Research Paper

Coffee-based Agroforestry Development Strategy in Sultan Adam Forest Park

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ABSTRACT

This study aims to formulate strategies for developing coffee-based agroforestry in Sultan Adam Forest Park, South Kalimantan, which faces pressures from deforestation and conventional farming practices. Coffee-based agroforestry was chosen as a solution to maintain ecosystem sustainability while improving local community welfare. The research was conducted in Tiwingan Baru Village over four months using interviews, field observations, and SWOT analysis to identify strengths, weaknesses, opportunities, and threats. The SWOT analysis revealed key strengths, including favorable geographical and climatic conditions, high community interest in coffee cultivation, land availability, and crop resistance to pests. Major weaknesses include limited cultivation techniques, low performance of farmer groups, and inadequate infrastructure. Opportunities consist of government support, expansive markets, and agrotourism potential, while threats such as fluctuating coffee prices, competition from other regions, and the entry of external coffee varieties pose significant challenges. Proposed strategies include optimizing government support for coffee cultivation, enhancing product quality through new technologies, strengthening local coffee branding, and leveraging agrotourism to diversify income. This study recommends integrating plans for coffee development, agro-tourism, and forest conservation, as well as increasing multi-stakeholder involvement to support the economic and ecological sustainability of Sultan Adam Forest Park.

Keywords: agroforestry, Coffea canephora, economic, robusta coffee, strategy, SWOT analysis

INTRODUCTION

Coffee-based agroforestry systems have emerged as a pivotal strategy for promoting sustainability, particularly in the context of climate change mitigation and enhancing community welfare. These systems facilitate carbon sequestration, which is crucial for reducing greenhouse gas emissions, and they also support biodiversity conservation and ecosystem services, thereby contributing to the resilience of agricultural landscapes[1-3]. The integration of coffee cultivation with diverse tree species creates microclimates that enhance soil health and water retention, which are vital for maintaining agricultural productivity amidst changing climatic conditions[4,3]. Furthermore, coffee agroforestry systems have been shown to improve the livelihoods of rural communities by providing multiple income sources through the sale of coffee and other forest products, thus aligning with

the Sustainable Development Goals (SDGs) related to poverty alleviation and sustainable economic growth[5-7]. The role of agroforestry in fostering food security is also significant, as it promotes dietary diversity and resilience against food shortages by diversifying crop production[5-6]. Additionally, these systems are recognized under international frameworks, such as the Kyoto Protocol, as effective mechanisms for climate change adaptation and mitigation, reinforcing their importance on a global scale[8-9]. Ultimately, coffee-based agroforestry exemplifies a holistic approach to sustainable land management that addresses environmental, economic, and social dimensions, thereby contributing to a more sustainable future[10-11].

The development of agroforestry in Indonesia has been significantly influenced by various policies aimed at enhancing environmental sustainability and improving rural livelihoods. The integration of coffee cultivation within agroforestry systems presents a unique opportunity to leverage Indonesia's rich biodiversity while addressing socio-economic challenges faced by smallholder farmers. In South Kalimantan, coffee-based agroforestry systems are particularly promising due to the region's favorable climatic conditions and the potential for enhancing soil quality through organic matter contributions from diverse plant species. Furthermore, the implementation of supportive policies, such as community forestry initiatives, is crucial for promoting sustainable practices and ensuring the long-term viability of coffee agroforestry systems in this region. Overall, the strategic development of coffee agroforestry in South Kalimantan not only aligns with national goals for sustainable development but also fosters economic resilience among local communities, thereby reinforcing the importance of agroforestry as a multifaceted approach to land management in Indonesia.

The development of coffee-based agroforestry in Sultan Adam Forest Park faces significant research problems and gaps, primarily due to the absence of a clear strategic framework. This lack of strategy hinders the effective implementation of agroforestry practices, which are essential for enhancing both ecological sustainability and economic viability in the region. Policy, technical, and social challenges further complicate the situation, as stakeholders often lack the necessary knowledge and resources to adopt innovative agroforestry techniques effectively. For instance, studies have shown that the integration of shade trees in coffee cultivation can significantly improve soil quality and biodiversity, yet these benefits are often overlooked in policy discussions[12-14]. Moreover, there is a pressing need for a data-driven strategy that utilizes empirical research to inform decision-making processes, thereby ensuring that coffee agroforestry systems are not only sustainable but also resilient to climate change and market fluctuations[15,13].

The research on developing a coffee-based agroforestry strategy in Sultan Adam Forest Park is critical for formulating recommendations that align with sustainable land management practices, as it provides a framework for integrating ecological and economic objectives. This study aims to enhance the livelihoods of local communities through diversified agricultural practices and offers substantial benefits to government entities and area managers by promoting sustainable forest management, which can lead to improved ecosystem services and biodiversity conservation[16-18]. Furthermore, the research contributes significantly to the scientific discourse in agroforestry and forest economics by providing empirical data on the socio-economic impacts of agroforestry systems, thus informing policy decisions and fostering a deeper understanding of the interplay between agricultural practices and forest conservation[19-21].

The research objectives of the study on the Coffee-based Agroforestry Development Strategy in Sultan Adam Forest Park are

multifaceted and aim to address critical aspects of sustainable agroforestry management. The study seeks to develop a comprehensive coffee-based agroforestry development strategy that integrates ecological, economic, and social dimensions to enhance the sustainability of coffee farming within the park. And the research aims to provide evidence-based policy recommendations that will foster sustainable agroforestry management, ensuring that the benefits of coffee production are maximized while preserving the ecological integrity of the Sultan Adam Forest Park.

Coffee-based agroforestry management activities in Sultan Adam Forest Park, especially Tiwingan Baru village, have actually been carried out by the community for a long time, this can be proven by the large number and very easy to find coffee plants in the garden or on cultivated land. The coffee plants grow and develop either by deliberately planted or grow naturally. However, the development of coffee-based agroforestry is faced with various challenges such as limited knowledge of farmers, limited market access, and dependence on global prices are the main obstacles[22]. Therefore, this research focuses on developing a strategy for coffee-based agroforestry development by considering the strengths, weaknesses, challenges and obstacles that exist in Sultan Adam Forest Park.

MATERIALS & METHODS
Research Location
This research was conducted in Tiwingan Baru Village. This location is included in the administrative area of Aranio District, Banjar Regency, South Kalimantan Province. This research was conducted over a period of 4 (four) months, which included literature review, preparation of a research proposal, data collection, data verification in the field, data analysis and final report writing. The map of the research location can be seen in Figure 1.
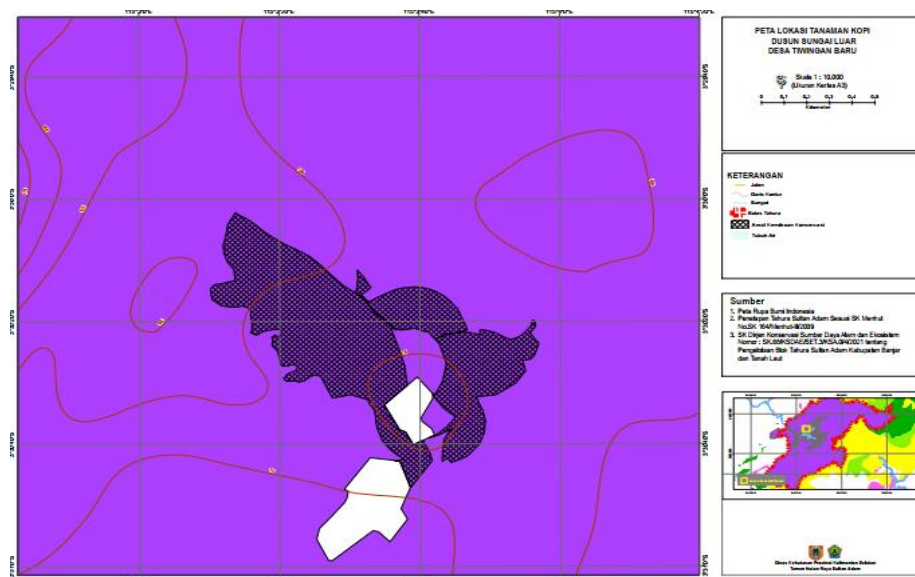

Figure 1 – Map of Research Location in Tiwingan Baru Village

The objects of this research are farmers who own coffee agroforestry plantations and traders who become one of the information sources used as supporting data in agroforestry development as well as related parties, in this case the local government of Banjar District and South Kalimantan Province. The tools and materials used in this research are cameras, stationery, measuring instruments, recorders, laptops and questionnaires.

Research Procedure
The data that support this research are primary data and secondary data. Primary data is used to determine the factors that

influence coffee-based agroforestry management in Sultan Adam Forest Park, while secondary data is obtained from data recording and literature studies that can support the achievement of the objectives of this study. Secondary data in the form of general conditions of the research location, community data, economic potential data and farming data.

Data Analysis

Analysis of coffee-based agroforestry management strategies was conducted using SWOT analysis. Respondents were collected using the snowball method by paying attention to representation in accordance with the research objectives. The research was conducted using interviews, field observations and SWOT analysis to identify strengths, weaknesses, opportunities and threats in the development of coffee-based agroforestry. Interviews were conducted in a structured manner using a list of questionnaires, then will get responses from respondents in the form of explanations or answers to the questions asked. Observations were made by direct observation of the location of coffee-based agroforestry management. SWOT analysis was used to identify internal and external factors. The instrument used in this research is a questionnaire with a Likert scale. The

variables used were internal factor variables and external factor variables. Variables including internal factors include geographical and climatic conditions, coffee cultivation, interest in coffee cultivation, farmer group performance, commodities, land availability, facilities and infrastructure, resistance to pests and diseases, production levels, and agroforestry contributions to coffee farmers. Variables that include external factors include government support for coffee farming, markets, fluctuating coffee prices, price competition, production and types of coffee from outside the Forest Park and Sultan Adam Forest Park's flagship agro-tourism. The SWOT matrix is an analysis that clearly illustrates how external opportunities and threats are faced and adjusted to the strengths and weaknesses of the community to formulate development strategies.

RESULT

IFAS (Strength & Weakness) Calculation

Strengths are resources, skills, or advantages. The value of strengths is obtained, while weaknesses are limitations or deficiencies in resources, skills, and capabilities that effectively hinder performance. The calculation of internal factors of strength can be seen in Table 1.

Table 1. Internal Factor of Strength

Strength Factors	Average	Weight	Weighted Score
Geographical conditions	3.67	0.22	0.80
Farmer's experience in the coffee business	3.56	0.21	0.75
Harvesting costs	3.00	0.18	0.54
Land availability	3.11	0.19	0.58
Resistance to pest and disease attacks	3.44	0.21	0.71
Total	**16.78**	**1.00**	**3.38**

The calculation of internal factors of weakness can be seen in Table 2.

Table 2. Internal Factors of Weakness

Weakness Factors	Average	Weight	Weighted Score
Farmers' knowledge of coffee cultivation	3.00	0.19	0.58
Superior commodities	3.11	0.20	0.62
Facilities and infrastructure	3.44	0.22	0.76
Coffee plant growing area	2.78	0.18	0.50
Production level	3.22	0.21	0.67
Total	**15.56**	**1.00**	**3.13**

EFAS (Opportunity & Threats) Calculation

Opportunities are important favorable situations, while threats are important unfavorable situations. The calculation of external factors of opportunities is presented in Table 3.

Table 3. External Factors of Opportunities

Opportunity Factors	Average	Weight	Weighted Score
Community economy	4.22	0.37	1.54
Government support for coffee farming	4.33	0.38	1.63
Production and coffee varieties from outside Forest Park	3.00	0.26	0.78
Total	**11.56**	**1.00**	**3.95**

The calculation of external factors of threats is presented in Table 4.

Table 4. External Factors of Threats

Threat Factors	Average	Weight	Weighted Score
Inter-island coffee export	3.89	0.34	1.31
Coffee price	3.33	0.29	0.96
Price from collectors/brokers (received by farmers)	2.22	0.19	0.43
Total	**9.44**	**0.82**	**2.70**

Determination of SWOT Quadrant and SWOT Matrix

The TOWS Quadrant is based on the SWOT Matrix, which combines an analysis of internal factors (Strengths and Weaknesses) with an analysis of external factors (Opportunities and Threats). While the SWOT Matrix is typically used as the first step in the strategic planning process, the TOWS Quadrant helps organizations identify specific strategic options and actions to take.

The formula for determining the point on the TOWS quadrant.

$$X = S - W \qquad Y = O - T$$
$$X = 3{,}38 - 3{,}13 \qquad Y = 3{,}95 - 2{,}70$$
$$X = 0{,}25 \qquad Y = 1{,}25$$

Furthermore, the SWOT matrix value is entered into the SWOT quadrant diagram. Based on the results of the quadrant analysis, the position of coffee-based agroforestry development is in Quadrant I presented in Figure 2.
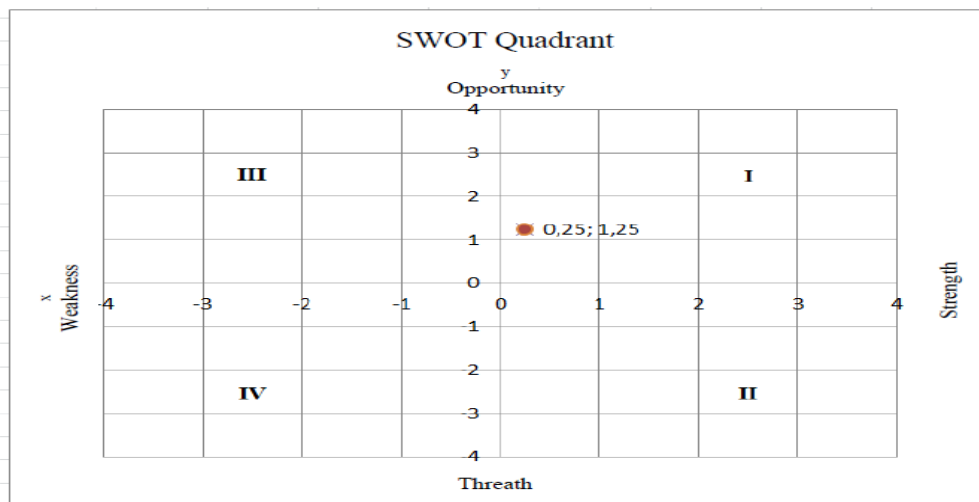

Figure 2 – SWOT Quadrant

The x and y values from the IFAS and EFAS calculations obtained the coordinate point (0.25; 1.25), which shows the position of the SWOT analysis in quadrant I. Although it is in quadrant I, the value of IFAS is quite low because the strengths are not too prominent or few, so the value obtained is close to 0. It needs proper development and strategy to increase the strengths and opportunities possessed by Sultan Adam Forest Park in coffee cultivation.

Based on the calculation of the IFAS and EFAS factor analysis, the position of the SWOT analysis is in quadrant I with the SO (Strengths and Weaknesses) strategy by using the internal strengths of the organization to take advantage of existing external opportunities. The development strategy is presented in Table 5.

Table 5. Coffee-based Agroforestry Development Strategy

IFAS \ EFAS	*Strengths* (S) 1. Geography and climate 2. Interest in coffee cultivation 3. Commodities 4. Land availability 5. Resistance to pests and diseases	*Weakness* (W) 1. Coffee cultivation 2. Farmer group performance 3. Facilities and infrastructure 4. Production rate 5. Contribution of coffee agroforestry to coffee farmers
Opportunities (O) 1. Government support for coffee farming 2. Market 3. Sultan Adam Forest Park's flagship agro-tourism	SO strategy 1. Optimizing the favorable climate and geography by utilizing aid programs and government policies to expand coffee cultivation.(S1,S4,O1) 2. Strengthen farmers' interest in coffee cultivation through training and workshops, with the aim of meeting high market demand.(S2,O1,O2) 3. Develop coffee agritourism by demonstrating environmentally friendly and pest-resistant cultivation practices, increasing tourist attraction and strengthening branding.(S2, S5, O2, O3)	WO Strategy 1. Submitting proposals and obtaining funds from the government for infrastructure development and improvement.(W3,O1) 2. Increase coffee production by using new technologies and more efficient cultivation methods to meet increasing market demand.(W1,W4,O1,O2) 3. Increase farmers' involvement in agritourism programs to improve farmers' economic welfare.(W5,O3)
Threats (T) 1. Coffee prices fluctuate 2. Price competition 3. Coffee production and types from outside Forest Park	ST Strategy 1. Improve coffee quality and strengthen branding to create added value so that products remain competitive despite fluctuating prices.(S3,T1) 2. Using pest- and disease-resistant coffee varieties to ensure stable production and quality, in the face of competition from outside coffee.(S5,T3)	WT Strategy 1. Improve coordination and management of farmer groups for production efficiency and cost reduction, so that they can compete with market prices.(S2,T2) 2. Improve cultivation techniques through intensive training and adoption of the latest technology to improve production quality and quantity.(W1,T3)

DISCUSSION

The results of the strength analysis for coffee cultivation in Sultan Adam Forest Park reveal several critical factors that contribute to the viability and sustainability of this agricultural practice. Firstly, the geographical and climatic conditions of the region are exceptionally conducive to coffee growth. The park's altitude and tropical climate create an environment that supports healthy coffee plants, as evidenced by research indicating that altitude significantly influences coffee quality and productivity due to specific microclimatic factors such as

temperature and light intensity[23-24]. Studies have shown that coffee grown at higher altitudes tends to have better flavor profiles and higher market value, which aligns with the findings from Sultan Adam Forest Park[23]. Furthermore, the availability of ample land for cultivation allows for large-scale coffee production, which can enhance economic benefits for local farmers. This is particularly important in regions where land is scarce, as it provides an opportunity for sustainable agricultural practices that can lead to increased income and community development[25].

The community's interest in coffee cultivation plays a pivotal role in the success of this agricultural endeavor. Active participation from local farmers demonstrates a commitment to sustainable practices, which is crucial for long-term viability. Research has shown that community engagement in coffee farming not only enhances productivity but also fosters a sense of ownership and responsibility towards environmental stewardship[26]. The integration of diverse cropping systems, as highlighted in various studies, can lead to improved environmental efficiency and resilience against pests and diseases[27]. The resistance of coffee plants to pests and diseases observed in Sultan Adam Forest Park suggests that the cultivation practices employed are effective, thereby minimizing losses and maximizing yields[28]. This is consistent with findings from other regions, where effective pest management strategies have been linked to higher coffee quality and productivity[29]. Overall, the combination of favorable geographical conditions, community involvement, and effective agricultural practices positions Sultan Adam Forest Park as a promising site for sustainable coffee cultivation.

The results of the Weakness Analysis in coffee cultivation reveal several critical areas that require attention to enhance productivity and farmer welfare. Firstly, the cultivation techniques employed by farmers are often outdated and inefficient, necessitating improved knowledge and technology to optimize these practices. Research indicates that productivity is closely correlated with land ownership, suggesting that expanding land access could significantly boost coffee yields[30]. Additionally, the performance of farmer groups is suboptimal, highlighting a pressing need for enhanced coordination and cooperation among farmers to achieve better collective outcomes. Studies have shown that effective farmer partnerships can lead to improved agricultural practices and increased income, underscoring the importance of collaborative efforts in the coffee sector[31]. Furthermore, limitations in facilities and infrastructure, such as inadequate road access and processing facilities, pose significant barriers to the development of coffee cultivation. The lack of proper infrastructure not only hampers productivity but also affects the overall efficiency of the supply chain[32].

The low production rates observed in many coffee-growing regions indicate untapped potential for increased productivity. For instance, research from Ethiopia has shown that addressing factors such as pest management and environmental conditions can lead to substantial improvements in coffee yields[33]. The economic benefits of coffee agroforestry systems are also not fully realized, with many farmers unaware of the potential advantages these systems can offer for enhancing their livelihoods. Studies have demonstrated that integrating coffee cultivation with other agricultural practices can lead to higher returns and improved land equity[34]. Therefore, targeted efforts are essential to educate farmers about the economic contributions of coffee agroforestry and to implement strategies that can elevate their overall welfare. In summary, addressing these weaknesses through improved cultivation techniques, enhanced farmer collaboration, better infrastructure, and education on agroforestry benefits is crucial for the sustainable development of coffee farming.

The opportunity analysis for coffee farming in Sultan Adam Forest Park reveals significant potential for development through government support, market demand, and agritourism. Government initiatives, including policies and financial assistance, are crucial for enhancing coffee cultivation, as evidenced by studies indicating that such support stabilizes farm income and reduces production risks for farmers[35]. The high market demand for coffee, both locally and internationally, presents a lucrative opportunity for farmers to increase production and income, aligning with findings that suggest a direct correlation between land ownership and coffee productivity[30]. Furthermore, the integration of coffee agro-tourism as a supplementary income source not only enhances farmers' earnings but also educates visitors about the coffee cultivation process, which has been successfully implemented in other regions, showcasing the benefits of agritourism in boosting local economies. Research indicates that coffee tourism can significantly benefit local farmers by providing them with a platform to showcase their products and practices, thereby enhancing their visibility and market reach[36]. Overall, the combination of government support, market opportunities, and agritourism can create a sustainable and profitable coffee farming ecosystem in Sultan Adam Forest Park.

Fluctuations in coffee prices significantly threaten the income stability of farmers, necessitating the implementation of robust marketing strategies and product diversification to mitigate risks associated with market volatility. Research indicates that coffee price instability can lead to severe economic repercussions for smallholder farmers, particularly in regions like Central America, where dependence on coffee as a primary income source is prevalent[37-38]. Furthermore, price competition from coffee producers in other regions exacerbates this issue, compelling local farmers to enhance product quality and differentiation to maintain competitiveness in the global market[39-40]. Studies have shown that the influx of coffee from areas with superior quality or pricing can undermine local products, highlighting the urgent need for strategic branding and quality improvement initiatives[41]. As such, the integration of sustainable practices and cooperative business models has been identified as a viable pathway for coffee farmers to navigate these challenges effectively, thereby fostering resilience against external market pressures[42-43].
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Determination of SWOT Quadrant and SWOT Matrix

Based on some of the above, the strategies that can be done for the development of coffee agroforestry include:

1. Expand local coffee planting crops by using good seeds with a regular planting pattern, either in between timber crops or other agriculture. The role of the agency is to provide seeds to be distributed to the community or by creating a nursery in each village so that the need for seeds can be quickly met.
2. For existing old plants, stem pruning can be carried out to obtain new low-yielding plants.
3. Increase community knowledge in terms of intensive coffee cultivation by means of counseling and training to coffee tenant farmers, the general public and village officials so that it is expected that they have one understanding in the development of local coffee in Sultan Adam Forest Park.
4. Strengthening farmers' institutions so that the coffee business can be more programmed and well-directed, institutions here can be in the form of forest farmer groups (KTH), Village Business Entities (Bumdes), Cooperatives and other business groups.
5. In the development of coffee agroforestry, external support is needed, so what needs to be done is to

strengthen the network both with the government as a fostering agency and the private sector as a partner in strengthening markets, technical processing and so on.

CONCLUSION

Strategies for the development of coffee-based agroforestry in Sultan Adam Forest Park are by optimizing the favorable climate and geography by utilizing assistance programs and government policies to expand coffee cultivation, optimizing the favorable climate and geography by utilizing assistance programs and government policies to expand coffee cultivation, developing coffee agro-tourism by demonstrating environmentally friendly and pest-resistant cultivation practices, increasing tourist attractiveness and strengthening branding, submitting proposals and obtaining funds from the government for infrastructure development and improvement, increasing coffee production by using new technology and more efficient cultivation methods to meet increasing market demand, increase farmers' involvement in agro-tourism programs to improve farmers' economic welfare, improve coffee quality and strengthen branding to create added value so that products remain competitive despite fluctuating prices, use pest- and disease-resistant coffee varieties to ensure stable production and quality, face competition from outside coffee, improve coordination and management of farmer groups for production efficiency and reduce costs, so as to be able to compete with market prices and improve cultivation techniques through intensive training and adoption of the latest technology to improve production quality and quantity.

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