration, ensure financial sustainability, and foster a conducive policy environment (HILKENS et al., 2018).

This study aims to develop an AHP-based institutional model for social entrepreneurship in rice-based agrotourism by identifying key institutional factors, analyzing stakeholder roles, and applying AHP to rank and prioritize institutional models for sustainable agrotourism development. The findings will provide valuable insights for policymakers, social entrepreneurs, and rural development practitioners in designing institutional frameworks that strengthen agriculture-tourism linkages and support rural economic growth.

## 2. MATERIALS AND METHODS

This study employed a mixed-methods approach to develop an AHP-based institutional model for social entrepreneurship in rice-based agrotourism in Bunga Raya District, Siak Regency, Indonesia. The region was selected for its established agricultural base, emerging agrotourism

initiatives, and active participation of key stakeholders, including farmers, government agencies, and social enterprises.

The data used in this research comprises both primary and secondary data. Primary data is data obtained through field observations. These data were obtained from interviews, questionnaires, and discussions with experts, focusing on the institutional model of rice-based agritourism with a social entrepreneurship approach. The research team comprises 17 key stakeholders, including representatives from the Riau Provincial Department of Agriculture, Department of Tourism, Department of Industry and Cooperatives, universities, agritourism entrepreneurs, and financial institutions. Additionally, structured questionnaire surveys were conducted among farmers, agrotourism managers, and local government officials, supplemented by focus group discussions (FGDs) with farmers and tourism operators. Secondary data were collected from government reports, policy documents, and academic literature related to institutional models and social entrepreneurship. In AHP analysis, structured interviews using predetermined questions generate quantitative data that help consistently identify criteria and sub-criteria. Semi-Structured Interviews: More flexible, allowing in-depth exploration of respondents' views, providing additional insight into the context and factors influencing decisions. The combination of the two enhances the AHP analysis with clear and in-depth data, supporting more informed decision-making.

The Analytical Hierarchy Process (AHP) was applied to systematically evaluate and prioritize key institutional factors. AHP is a well-established multi-criteria decision-making (MCDM) tool that structures complex decision problems into a hierarchy, allowing for systematic comparison of different factors (SATTY, 1994). In hierarchical models, "factors" and "sub-elements" are selected through a process of analysis that involves judgment and prioritization. Methods such as the Analytic Hierarchy Process (AHP) are often used to evaluate and compare elements on a pair-wise basis, thus allowing the determination of the weight and importance of each element in the context of a larger goal.

The hierarchical model consisted of four levels: the main objective of developing an institutional model for social entrepreneurship in agrotourism, key institutional factors (governance, financing, stakeholder engagement, and infrastructure), stakeholders (farmers, government agencies, financial institutions, and social enterprises), and institutional model alternatives (Public Service Agency, Partnership Model, Cooperative Model, Destination Management Organization, and Community-Based Tourism). Expert Choice 11 Software was used to compute eigenvalues and derive priority rankings based on pairwise comparisons provided by experts. The Consistency Ratio (CR $\leq$ 0.1) validated expert judgments, while sensitivity analysis tested the model's robustness under different weighting scenarios (RAZAVI et al., 2021).

The study ensured methodological rigor through content validation, reliability testing using CR analysis, and data triangulation across multiple sources. Ethical considerations were addressed through informed consent procedures and confidentiality measures. These methodological approaches enabled a comprehensive analysis of institutional factors influencing rice-based agrotourism development while maintaining research integrity.

The evaluation process in a hierarchical model, such as the Analytic Hierarchy Process (AHP), begins with identifying relevant factors and their corresponding sub-elements. Next, a hierarchical structure is built, with the goal at the top, followed by the factors and their sub-elements. Pairwise judgments are made to compare elements, resulting in weights that reflect the importance of each. The consistency of the assessments is checked, and the sub-element weights are combined to get the total weight for each factor. Finally, alternatives are evaluated based on the calculated weights, and a decision is made based on the evaluation results. This process can be repeated to improve the accuracy and relevance of the decision.

The hierarchical structure of rice-based agrotourism consists of four levels: factors, actors, objectives, and institutional models. At the first level, key factors influencing the development of rice-based agrotourism include human resources, technology, market potential, government policy, institutional support, financial resources, and infrastructure. These factors serve as fundamental elements that shape the sustainability and competitiveness of agrotourism. Human resources refer to the individuals involved in planning, operating, and innovating within an organization or system. Technology includes the tools and machinery necessary for rice farming and agrotourism activities. Market potential reflects the acceptance and commercialization of rice-based agrotourism products, while government policy plays a crucial role in providing regulatory support. Institutional support ensures collaboration among stakeholders, while financial resources determine the sustainability of investments (BAAH et al., 2019). Finally, infrastructure provides the necessary facilities for both tourism and agricultural operations (ISKANDAR et al., 2022).

The second level identifies seven key stakeholders who play vital roles in the governance and operation of rice-based agrotourism. These actors include rice farmers, management teams, agricultural and tourism departments, the industry and trade department, research institutions, and financial institutions. Farmers are responsible for rice cultivation and post-harvest activities, while the management team oversees the overall agrotourism system. Government agencies, such as the agriculture and tourism departments, provide regulatory support, while research institutions contribute knowledge and technological advancements. Financial institutions facilitate funding to sustain and expand operations. The interaction among these actors influences the overall success and sustainability of rice-based agrotourism.

The third level outlines five primary objectives that drive the development of rice-based agrotourism: technology development, local economic growth, business integration, quality improvement, and regional development. Technology development fosters innovation and knowledge transfer in rice production and tourism. Local economic growth is achieved through value-added activities in agriculture and tourism, benefiting farmers, small businesses, and local communities. Business integration creates a holistic system that maximizes the potential of both sectors, ultimately enhancing their combined value. Quality improvement enhances the competitiveness of rice products and their derivatives, while regional development contributes to infrastructure improvement and overall economic growth. These objectives align with the principles of sustainable agrotourism and community-based entrepreneurship.

At the fourth level, the model presents five institutional frameworks for managing rice-based agrotourism: Local Public Service Agencies (LPSA), partnerships, Destination Management Organizations (DMO), cooperatives, and Community-Based Tourism (CBT). The LPSA model places

the local government as the primary operator, with farmers and research institutions as supporting partners. The partnership model is led by private entrepreneurs who collaborate with farmers, government agencies, and other stakeholders. DMOs function as specialized organizations responsible for promoting and managing tourism destinations (VOLGGER; PECHLANER, 2014). The cooperative model involves farmers collectively managing agrotourism activities and acting as technopreneurs to develop value-added rice-based products. Lastly, the CBT approach emphasizes local community participation in managing and developing agrotourism initiatives. The selection of an appropriate institutional model depends on local socio-economic conditions, stakeholder engagement, and policy support (MICHAELIDES; LAOURIS, 2024).

This hierarchical model provides a structured framework for understanding the institutional dynamics of social entrepreneurship in rice-based agrotourism. By integrating key factors, engaging relevant stakeholders, and aligning with clear objectives, the model enhances the feasibility of sustainable and community-driven agrotourism. It also facilitates effective governance, policy formulation, and business development strategies, ultimately contributing to the growth of rural economies and the sustainability of agriculture.

## 3. RESULTS

Based on discussions with experts and literature review, several key elements were obtained at each level of the hierarchy of the selection of rice-based agro-tourism institutional models in Bunga Raya District, Siak Regency, namely hierarchy level I (factors), 7 sub-elements, hierarchy level II (actors), 7 sub-elements, hierarchy level III (objectives), 5 sub-elements, hierarchy level IV (institutional model), 5 sub-elements. To illustrate how the complete hierarchical arrangement is presented in Table 1.

Table 1. Rice-based agrotourism hierarchy structure.
Tabela 1. Estrutura hierárquica do agroturismo baseado em arroz.

| Hierarchy | Sub Element | Description |
|---|---|---|
| Level I Factor | Human Resources (HR) | These are individuals who can be employed in the system as supporters, thinkers, planners, and movers to achieve the goal of developing rice-based agrotourism with entrepreneurial elements. |
| | Technology | Various types of tools and machines are required for the processing of lowland rice farming at both the farmer and rice-based agrotourism levels. |
| | Market Potential | Marketing capabilities and acceptance of rice-based agrotourism products with social entrepreneurship |
| | Government policy | A direction of action proposed by the government to support and encourage integration and togetherness of various parties. |
| | Institutional Support | The role of institutions involved in the system, both core institutions and supporting institutions, in realizing integrated and sustainable agrotourism. |
| | Financial Resources | Everything related to finance, or funds and assets that finance the activities and investments of an organization. |
| | Infrastructure | Basic facilities and structures needed to support community and organizational activities, both physically and socially. |
| Level II Actor | Rice Farmer | Actors who cultivate, pre- and post-harvest handling of rice. |
| | Manager Management | The party that manages and operates a rice-based agrotourism system with a social entrepreneurship approach. |
| | Department of Agriculture | Executive of regional government affairs based on the principle of autonomy, whose task is to assist in the agricultural sector, in this case, rice farming. |
| | Government tourism office | Implementing regional government affairs based on the principle of autonomy, whose task is to assist in the tourism sector, in this case, agrotourism. |
| | Department of Industry and Trade | Executive of regional government affairs based on the principle of autonomy, whose task is to assist in the fields of Industry, Trade, Cooperatives and Micro, Small and Medium Enterprises. |
| | Research Institute | Institutions that provide science, technology and disseminate research results. |
| | Financial institutions | Institutions that distribute funds to the community to improve people's living standards. |
| Level III Objective | Technology Development | A vehicle to facilitate discoveries (inventions) to become innovations, and become a medium for distributing knowledge and technology. |
| | Local Economy | Increasing the added value of both sectors (agriculture and tourism) to improve the welfare of local communities at the level of rice farmers, small and medium businesses and the general public. |
| | Business Integration | Creating an integrated business system to optimize the utilization of the potential of both sectors. |
| | Quality Improvement | Improving the quality and competitiveness of rice and processed rice products, as well as media for the exploitation and promotion of the superiority of lowland rice in Bunga Raya District, Siak Regency. |
| | Regional Development | The development will provide significant benefits for regional development and increase infrastructure development. |
| Level IV Institutional Model | Local Public Service Agency (LPSA) | The development and management of rice-based agrotourism, incorporating social entrepreneurship, is carried out by the regional government through the Regional Public Service Agency. Regional governments are the primary actors responsible for managing and operating agrotourism. Farmers, research institutions, and other organizations are involved as working partners. |
| | Partnership | In the partnership institution model, entrepreneurs act as the primary actors responsible for and operating rice-based agrotourism with a social entrepreneurship approach. To run their businesses, entrepreneurs partner with farmers, farming groups, local governments, research institutions, and other relevant organizations. |
| | DMO | An institution that manages and promotes tourist destinations to improve the local economy through tourism. |
| | Cooperative | In the cooperative institutional model, cooperative members are jointly responsible for managing and developing rice-based agritourism with a social entrepreneurship approach. These members are technopreneurs in developing creative products. |
| | CBT | An approach to tourism development that involves local communities in the management and development of tourism destinations. |

The Analytic Hierarchy Process (AHP) model, as presented in the diagram, provides a structured decision-making framework for selecting the most suitable institutional model for rice-based agritourism with social entrepreneurship. The hierarchy consists of four levels: factors, actors, objectives, and institutional alternatives. At the factor level, human resources have the highest weight (0.302), indicating that skilled and capable individuals are the most critical element in developing a successful rice-based agritourism system. Technology (0.229) is the second most influential factor, reflecting the need for mechanization and innovation in both farming and tourism-related activities. Other factors include market potential (0.146), government policies (0.120), institutional support (0.073), financial resources (0.064), and infrastructure (0.067). These elements collectively contribute to the feasibility and sustainability of the agrotourism model.

At the actor level, the most important stakeholders are farmers (0.284) and agrotourism management (0.291), demonstrating their critical roles in implementing and maintaining the system. Government agencies, including the Department of Agriculture (0.103), tourism government offices (0.097), and the Department of Industry and Trade (0.083), have supporting roles in regulation, promotion, and market facilitation. Research institutions (0.049) and financial institutions (0.046) play smaller but essential roles in providing knowledge, technology, and financial resources. At the objective level, the highest priority is given to technology development (0.253) and local economic growth (0.272), emphasizing the need for continuous innovation and value addition in rice farming and tourism. Business integration (0.236) is another key goal, ensuring a well-coordinated system between agriculture and tourism. Product quality improvement (0.139) and regional development (0.101) contribute to competitiveness and sustainable infrastructure growth.

The final institutional model selection indicates that the Local Public Service Agency (LPSA) is the most preferred model (0.429). This suggests that government-led management, with partnerships involving farmers and supporting institutions, is considered the most effective approach for sustaining rice-based agritourism. The partnership model (0.237) ranks second, indicating that collaboration between private entrepreneurs and farmers is also a viable alternative. Destination Management Organizations (DMO) (0.147), cooperatives (0.118), and Community-Based Tourism (CBT) (0.068) are less favored, suggesting that centralized or structured governance is preferred over purely community-driven or cooperative approaches.

Rice-based agritourism not only attracts tourists but also plays a pivotal role in promoting local rice products through various tourism activities. This promotion enhances market visibility and brand value for agricultural products, which is crucial for increasing farmers' incomes. By providing a platform for farmers to showcase their products directly to consumers, agritourism creates a direct link between production and consumption, thereby increasing demand for local rice and related products. This increased visibility translates into higher sales and improved profit margins for farmers, contributing significantly to their overall economic well-being.

Moreover, rice-based agritourism fosters rural economic development by creating jobs in hospitality, guiding, and local crafts, which stimulates local economies. The influx of tourists generates additional revenue for local businesses, further enhancing the economic landscape of rural areas. The success of these initiatives relies on robust institutional frameworks that facilitate collaboration among stakeholders, including farmers, local governments, and tourism operators. By integrating social entrepreneurship, these frameworks empower communities to develop innovative business models that enhance economic resilience while preserving cultural heritage and agricultural landscapes.

The comparative analysis of institutional models reveals significant differences in governance structure, stakeholder participation, and sustainability potential. The LPSA model, receiving the highest weight (0.429), demonstrates superior characteristics, including a clear governance structure backed by government policy, which ensures more stable financial resources and better access to infrastructure and technology. However, this model faces challenges in terms of operational flexibility and business innovation, potentially limiting its ability to adapt rapidly to market changes. The partnership model (0.237) exhibits distinct advantages through higher flexibility in business decision-making and greater innovation potential through multi-stakeholder collaboration. This model enables more efficient operational management through private sector involvement while maintaining connections with agricultural stakeholders. Nevertheless, it requires more complex coordination mechanisms among partners and careful balancing of diverse interests to maintain effective collaboration.

The DMO approach (0.147) distinguishes itself through a strong focus on tourism destination development and specialized expertise in tourism management, including broader marketing networks and professional destination promotion. However, this model shows relative weakness in integrating agricultural aspects, potentially compromising the balance between tourism and farming activities that is essential for successful rice-based agritourism. The cooperative model (0.118) demonstrates strengths in collective farmer economic empowerment and more equitable distribution of benefits among members. It particularly excels in developing community-based technopreneurship and maintaining strong local ownership of agritourism initiatives. Yet, this model often struggles with professional management capabilities and may face challenges in competing with more commercially oriented operations.

The CBT model, despite receiving the lowest weight (0.068), offers unique advantages in maximizing local community participation and alignment with local social values. It provides strong potential for community capacity development and preservation of local wisdom in agrotourism development. However, this model faces significant limitations in accessing resources and maintaining professional management standards necessary for sustainable operations. This comparative analysis suggests that institutional model selection necessitates a careful consideration of trade-offs among governance effectiveness, stakeholder participation levels, and operational sustainability. The LPSA model's highest ranking suggests that it offers an optimal balance between government support and multi-stakeholder involvement. However, mechanisms for enhancing flexibility and innovation may need to be incorporated. The varying strengths and limitations of each model also suggest that hybrid approaches might be considered, potentially combining LPSA's structural advantages with the participatory elements

of other models to create more robust institutional frameworks for rice-based agrotourism development.

## 4. DISCUSSION

The AHP model highlights that human resources and technology are the most critical factors in ensuring the success of rice-based agrotourism (Figure 1). The AHP analysis results reveal multifaceted insights into institutional models for rice-based agrotourism development, highlighting complex interactions between human resources, technological infrastructure, and governance mechanisms.

Local factors, including land ownership, agricultural culture, migration, and environmental conditions, have a significant influence on the development of rice-based agritourism through the LPSA (Local Public Service Agency) model. Clear land tenure allows farmers to invest in agritourism infrastructure and actively participate in the LPSA program. At the same time, a rich agricultural culture can attract tourists through traditional practices and festivals that enrich the tourism experience. Migration, both outbound and inbound, affects labor availability and social dynamics, which can bring new perspectives and innovations to agritourism development. In addition, environmental conditions such as climate, soil fertility and adequate infrastructure are critical to support the accessibility and sustainability of agritourism. By understanding and integrating all these factors, LPSA can design and implement agritourism models that are not only sustainable and economically profitable but also empower local communities, preserve culture, and maintain environmental sustainability, thus creating a harmonious synergy between agriculture, tourism, and community.

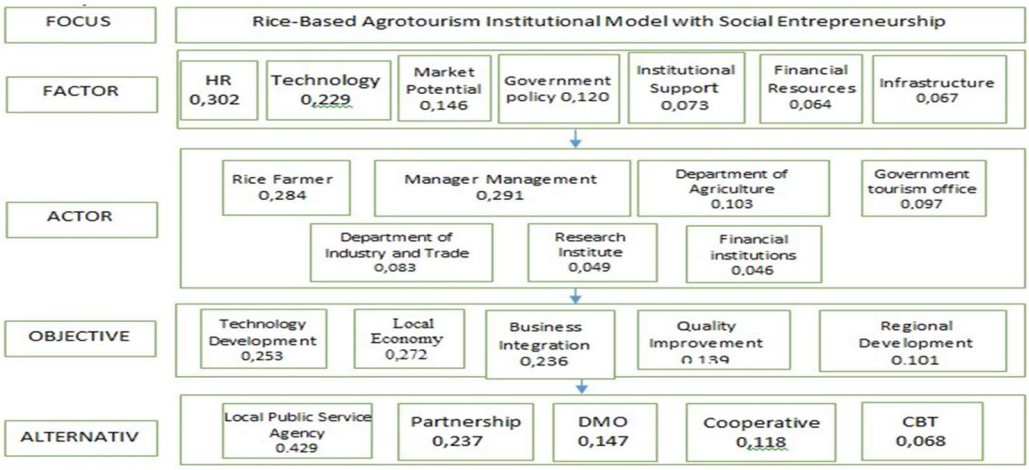



Figure 1. Hierarchy of selection for institutional models of rice-based agrotourism with social entrepreneurship.
Figura 1. Hierarquia de seleção para modelos institucionais de agroturismo baseados em arroz com empreendedorismo social.

### 4.1. Human Resource Primacy and Institutional Capacity

Rice-based agritourism has emerged as a transformative force in enhancing agricultural economics, particularly by increasing farmers' incomes and fostering rural economic development. A critical factor in this dynamic is the primacy of human resources, which received the highest weighting (0.302) in the factor analysis. Emerging research highlights the critical importance of human resource development and institutional capacity in successfully implementing agritourism strategies. Chiang et al. (2025) emphasize that strategic agritourism interventions can increase farmer incomes while simultaneously preserving cultural agricultural landscapes and promoting sustainable economic practices.

This finding highlights the crucial role of human capital in ensuring the sustainability of agrotourism initiatives, particularly in light of the declining agricultural workforce. According to Yang; Solangi (2024), there has been a reported 30% reduction in the agricultural workforce over the past decade, highlighting the urgent need for human resource development within the sector.

The emphasis on human capital is particularly relevant in the context of social entrepreneurship, where capacity building is recognized as a key success factor for rural enterprises. Musinguzi et al. (2023) found that enhancing the skills and knowledge of local communities not only empowers farmers but also equips them to engage effectively in agritourism activities, thereby increasing their income potential. By investing in training programs and educational initiatives, rice-based agritourism can cultivate a skilled workforce that is adept at managing both agricultural and tourism-related activities, ultimately leading to improved productivity and profitability.

Moreover, rice-based agritourism supports rural economic development by creating diverse income streams for farmers. By attracting tourists, farmers can sell their products directly, enhancing market visibility and brand value. This direct connection between producers and consumers not only increases demand for local rice and related products but also allows farmers to capture a larger share of the value chain. Additionally, the integration of tourism with agriculture fosters job creation in rural areas, extending beyond farming to include roles in hospitality, guiding, and local crafts. This diversification of employment opportunities stimulates local economies and helps mitigate the effects of declining agricultural workforces. The influx of tourists generates additional revenue for local businesses, further enhancing the economic landscape of rural communities.

### 4.2. Institutional Model Selection and Governance

The strong preference for the Local Public Service Agency (LPSA) model, which received a weight of 0.429, represents a significant finding that warrants careful analysis. This preference indicates a notable shift from purely market-driven approaches toward more structured institutional frameworks, aligning with Grabs et al. (2021), who argue for the importance of robust governance mechanisms in ensuring the

sustainability of agritourism initiatives. The LPSA model's emphasis on government-led management and collaboration with local stakeholders provides a solid foundation for integrating agricultural practices with tourism, thereby enhancing the overall effectiveness of rice-based agritourism.

However, this finding presents an interesting contrast to the advocacy for community-based tourism models put forth by Anindhita et al. (2024), which emphasize the importance of local participation and grassroots involvement in tourism development. This divergence suggests that while community-based approaches can be effective in certain contexts, the unique challenges faced by the rice farming sector may necessitate more formalized institutional structures to ensure long-term sustainability and resilience. The LPSA model's structured governance can facilitate better resource allocation, regulatory support, and access to technology, which are critical for enhancing the viability of agritourism ventures.

Additionally, the relatively high ranking of the partnership model (0.237) aligns with recent success stories in Asian agritourism, highlighting the effectiveness of collaborative approaches. Liu et al. (2024) documented how partnership-based social enterprises have successfully increased farmer incomes by 45-60% while simultaneously preserving cultural heritage. This model's effectiveness resonates with Song (2024) findings on successful multi-stakeholder collaborations in Thailand and Vietnam, where coordinated efforts among farmers, tourism operators, and government agencies have yielded sustainable tourism products that benefit all parties involved.

Rice-based agritourism necessitates a sophisticated, multidimensional governance approach that balances structured institutional frameworks with collaborative and community-oriented strategies. The research suggests that success lies in creating flexible, technology-enabled, and stakeholder-integrated models that can respond to the dynamic challenges of agricultural tourism. The hybrid approach emerges as the most promising strategy, offering a comprehensive framework for sustainable rural economic development, cultural preservation, and agricultural innovation.

### 4.3. Technological Integration and Innovation

The significant weighting of technology (0.229) as the second most important factor in the analysis underscores the modernization imperatives facing the rice-based agritourism sector. This finding aligns with the research conducted by Wei et al. (2022), which highlights the critical role of technological integration in agricultural tourism. Their study emphasizes that the adoption of digital platforms and modern farming techniques not only enhances visitor experiences but also improves operational efficiency for agritourism enterprises (WEI et al., 2022). By leveraging technology, farmers can streamline their operations, optimize resource utilization, and offer more engaging and informative experiences for tourists, thereby enhancing the overall attractiveness of agritourism offerings.

Moreover, the prioritization of technology development (0.253) within the objectives hierarchy reflects a broader recognition of what Alaqeel; Suryanarayanan (2018) describe as the "digital transformation imperative" in agricultural tourism. This imperative highlights the necessity for agritourism stakeholders to embrace innovative solutions that can enhance productivity and sustainability. For instance, the use of precision agriculture technologies can help farmers monitor crop health and optimize inputs, resulting in higher yields and a reduced environmental impact. Additionally, digital marketing strategies can effectively promote agritourism experiences, reaching a wider audience and attracting more visitors.

The integration of technology also facilitates better data collection and analysis, enabling stakeholders to make informed decisions that enhance both agricultural practices and tourism management. By utilizing data analytics, farmers can identify trends in consumer preferences and adjust their offerings accordingly, ensuring that they meet the evolving demands of the market. This adaptability is crucial for maintaining competitiveness in an increasingly dynamic tourism landscape.

Technological integration and innovation are vital components of rice-based agritourism, significantly contributing to the sector's modernization and sustainability. By prioritizing technology development, stakeholders can enhance operational efficiency, improve visitor experiences, and ultimately increase farmers' incomes (GIANG, 2022). Embracing the digital transformation imperative will not only benefit individual agritourism enterprises but also strengthen the overall agricultural economy and promote rural development.

### 4.4. Economic and Social Impact Dimensions

Rice-based agritourism is emerging as a transformative approach to rural economic development, highlighting the complex interplay between economic growth and social inclusion. The high prioritization of local economic growth (0.272) within the objectives hierarchy underscores a clear focus on achieving sustainable development outcomes through rice-based agritourism. This emphasis aligns with recent market projections indicating that the global agritourism sector is expected to reach USD 85 billion by 2025, highlighting the significant economic potential of this industry (MARKET RESEARCH FUTURE, 2021). By fostering local economic growth, rice-based agritourism not only enhances farmers' incomes but also stimulates broader economic activity in rural areas, creating jobs and supporting local businesses.



However, the relatively lower weighting of Community-Based Tourism (CBT) models (0.068) raises important questions about the balance between economic efficiency and social inclusion. LPSA provides structural and financial support, while CBT empowers local communities to actively participate in agritourism management and development, improving welfare and sustainability. This concern has been previously highlighted by Munsch et al. (2012), who examined rural tourism governance and emphasized the need for inclusive practices that ensure all community members benefit from tourism development. While economic growth is essential, it is equally important to consider how agritourism initiatives can promote social equity and empower marginalized groups within rural communities.

The challenge lies in designing agritourism models that not only drive economic benefits but also foster social cohesion and inclusivity. For instance, while the LPSA and partnership models may enhance economic efficiency through structured governance and collaboration, it is crucial to ensure that these frameworks also incorporate mechanisms for community engagement and participation. This can be achieved by involving local stakeholders in decision-making processes, ensuring that their voices are heard and their needs are addressed.

Furthermore, successful agritourism initiatives should prioritize the preservation of local culture and heritage, thereby enhancing the social fabric of rural communities. By promoting cultural exchange and providing opportunities for local artisans and producers to showcase their products, agritourism can contribute to a more holistic approach to rural development that values both economic and social dimensions. Rice-based agritourism offers a sophisticated approach to rural development, requiring a multidimensional strategy. The success of these models depends on the ability to design flexible, inclusive, and responsive institutional frameworks that can adapt to the dynamic socio-economic landscape of local communities. It represents a holistic model of development that simultaneously addresses economic, social, cultural, and sustainable development objectives.

### 4.5. Stakeholder Dynamics and Coordination

The balanced weighting between farmers (0.284) and management (0.291) in the actor analysis highlights a recognition of what Tzouramani et al. (2020) describe as the "dual imperative" in agrotourism: the need to maintain agricultural authenticity while ensuring effective and professional tourism management.

This balance is essential for the success of rice-based agritourism initiatives, as it allows for the preservation of traditional farming practices and cultural heritage while simultaneously enhancing the visitor experience through professional management. Farmers play a pivotal role in creating genuine, immersive experiences that connect visitors to the region's cultural and agricultural heritage. Their deep-rooted knowledge of traditional farming practices, local ecosystems, and cultural narratives provides the foundational authenticity that distinguishes rice-based agritourism from conventional tourism offerings. However, this authentic experience requires sophisticated management to truly resonate with visitors. Professional tourism management ensures that these genuine agricultural experiences are effectively packaged, marketed, and delivered, transforming raw agricultural expertise into compelling visitor experiences that meet contemporary tourism expectations.

Maintaining agricultural authenticity is crucial for attracting tourists who seek genuine experiences that connect them to the local culture and farming practices. Farmers play a vital role in this aspect, as their knowledge and skills are integral to showcasing the agricultural processes and products that define the region. However, without effective management, the potential for these experiences to resonate with visitors may be diminished. Professional tourism management ensures that agritourism offerings are well-coordinated, effectively marketed, and aligned with visitor expectations, thereby enhancing overall satisfaction and encouraging repeat visits.

Moreover, this balanced approach is critical in addressing the concerns raised by Tanrıvermiş et al. (2024) regarding the need to prevent fragmented governance in agricultural tourism initiatives. Fragmented governance can lead to inefficiencies, miscommunication, and a lack of cohesive strategy among stakeholders, ultimately undermining the potential benefits of agritourism. By fostering collaboration between farmers and management, stakeholders can create a more integrated governance structure that facilitates communication, resource sharing, and joint decision-making.

Effective stakeholder dynamics also involve recognizing the roles of other actors, such as government agencies, local communities, and tourism operators, in supporting the agritourism ecosystem. Engaging these stakeholders in a coordinated manner can enhance the overall effectiveness of agritourism initiatives, ensuring that they are sustainable and beneficial for all parties involved.

### 4.6. Implementation Challenges and Future Directions

The research findings highlight several critical implementation challenges that demand careful attention in developing rice-based agritourism institutions. A primary concern revolves around governance flexibility; despite the LPSA model's promising framework, its inherent bureaucratic nature could potentially constrain adaptability and innovation. This observation aligns with the research by Pratt et al. (2022), which identified regulatory barriers as significant impediments to the development of agrotourism. The rigidity of bureaucratic processes can hinder timely responses to market changes and limit the ability of stakeholders to innovate, which is essential for maintaining competitiveness in the evolving agritourism landscape.

Additionally, the study reveals concerning gaps in stakeholder integration, as evidenced by the notably low weights assigned to research institutions (0.049) and financial institutions (0.046). These findings align with earlier work of Susila et al. (2024), which emphasized the crucial role of knowledge transfer and financial support mechanisms in sustainable agrotourism development. The lack of engagement from these critical stakeholders can lead to missed opportunities for collaboration and resource sharing, ultimately undermining the effectiveness of agritourism initiatives.

The challenge of innovation management also emerges as a critical consideration, particularly in striking a balance between technological advancements and traditional farming practices. Yotsumoto thoroughly documents this complexity; Vafadari (2021), in their examination of rice farming heritage preservation, highlight the need for careful integration of modern techniques without compromising the cultural and historical significance of traditional practices.

Based on these identified challenges, several practical recommendations emerge for consideration. The development of hybrid institutional models that effectively combine the structural robustness of the LPSA with the flexibility of partnership arrangements appears crucial. Such models can leverage the strengths of both governance approaches, allowing for more adaptive and responsive management of agritourism initiatives. This should be complemented by the establishment of comprehensive capacity-building programs that address both agricultural and tourism competencies, ensuring that stakeholders are equipped with the necessary skills to thrive in a dual-focused environment.

Furthermore, creating technology integration frameworks that respect traditional farming practices while enhancing operational efficiency is essential. These frameworks should facilitate the adoption of innovative technologies in a manner that respects and preserves the cultural heritage of rice farming. Additionally, carefully designed stakeholder engagement mechanisms are needed to ensure equitable representation and participatory decision-making processes, fostering a sense of ownership and commitment among all involved parties.

Looking ahead, this research opens up several promising avenues for future investigation. There is a clear need for longitudinal studies examining the implementation of the LPSA model across diverse regional contexts, which would provide valuable insights into the model's adaptability and

effectiveness in varying environments. Comparative analyses of hybrid institutional models could offer a deeper understanding of optimal organizational structures for agritourism development, identifying best practices that can be replicated in different settings.

Moreover, investigating the impacts of digital transformation on traditional farming communities represents a critical area for future research. Understanding how technological advances can be integrated while preserving cultural heritage will be essential for developing sustainable agritourism practices. Finally, assessing the role of social entrepreneurship in agricultural heritage preservation emerges as another vital research direction, potentially offering new perspectives on sustainable development approaches in the agritourism sector. By exploring these avenues, future research can contribute to a more nuanced understanding of the complexities and opportunities within rice-based agritourism, ultimately supporting its growth and sustainability.

### 4.7. Institutional Model (Regional Public Service Agency) of Rice-Based Agrotourism with Social Entrepreneurship

Rice-based agritourism represents a dynamic sector that merges agricultural activities with tourism, offering significant economic benefits while simultaneously raising public awareness about the importance of sustainable agricultural practices (Figure 2). In this context, the Local Public Service Agency (LPSA) can play a pivotal role in managing rice-based agritourism initiatives through a social entrepreneurship approach.

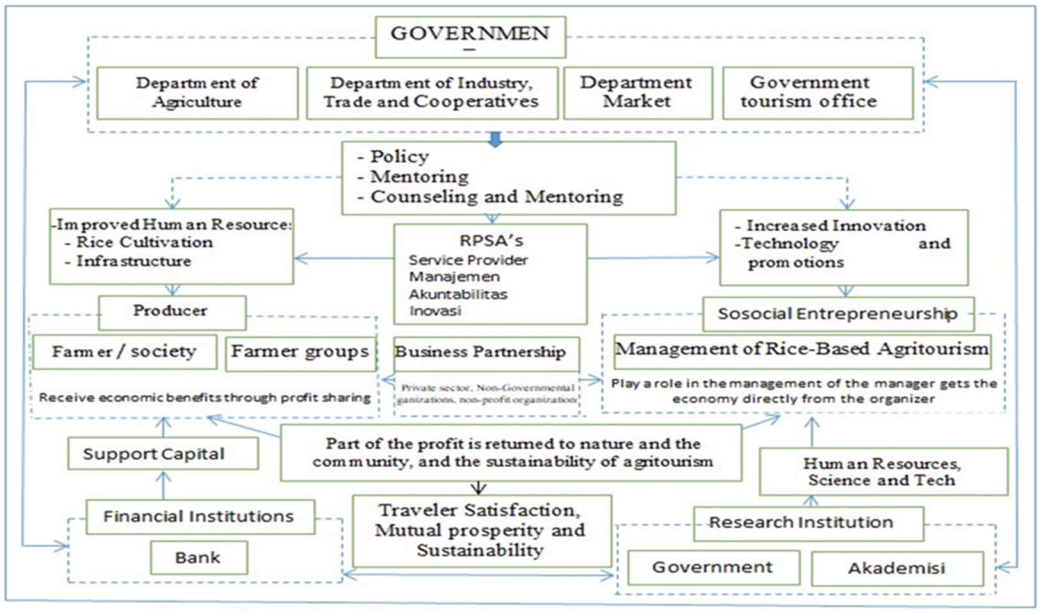



Figure 2. The role of institutions in rice-based agrotourism with social entrepreneurship.
Figura 2. O papel das instituições no agroturismo baseado em arroz com empreendedorismo social.

Social entrepreneurship is characterized by its focus on creating social value alongside economic returns. As defined by Germak; Robinson (2014), social entrepreneurship encompasses various elements, including social enterprises, social innovations, social businesses, venture philanthropy, and businesses with a social purpose. This multifaceted nature of social entrepreneurship aligns well with the objectives of rice-based agritourism, which seeks not only to generate income for farmers and local communities but also to promote sustainable agricultural practices and enhance community well-being.

The LPSA model provides a structured framework for implementing rice-based agritourism initiatives that prioritize social entrepreneurship. By leveraging government support and resources, the LPSA can facilitate the development of agritourism projects that are both economically viable and socially responsible. This model enables the integration of various stakeholders, including farmers, local communities, tourism operators, and government agencies, thereby fostering collaboration and ensuring that the benefits of agritourism are distributed equitably.

One of the key advantages of the LPSA model is its ability to implement capacity-building programs that empower local farmers and communities. Through training and education, the LPSA can enhance the skills and knowledge of stakeholders, enabling them to engage in agritourism activities effectively. This capacity building is essential for fostering innovation and ensuring that local communities can adapt to changing market demands while preserving their cultural heritage and agricultural practices.

Moreover, the LPSA can facilitate the establishment of social enterprises within the agritourism sector, serving as vehicles for social innovation. These enterprises can focus on creating products and services that not only meet the needs of tourists but also address social issues within the community, such as poverty alleviation, environmental sustainability, and cultural preservation. By promoting social enterprises, the LPSA can help create a more resilient and inclusive agritourism ecosystem.

The integration of social entrepreneurship within the LPSA institutional model represents a sophisticated approach to rice-based agritourism. By creating a holistic framework that balances economic opportunities with social value creation, this model offers a promising pathway for sustainable rural development.

Social entrepreneurship requires contributions that have a broader impact on society, production processes that are sustainable and socially responsible, and profits that are either contributed to or reinvested in a responsible manner. Social

enterprises must adopt an integrated approach and collaborate with other organizations.

The Cluster Value Chain Model in rice-based agro-tourism areas is an approach that integrates various actors and activities to create added value and increase the competitiveness of rice products (Figure 3). With effective collaboration among farmers, processors, entrepreneurs, and the government, this model can empower communities, enhance welfare, and promote environmental sustainability. Implementation of this model requires commitment and cooperation from all parties involved to achieve common goals in the development of rice-based agritourism.

The rice-based agritourism institutional model with social entrepreneurship is a framework that integrates agriculture, tourism and social entrepreneurship to create added value, improve community welfare and preserve the environment (Figure 4). The model aims to empower local communities through the development of sustainable agritourism, with a focus on rice cultivation as the primary commodity.

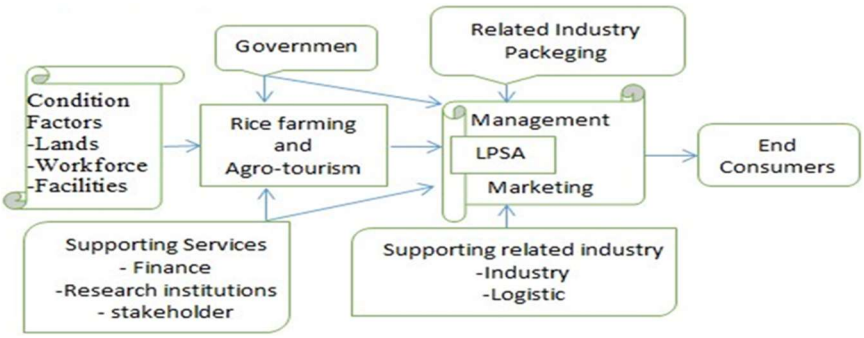
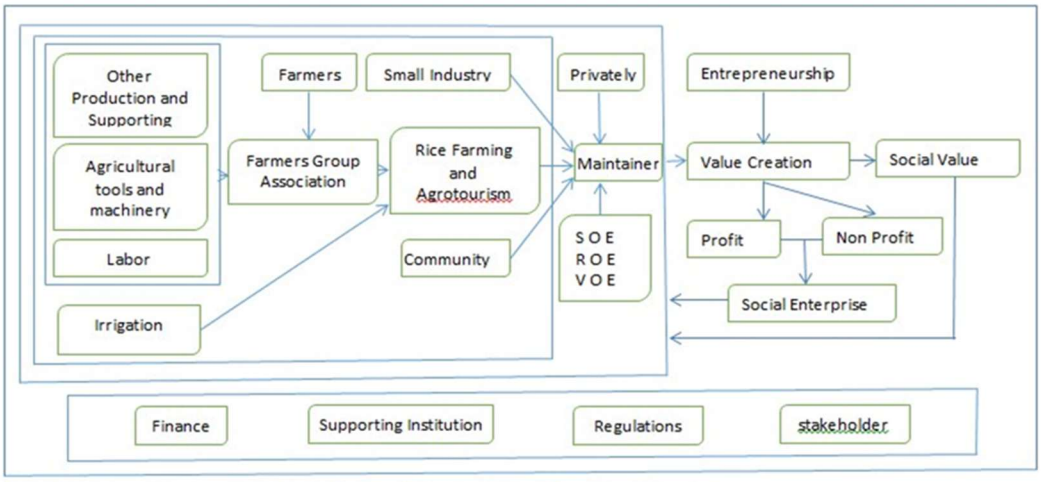



Figure 3. Cluster value chain model in rice-based agrotourism area.
Figura 3. Modelo de cadeia de valor de cluster em área de agroturismo baseada em arroz.




SOE = State-Owned Enterprises, ROE = Regionally Owned Enterprises, VOE = Village-Owned Enterprises

Figure 4. Rice-based agrotourism institutional model with social entrepreneurship.
Figura 4. Modelo institucional de agroturismo baseado em arroz com empreendedorismo social.



### 4.8. Agronomic Factors in Rice-Based Agrotourism Social Entrepreneurship

The incorporation of agronomic factors is crucial for developing sustainable institutional models for social entrepreneurship in rice-based agrotourism. Rice cultivation systems involve distinct ecological, technical, and management aspects that directly affect the feasibility and sustainability of agrotourism initiatives. Sustainable rice production methods act as both a foundation for agricultural productivity and as educational exhibits for visitors, generating dual streams of economic value (DATTA et al., 2017). The adoption of climate-smart agricultural practices within rice ecosystems enhances resilience against environmental stressors and provides demonstration opportunities that improve the agrotourism experience (ARYAL et al., 2019).

Water management is a vital agronomic element in rice-based systems. Cutting-edge water-saving techniques, like Alternate Wetting and Drying (AWD), not only enhance resource efficiency but also offer educational opportunities for agrotourism by showcasing contemporary sustainable practices (LAMPAYAN et al., 2015). These technologies can be effectively incorporated into agrotourism narratives that highlight the intersection of traditional rice cultivation with modern agronomic science. The selection of appropriate rice varieties that balance productivity with consumer preferences is another key consideration. Muthayya et al. (2014) Biofortified and heritage rice varieties can fulfill two important roles: they enhance nutritional security and provide distinctive selling points for marketing in agrotourism.

Integrated pest management strategies in rice cultivation systems add dimension to the agrotourism experience. Yele et al. (2023) suggest that ecological engineering in rice fields can foster biodiversity-rich landscapes by integrating diverse vegetation and habitat structures, thereby supporting wildlife and enhancing ecosystem services. This approach not only boosts productivity through natural pest control and

pollination but also enriches visitor experiences by creating vibrant and engaging environments. These approaches align with growing consumer interest in sustainable agricultural practices. Furthermore, soil fertility management practices influence both the productive capacity of rice systems and their aesthetic appeal. The application of organic amendments and green manures improves soil health indicators while creating visually appealing landscapes (Tahat et al., 2020), enriching the agrotourism experience.

Crop diversification strategies within rice-based systems expand the scope and seasonal appeal of agrotourism offerings, enhancing the overall experience. Describe how rice-fish integration and rice-duck systems create multifunctional agricultural landscapes that attract diverse visitor interests throughout the year (KUMARA et al., 2024). These integrated systems exemplify the principles of circular economy in agriculture, providing educational value for agrotourism participants. The timing of agronomic operations also plays a crucial role in synchronizing agricultural activities with tourism potential. Strategic scheduling of planting, harvesting, and cultural practices can be aligned with regional tourism patterns to maximize visitor engagement opportunities (MANTRA, 2024).

The degree of mechanization in rice farming has a substantial impact on farm productivity and the labor needs for agrotourism activities. Agricultural mechanization plays a vital role in attaining Sustainable Development Goals by enhancing productivity, improving food quality, increasing resource efficiency, and contributing to climate change mitigation (WINARNO et al., 2025). This balanced strategy preserves authenticity while promoting operational efficiency. Post-harvest processing facilities are another key agronomic factor that directly impacts value-added agrotourism activities. The processes of rice milling, packaging, and traditional processing demonstrations offer additional engagement opportunities for visitors and help diversify income streams for social enterprises (OKPOKO, 2018).

The layout of rice fields and related infrastructure necessitates thoughtful agronomic planning to ensure visitor access while preserving productivity. Enhancing road connectivity and improving water availability for irrigation are interconnected and can be supported by the same infrastructure. This concept, referred to as multifunctional roads, enables the optimization of both agricultural functions and visitor circulation patterns (SENZANJE, 2016). These design elements facilitate immersive experiences while maintaining agronomic effectiveness. Climate adaptation strategies in rice cultivation are becoming increasingly significant agronomic factors that can be woven into agrotourism narratives. These climate-smart practices encompass the use of improved rice varieties, insurance, crop diversification, livelihood diversification, soil and water conservation methods, adjustments to planting and harvesting schedules, irrigation, utilization of climate information and forecasts, nursery planting, proper fertilizer application, and the efficient use of pesticides (ONYENEKE et al., 2021).

In creating institutional models for social entrepreneurship in rice-based agrotourism, it is essential to systematically incorporate these agronomic factors into business planning, stakeholder engagement strategies, and operational frameworks. The institutional framework should promote knowledge sharing between agronomic specialists and tourism professionals to develop authentic, educational, and economically viable experiences. The sustainability of social entrepreneurship should encompass the three dimensions of sustainability: social, economic, and environmental (KAMALUDIN, 2023).

The development of rice-based agro-tourism offers an innovative approach that integrates sustainability in three main aspects: environmental, social, and economic, to expand the discourse on conservation and production. By implementing sustainable agricultural practices, such as the use of natural pesticides and efficient water management, these agritourisms not only maintain soil and water quality but also protect biodiversity. In addition, empowering local communities through active participation in agritourism management and educational programs can enhance their welfare and introduce local culture to visitors. From an economic perspective, diversification of processed rice products and educational tourism experiences can create new income opportunities, reducing dependence on traditional agriculture. By integrating these three aspects, rice-based agritourism not only supports natural resource conservation but also creates a win-win synergy between environmental preservation and community welfare improvement, making it a sustainable model for the future.

## 5. CONCLUSIONS

This study presents a sophisticated analysis of institutional models for rice-based agritourism development, with the Local Public Service Agency (LPSA) model emerging as the most suitable framework, receiving the highest weight score (0.429) in the AHP analysis. The study specifically identified human resources (0.302) and technology (0.229) as critical success factors, emphasizing the fundamental importance of capacity building and technology integration in agritourism systems.

A particularly interesting finding emerged in the stakeholder analysis, where farmers (0.284) and agritourism management (0.291) were assigned almost equal weight, indicating a crucial need to strike a balance between traditional farming practices and professional tourism management. The study also highlighted technology development (0.253) and local economic growth (0.272) as key objectives, underscoring the importance of continuous innovation and value creation in both the rice farming and tourism sectors. Alternative institutional models, including partnerships (0.237), Destination Management Organizations (DMOs) (0.147), cooperatives (0.118), and Community-Based Tourism (CBT) (0.068), each demonstrated different strengths and limitations in the context of agritourism development.

While this study made a significant contribution to understanding the institutional framework for rice-based agritourism, it also identified several implementation challenges that need to be addressed, including governance flexibility, stakeholder integration, and innovation management. Future research directions should focus on longitudinal studies of LPSA model implementation across different regional contexts, comparative analyses of hybrid institutional models, and investigations into the impact of digital transformation on traditional farming communities.

Rice-based agritourism not only provides a new momentum for rural economic development but also makes a significant contribution to agricultural economics. By increasing farmers' incomes and promoting rural economic growth, rice-based agritourism offers a compelling case for sustainable development within the agricultural sector. This

comprehensive approach to institutional modeling offers valuable insights for policymakers and practitioners in developing sustainable rice-based agritourism initiatives.

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**Data availability:** Study data can be obtained by email from the corresponding author or the second author upon request. It is not available on the website as the research project is still under development.

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