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Strategy for Developing Dukuh Agroforestry System in Ati'im Village, Pengaron Sub-District, Banjar Regency, South Kalimantan Province, Indonesia

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Abstract: South Kalimantan citizens in the Banjar Regency, Indonesia, have developed a community forest using a Dukuh agroforestry system. The Dukuh agroforestry is a land system utilized by the community with plants dominated by fruit crops. Land use should be carried out optimally and refer to environmentally sound management that should be conducted to achieve a productivity of yields to support a regional economy. The purposes of this study were to analyze income and formulate strategies for developing the Dukuh agroforestry system that can be recommended for the utilization of forests in Ati'im Village, Pengaron Sub-district, Banjar Regency. The research methods included observation, interviews, and library study. The results showed that (a) The average income earned by farmers through the dukuh agroforestry system for a year is IDR 33,734,000 or the equivalent of IDR 2,800,000 (b) Strategy (SO) can increase the cooperation among farmers, to maximize the farmer experiences, and to take advantage of climate and weather; (c) Strategy (ST) will take advantage of farmer experiences in order to manage the Dukuh agroforestry in simple ways and to overcome pest problems to gain expected yields of crops; (d) Strategy (WO) can be used to increase the roles in the village institutions or government agencies in terms of the counseling implementation and training; and (e) Strategy (WT) applied to utilize the existing technology and simple management, as well as the certainty of the selling price for crops to increase the farmer's interest and economy.

Keywords: Dukuh agroforestry, forest community, land use.

印度尼西亚南加里曼丹省班吉摄政区彭加隆分区阿蒂姆村发展杜库农林业系统的战略

摘要：印度尼西亚班贾尔摄政区的南加里曼丹公民使用杜库农林业系统开发了社区森林。杜库农林业是社区利用的一种土地系统，其植物以水果作物为主。土地的使用应进行优化，并应进行无害环境的管理，以实现单产，以支持区域经济。这项研究的目的是分析收入并制定发展杜库农林业系统的策略，该系统可建议用于班贾尔丽晶彭加隆酒店街道阿蒂姆村的森林利用。研究方法包括观察，访谈和图书馆研究。结果表明（一种）农民通过杜库农林业系统一年的平均收入为33,734,000印尼盾或相当于2,800,000印尼盾（b）战略（所以）可以增强农民之间的合作，从而最大程度地提高农民的经验，并利用气候和天气；（c）战略（英石）将利用农民的经验，以简单的方式管理杜库农林业，并克服虫害问题，以获得预期的农作物产量；（d）在咨询的实施和培训方面，可以采用战略（WO）来增加在乡村机构或政府机构中的作用；（e）运用战略来利用现有技术和简单管理，以及确定作物销售价格以增加农民的利益和经济。

关键词：杜库农林业，森林社区，土地利用。

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1. Introduction

Agroforestry is defined as agriculture that subsumed trees. According to Barry Nestel and Deutsche Stiftung für Internationale Entwicklung. Zentralstelle für Ernährung und Landwirtschaft [1], the definition of agroforestry must contain two main characteristics for all forms of agroforestry and distinguish these forms from other land uses between its constituents. The majority population in the Asia Pacific has an agroforestry system under various agro-ecological environments [2]. The communities depend on agroforestry for livelihood such as food, medical products, agrofuels as a money income [3]. However, the change of the weather becomes a challenge for the farmers [4]. In Indonesia, even wetland water contains salt particulates is found [5-8]. To withstand climate variability, the sustainability elements like flexibility, diversified niches, and income generation are powerful assets [9].

The sustainable development agenda in 2030, adopted by all United Nations member states in 2015, gives a shared blueprint for peace and profitability for the planet and people, now and into the future [10]. As part of the agenda, food provision, energy, water, and environmental protection must be considered in agroforestry activities. Understanding the social-ecological system before 'leverage points' as a feedback system also makes the activities more sustainable [11].

Several locations worldwide have implemented agroforestry practices to diversify production and enhance farm systems' ecological benefits [12-14]. The South Kalimantan citizens have developed a *Dukuh* agroforestry system. *Dukuh* agroforestry is a land system used by the community. The dominant plants are the fruit crops [15]. This *Dukuh* agroforestry system has been attached to the community and has become a community habit in managing and utilizing the land. However, the community still experiences many obstacles in developing the *Dukuh* agroforestry system.

SWOT was introduced by Albert Humphrey (1960s) and has been practically used in management and strategic planning [16]. It has been used to expand the strengths and opportunities and minimize threats and weaknesses in many previous studies [17, 18]. [17] did planning for mindi agroforestry. [18] also investigate the local stakeholder's perception for developing an agroforestry intercropping in Canada. All these studies show the importance of SWOT tools in the decision-making process.

Only a little information about the *Dukuh* agroforestry, especially the farmer's income. Therefore, this study is necessary to overcome the various obstacles using a SWOT analysis. The results are used to formulate strategies in developing *Dukuh* agroforestry in the long and short terms by finding out the *Dukuh* agroforestry contribution to farmer earnings. Specifically, the study's objective is to analyze the income and formulate the strategies for developing the *Dukuh* agroforestry system that can be recommended for forest utilization in Ati'im Village, Pengaron Sub-district, Banjar Regency.

2. Methods

Some of the techniques used for data collection in the field to support data analysis as follows:

1. Observation: data were collected by observing the condition directly to collect information on how to collect data.
2. Interviews: data were collected by interviewing the respondents using a questionnaire.
3. Library study: data were collected through literature, reports, scientific papers, and results of studies that have to do with this study.

2.1. Data Analysis

a. The analytical approach to calculate the value obtained by farmers in the hamlet agroforestry program uses the following equations:

Iaf = ∑ Farmers' income from dukuh agroforestry products

Information: Iaf: Farmers' income from agroforestry products: Income derived from selling fruits and plawija.

b. The analytical approach for the dukuh agroforestry system development strategy using the SWOT analysis matrix as follows:

3. Results and Discussion

3.1. Description of Dukuh Agroforestry

The types of plants cultivated in the dukuh agroforestry program for staple crops are durian (*Durio zebethinus*), cempedak (*Artocarpus integer*), langsat (*Lansium domesticum*), and rubber (*Hedvea brasiensis*). The lower or intercrops consist of turmeric (*Curcuma longa linn*), kencur (*Kaenipterra galangal L*), ginger (*Zingiber offianalis*), galangal (*Lenguas galangal*), and pisan (*Mussa paradisical*). PA Huxley [19] reported agroforestry systems' purpose to maximize the limited resources' positive outcomes than other land systems to gain diversified and more sustainable production systems. Agroforestry offers a multipurpose sustainable land-use. In practice, the farmers focus on restoring soil fertility and providing plants' selective advantages [20].

Table 1 Matrix of SWOT analysis

External / **Internal**	**Strengths (S) Determine factors that can be strengths**	**Weakness (W) Determine factors that can be weaknesses**
Opportunities (O) Determine factors that can be the opportunities	Strategy (SO) Create strategies that use strengths to take advantage of opportunities	Strategy (WO) Create strategies that minimize weaknesses to take advantage of opportunities

Threats (T) Determine factors that pose threats	Strategy (ST) Create strategies that use strengths to overcome threats	Strategy (WT) Create strategies that minimize weaknesses to avoid threats

The results of income obtained by dukuh agroforestry farmers for a year are as shown in Table 2. The amount of income obtained by farmers for staple crops is less than for understorey because staple crops only produce once a year, while understory crops can produce all year round. The net income that farmers get through the dukuh agroforestry system is IDR 33,734,000 or the equivalent of IDR 2,800,000 / month. This income is quite promising for farmers because it is an additional income. The respondents' main jobs consisted of motorbike mechanics, animal husbandry, rubber buyers, traders, and traditional gold miners.

Table 2 Farmers' income from the Dukuh agroforestry in Atim Village and the costs incurred for one year

No	Dukuh agroforestry	Income/People/Year	Taken fee/ People/Year	Amount
1	Income from Principal (the main)	Rp. 11,854,000		
2	Income from Bottom crps	Rp.25,415,000	Rp.3,534,550	-
Total		Rp. 37,269,000	Rp.3,534,550	Rp.33,734,450

3.2. Internal Factors and External Factors

SWOT-analysis helps a strategic planning decision by doing the assessment and evaluating the various strengths (S), weaknesses (W), opportunities (O), and threats (T) as well as other factors in a specific topic [21]. In the SWOT method, the internal and external factors were used in strategy formulation [22]. Internal and external factors are used in research to develop a dukuh agroforestry system, namely by utilizing its potential to increase the dukuh agroforestry system's benefits. A comprehensive analysis is needed to identify the internal and external factors, including the potential weakness [23].

3.2.1. Internal Factors

Internal factors related to strengths and weaknesses. Socio-economic factors in agroforestry are highly important to be investigated. Development of agroforestry system would be achieved with consideration of opportunities in socio-economic. Effective planning process system for farm forestry was helped by analyzing the household and farm characteristics [20]. In this work, production, management, human resources, labor, and marketing are internal factors. The matrix framework of the internal strategy for *Dukuh* agroforestry's strengths in Ati'im Village can be seen in Table 3.

Table 3 Matrix framework of internal factor strategies for strengths

Component	Strength	Weight	Rating	Total	Ranking
Production	The crop production is good in quality and always available every harvest time	0.25	4	1	1
Management	The management is carried out in simple ways	0.25	4	1	2
Human Resource	Most farmers are experienced	0.15	3	0.45	4
Labor	It does not require many laborers in management	0.20	4	0.80	3
Marketing	The crop yields are easy to sell or market	0.15	4	0.60	5
Total				3.85	

Sequentially based on the results, the first rank for Dukuh agroforestry's strengths in Ati'im Village is the quality crops production and their availability. Turmeric plant as the main commodity in Ati'im village reaches the production of 1-2 kg rhizome in one plant per year. It is It also can be cultivated every day. The use of turmeric for industry, medicine, and herbs is quite big. Farmers also harvested the turmeric without specific maintenance [24].

In the second rank position is the management. Some farmers are experienced because the knowledge has been present for generations, and the farmland is a part of the family's legacy. Besides, this agroforestry management does not require many laborers because each farmer only possesses the cultivated land of 2.6 ha on average. Labor is one of the important factors in a production system. In Nepal's farmer also has the family mainly farming in agroforestry [25]. The laborers are needed only in the initial planting process, while a landowner responsible for the maintenance and harvesting. The type and objective of agroforestry influences labor-intensive. A study state that coffee and cocoa are more labor-intensive [26, 27]. Furthermore, in Ati'im Village, 4 collectors collect the yields of bottom plants such as turmeric, kencur (*Kaemferia galangal*), ginger, and galangal. Fruit crops are generally purchased directly by the buyers, and the fruits are resold to consumers. It will help farmers to sell the crops easily.

Besides, the framework matrix of internal strategy for weaknesses can be seen in Table 4. The *Dukuh*

agroforestry's weakness is the selling price is not based on the quality of the crops but rather on the overflow or crops scarcity in the market. It led to the crops selling price set by the collectors and buyers. When the harvest time has not yet come, the selling price will be high. On the other hand, when the crops are abundant in the harvest time, the selling price tends to decrease. Moreover, limited tools in management make the farmers take a long time to complete their work. Next, the roles of farmer institutions or government agencies in the activities of farmers in managing agroforestry are actually very important because all this time, the farmers rely on their experiences alone without any knowledge in developing *Dukuh* agroforestry. There is almost no program or extension conducted by farmer institutions or local government agencies to the farmers, resulting in the lack of farmer knowledge to develop the *Dukuh* agroforestry. Besides, most laborers who manage *Dukuh* agroforestry are laborers with a less productive age range, which makes laborers' regeneration in managing *Dukuh* agroforestry necessary. Similarly, farmers in Ati'im Village cannot afford to build market networks for the crops. Therefore, farmers do not have any second option to sell their crops other than to the collectors. If the farmers can build a market network, they will have a chance to determine the crops selling price.

Table 4 Framework matrix of internal strategies for weaknesses

Component	Weakness	Weight	Rating	Total	Ranking
Production	The selling price is uncertain	0.30	3	0.90	1
Management	Tools for management are limited	0.25	3	0.75	3
Human Resource	Knowledge on how to develop Dukuh agroforestry is still limited	0.10	3	0.30	5
Labor	Labors are in the phase of unproductive age	0.20	3	0.60	2
Marketing	Unable to build marketing networks	0.15	3	0.45	4
Total				3.00	

3.2.2. External Factors

Adil Siswanto [28] reported a strategy depends on the external environment, including opportunities and threats. External factors consist of opportunities and threats that have components such as socio-cultural economy, technology, crop maintenance, climate-weather, and farmers' perceptions of making Dukuh agroforestry a saving for the future. The way to overcome the existing weaknesses is to strengthen the existing opportunities shown in Table 5.

Table 5 Matrix framework of external factor strategies for opportunities

Component	Opportunity	Weight	Rating	Total	Ranking
Economy, social, and culture	The increase in demand and need for the products of Dukuh agroforestry	0.20	4	0.80	2
Technology	Cooperation in providing tools and materials for management	0.20	3	0.60	3
Plant maintenance	Increasing the fertility of plants	0.25	4	1	1
Climate and weather	Factors of climate and weather can accelerate the plant growth	0.15	3	0.45	5
Saving for the future	It can be cashed anytime in urgent situations	0.20	3	0.60	4
Total				3.45	

The opportunities can be maximized to overcome the weaknesses, such as the increase in demand and the need for Dukuh agroforestry products. Then, to overcome the limitation of farmers' tools, working together in providing tools and materials for management could be the solution. This could save costs when compared to buying the individual tools. Besides, by increasing the fertility of crops, each farmer will obtain their crops' yields to the maximum because the fertility of crops will affect the time and yields. Study shows that the climate and weather affect the acceleration of plant growth. Generally, in the rainy season, plants' growth rate will be faster than during the dry season. Another, the harvesting process is done by harvesting only part of the crops, hence in certain conditions, the farmers can harvest their crops as a whole. In this case, farmers can make money from their crops at any time for urgent situations. The matrix of external strategic factors for threats can be seen in Table 6.

Table 6 Matrix framework of external factor strategies for threats

Component	Threat	Weight	Rating	Total	Ranking
Economy, social, and culture	Level of the economy and lack of successors for Dukuh agroforestry	0.20	3	0.60	2
Technology	Difficulty in keeping pace with technology	0.20	3	0.60	3
Plant maintenance	Difficulty in overcoming pest attacks	0.25	3	0.75	1
Climate and weather	Irregular climate	0.15	3	0.45	5

Saving for the future	Growing time and harvest time that take a long time	0.20	3	0.60	4
Total				3.00	

The existing threats that can be obstacles in the development of Dukuh agroforestry in Ati'im Village are initially the economic level and the lack of successors for Dukuh agroforestry. The farmers' economic condition is very dependent on the yields of Dukuh agroforestry, and the successors are less interested in this system that causes the regeneration delay. Second place, farmers are very difficult to keep pace with the rapid development of technology because they still feel comfortable with the old technology they have, so the development of technology does not affect the farmers' activities. This limitation could be overcome by transferring the knowledge and skill of innovative technology through training. Besides, pests that often attack the fruit are difficult to cope with because the number of pests increases along with the coming of the harvest season. The most common pests are squirrels and monkeys. The pest will attack the fruit that is ready to be harvested, so it could be possible that one tree can experience harvest failure due to pest attacks. Another problem is the irregular changes in rainy and drought seasons, making the fruit harvest difficult to predict because the harvest time is heavily influenced by climate and weather factors. Finally, fruit crops such as durian, langsat, and cempedak are the fruit trees with the growth that tends to be longer, from the planting time to harvest time, and bear fruit within one year only.

3.3. Development Strategies of Dukuh Agroforestry System

The total weighting results on each internal or external factor are counted for the difference of each factor. The differences ease the making of a SWOT diagram.

The weighting has a scale from 0 (unimportant) to 1 (most important) [22]. The weights were obtained by using the questionnaire result [29]. After the weighting for internal and external factors, the results showed that the difference of internal factors was +0.85, while the external factors' difference was +0.45. Having obtained the difference figures of internal and external factors, the SWOT diagram was made, as shown in Fig. 1.

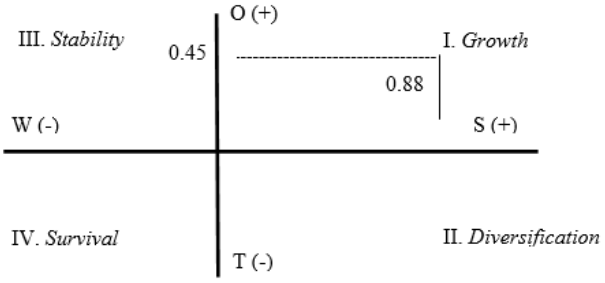

Fig. 1 SWOT diagram of *Dukuh* agroforestry development strategies in Ati'im Village, Pengaron Sub-district, Banjar Regency

Based on Fig. 1, it can be seen that *Dukuh* agroforestry is in quadrant I because the differences of internal and external factors showed positive values. If the difference values are included in the SWOT diagram, the two lines of values meet when they are pulled straight. Quadrant I means that *Dukuh* agroforestry is in growth condition, and quadrant I also has another meaning that *Dukuh* agroforestry in Ati'im Village should use growth strategies to achieve growth in all aspects, such as socio-cultural economy, human resource, technology, production, and marketing.

Fig. 2 shows the summarized of specific strategies which can be applied in Ati'im village. The SWOT analysis permits to build four types of strategies: SO (Strengths – Opportunities), ST (Strengths – Threats), WO (Weaknesses – Opportunities), and WT (Weaknesses – Threats) [30]. In this way, it gives a framework for identifying and formulating strategies for Dukuh agroforestry. By doing these strategies, agroforestry will be developed in quality crops and saving more cost production.

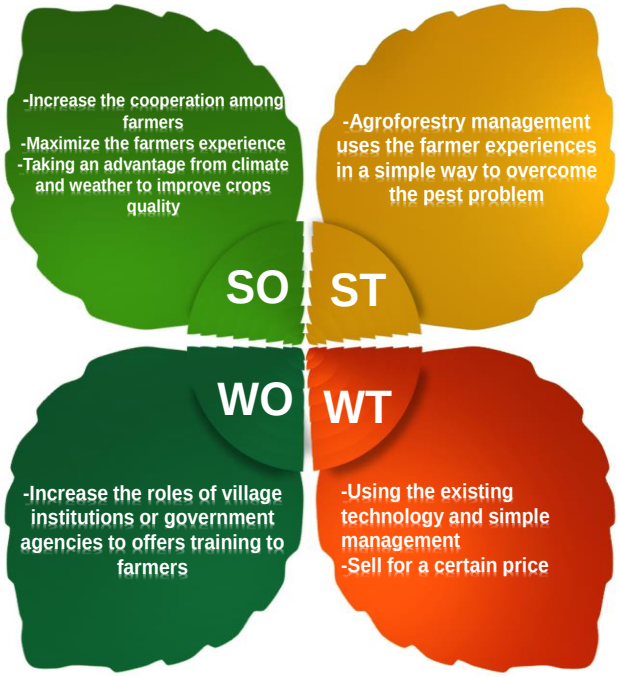

Fig. 2 The Dukuh agroforestry strategic opportunity in Ati'im village

4. Conclusion

The Dukuh agroforestry system in Ati'im village can be developed by applying the strategies such as the average income earned by farmers through the dukuh agroforestry system during the year is IDR 33,734,000 or the equivalent of IDR 2,800,000/month. Secondly (SO) uses the strengths to exploit opportunities, namely by increasing cooperation among farmers, maximizing the farmer experience, and using climate and weather to improve the quality of crops so that they are easy to be sold or marketed. Thirdly, the strategy (ST) uses the

strengths to overcome threats, utilizing the farmer experiences to manage Dukuh agroforestry in simple ways and to overcome pest problems to gain the expected crop yields. Next, the strategy (WO) to minimize weaknesses to take advantage of opportunities, namely by increasing the roles of village institutions or government agencies in the implementation of counseling and training to farmers to maximize the opportunities that would eventually increase the demand for crops. Lastly, the Strategy (WT) to minimize weaknesses to avoid threats by utilizing existing technology and simple management, and certainty of the crop selling price to increase the interest and economic condition of farmers.

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