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# Strategy for Integrating Rice and Peanut Cultivation in a Polyculture System to Increase Agricultural Land Productivity

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***Abstract---****Efforts to increase agricultural productivity to meet national food needs are complex challenges that require an integrated strategic approach. One step that can be taken is to improve the efficiency of the rice agribusiness through the application of balanced fertilization recommendations and appropriate pricing policies. Therefore, the development of the peanut-based food industry has led to an increase in domestic demand for peanuts. The increasing demand for peanuts is a great market opportunity for the development of peanut production. Increased income and public knowledge about nutrition have changed people's food consumption patterns from energy-producing carbohydrate foods to protein-producing foods, both animal and vegetable. The integration of the two through a polyculture system provides opportunities for synergy: peanut roots provide biological nitrogen for rice, help suppress weeds, and increase the efficiency of space and resource utilization. Intercropping rice and peanuts significantly increases land productivity.*
***Keywords---****strategy, rice and peanut cultivation, polyculture system, agricultural land productivity.*

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## Introduction

Efforts to increase agricultural productivity to meet national food needs are complex challenges that require an integrated strategic approach. One step that can be taken is to improve the efficiency of the rice agribusiness through the application of balanced fertilization recommendations and appropriate pricing policies. Research by Akhsan et al. (2022) in Assopi et al. (2025) reveals that technical efficiency in rice paddy production can be improved through the application of more optimal production technologies, including the proportional use of NPK, KCl, and organic fertilizers. The results of this study show that increased efficiency in the rice agribusiness can be achieved through improvements in fertilizer application technology, which ultimately contributes to an increase in overall agricultural productivity. In addition, another strategy that can be implemented is the development of sustainable agricultural policies, which emphasize increasing food crop productivity through support for agricultural technology investment and more efficient resource management. This approach is important to ensure adequate food availability in line with population growth (Assopi et al., 2025).

Rice (Oryza sativa L.) is the main staple food in Indonesia, but rice production often faces challenges such as soil degradation, climate change, and dependence on inorganic fertilizers. On the other hand, peanuts (Arachis hypogaea L.), as legumes, have nitrogen fixation capabilities that can improve soil fertility (Nurullaev, 2021). Peanuts are a multifunctional commodity, which can be consumed directly in the form of fresh seeds, and can be used as raw materials for various types of processed foods and vegetable oils, as well as stems and leaves for animal feed (Jena et al., 2002). Therefore, the development of the peanut-based food industry has led to an increase in domestic demand for peanuts. The increasing demand for peanuts is a great market opportunity for the development of peanut production. Increased income and public knowledge about nutrition have changed people's food consumption patterns from energy-producing carbohydrate foods to protein-producing foods, both animal and vegetable (Zainab & Wangiyana, 2021).

The integration of the two through a polyculture system provides opportunities for synergy: peanut roots provide biological nitrogen for rice, help suppress weeds, and increase the efficiency of space and resource utilization. Intercropping rice and peanuts significantly increases land productivity. Rice-peanut intercropping shows an increase in rice yield of 29–37% and peanuts of 4–7%, with a Land Equivalent Ratio (LER) of 1.36–1.41 (Chu et al., 2004). The additive series approach to rice–peanut intercropping has also been shown to increase yield per clump compared to monoculture, especially when supported by biofertilizers such as mycorrhiza (Wangiyana et al., 2024; Erythrina et al., 2022).

Although promising, the success of this cultivation integration requires a well-thought-out strategy: selection of compatible varieties, planting timing (e.g., relay planting system), and adaptive pest and nutrient management. Rhizobium inoculation has been shown to increase productivity and LER in rice–peanut intercropping systems (Asuncion, 2019). Meanwhile, theoretical studies on nitrogen transfer from legumes to secondary crops in polyculture systems reinforce the biological justification for this integration (Wiley, 1079). Therefore, this study aims to explore and formulate optimal agronomic-biological integration strategies to increase soil productivity through rice–groundnut synergy.

## Research Method

### *Data Collection Techniques*

The data collection techniques used in this study are as follows:

1. FGD

Focus Group Discussion/FGD is a method that relies on obtaining data or information from interactions between experts based on the results of discussions in a group that focuses on solving specific problems (Afiyanti, 2008). The advantage of using the FGD method is that it provides richer data and adds value to data that cannot be obtained when using other data collection methods.

2. In-depth interviews using questionnaires

Interviews are in the form of direct questions and answers with several respondents using a questionnaire. In-depth interviews are a process of obtaining in-depth information for research purposes by meeting face-to-face with respondents in this study, who are experts. In SWOT analysis, experts who understand the use of strategies are needed.

***Data Analysis Method***

The analysis method used is the SWOT analysis method. The descriptive analysis method is used to identify the potential of the Bali koi ornamental fish. Strategy design uses the SWOT analysis method. SWOT analysis is a strategic planning method used to evaluate the strengths, weaknesses, opportunities, and threats that occur in a project or business venture, or to evaluate one's own products and competitors. Strengths and weaknesses are grouped into internal factors, while opportunities and threats are identified as external factors (Rangkuti, 2017).

**Discussion**

Strategy formulation begins with analyzing the internal and external environment. Analysis of internal and external environmental factors will enable management to identify strengths, weaknesses, threats, and opportunities. Factors included in internal factors are strengths and weaknesses, which can be seen as follows.

A. Strengths

1. Efficient Land Use
An agricultural system that combines several types of crops or businesses on one plot of land (such as intercropping or crop-livestock integration) can optimize planting space and time. Crops with different light, nutrient, and harvest requirements can be planted together without interfering with each other. This allows farmers to utilize the land more productively than single cropping (monoculture).

2. Increased Soil Fertility
Some types of crops, especially legumes (beans), can bind nitrogen from the air and add natural nutrients to the soil. In addition, crop rotation and diversity can prevent a drastic decline in nutrients because each crop has different nutritional requirements. As a result, soil quality can be maintained longer, and the use of chemical fertilizers can be reduced.

3. Diversification of Farmers' Income
By planting more than one type of commodity, farmers have more diverse sources of income, thereby reducing the risk of losses due to crop failure of one commodity. If one type of crop is not marketable or fails to yield, there are still other crops that can be harvested and sold. This diversification increases farmers' economic resilience to price fluctuations and weather conditions.

4. Natural Weed and Disease Control
Crop diversity within a single field can inhibit the spread of pests and diseases, as irregular planting patterns make it difficult for pests to reproduce. Certain crops can also act as natural repellents or pest deterrents for other crops. In addition, covering the land with various types of crops helps suppress weed growth without the need for large amounts of herbicides.

5. Increased Agricultural Sustainability
Mixed farming systems support the principles of sustainable agriculture, as they maintain ecosystem balance, improve soil structure, and reduce dependence on external inputs such as chemical fertilizers and pesticides. In addition, these systems are more adaptive to climate change because they rely on complementary crop diversity.

B. Weakness

1. Resource Competition
Crops planted together can compete for water, light, and soil nutrients. If planting distances or crop combinations are not planned properly, one crop may be stunted, and yields may decline. Therefore, crop selection and planting patterns are key factors for success.

2. More Complex Land Management
Mixed farming systems require more complex planning and management than monocultures. Farmers must pay attention to the planting and harvesting times of each commodity, different water requirements, and more diverse pest and disease control. This requires more time, energy, and intensive supervision.

3. Requires Specialized Technical Knowledge
To implement this system optimally, farmers must understand the interactions between crops, appropriate rotations, and the nutritional and climatic requirements of each commodity. A lack of technical knowledge can lead to errors in crop combination selection, resulting in suboptimal yields. Therefore, training and technical assistance are essential.

4. Potential for Decreased Yield of One of the Crops
In some cases, if the crop combination is not suitable, one of the crops may experience a decrease in productivity due to competition for resources or the shading effect. For example, tall crops such as corn can block light for shorter crops such as peanuts, resulting in suboptimal growth.

The internal factors above are then calculated using the IFAS matrix. The results of the internal environmental (IFAS) calculations can be seen in Table 1.

Table 1
IFAS Matrix

| Internal Strategic Factors | | Point | Rating | Score |
|---|---|---|---|---|
| | **Strengths** | | | |
| 1 | Efficient Land Use | 0,23 | 3 | 0,690 |
| 2 | Improved Soil Fertility | 0,10 | 4 | 0,400 |
| 3 | Diversification of Farmer Income | 0,10 | 4 | 0,400 |
| 4 | Natural Weed and Disease Control | 0,03 | 3 | 0,090 |
| 5 | Improved Agricultural Sustainability | 0,07 | 4 | 0,284 |
| | **Weaknesses** | | | |
| 1 | Competition for Resources | 0,05 | 4 | 0,200 |
| 2 | More Complex Land Management | 0,05 | 3 | 0,150 |
| 3 | Requires Specialized Technical Knowledge | 0,17 | 4 | 0,680 |
| 4 | Potential for Decreased Yields of One Crop | 0,20 | 4 | 0,800 |
| **TOTAL** | | **1,00** | | **2,894** |

In addition to internal factors in SWOT analysis, there are also external factors consisting of threats and opportunities. The threats and opportunities of rice and peanut cultivation in a polyculture system are as follows.

C. Opportunities

1. Climate Change and Extreme Weather
Although climate change is a global challenge, for farmers who are able to adapt, these conditions actually open up opportunities for the implementation of adaptive and sustainable agricultural systems. Through mixed cropping or crop diversification, farmers can reduce the risk of crop failure due to extreme weather such as drought, flooding, or high temperatures. Crops with different climate tolerances complement each other, so that total land productivity remains stable even if some crops are affected.

2. Market Price Fluctuations
Commodity diversification provides opportunities for farmers to maintain their income even if the market price of one commodity declines. By having more than one type of product, farmers can adjust their sales strategies according to market conditions and take advantage of high prices at certain times. In addition, current market trends tend to favor local, healthy, and environmentally friendly products, giving a competitive advantage to farmers who implement sustainable systems.

3. New Pest Resistance
Climate change often leads to the emergence of new pest species or increased resistance to chemical pesticides. In this context, diversified (multiculture) agricultural systems present an opportunity because they can reduce dependence on synthetic pesticides and utilize natural control mechanisms between plants. In addition to being environmentally friendly, this strategy also opens up opportunities for research and innovation in the field of biopesticides and ecosystem-based biological control.

D. Threats

1. Support for Sustainable Agricultural Policies
Inconsistent or uneven government policies in supporting sustainable agriculture can threaten the continuity of this system. Lack of incentives, limited access to green capital, and weak technical assistance can make it difficult for farmers to implement environmentally friendly practices. Conversely, if policies are strengthened, this can be a great opportunity to expand sustainable agricultural systems nationwide.

2. Development of Superior Varieties
Delays in research and adoption of superior varieties that are adaptive to climate change and pests can be a threat to productivity. Farmers who still use old varieties risk experiencing a decline in yields and competitiveness in the market. However, if the development of superior varieties is carried out sustainably, this can be a strategic opportunity to improve the efficiency and quality of agricultural yields.

3. Broad Market for Both Commodities
Although a broad market provides great economic opportunities, high market competition and price fluctuations can be a threat to small farmers with limited capital and production capacity. Without good supply chain management, farmers may find it difficult to meet the quality standards or supply continuity demanded by modern markets.

4. Reduction in Nitrogen Fertilizer Costs
The practice of reducing the use of synthetic nitrogen fertilizers through intercropping with legumes actually provides opportunities for production cost efficiency. However, without adequate technical knowledge, this can be a threat because the risk of nutrient deficiency can reduce the productivity of the main crop. Therefore, an understanding of the appropriate crop proportions and soil management is needed.

5. Increased Local Food Security
Agricultural diversification provides a great opportunity to increase regional food security by providing a variety of food sources throughout the year. However, if not supported by an efficient distribution and marketing system, this potential can be hampered. An imbalance between local production and consumption can lead to oversupply or undersupply at certain times.

6. Adaptation to Climate Change
Farmers' ability to adapt to climate change is a key factor in agricultural sustainability. If adaptation knowledge is low—such as water management, selection of climate-resistant varieties, and application of soil conservation—then climate change becomes a serious threat to agricultural stability. Conversely, with guidance and adaptive technological innovations, the agricultural sector can become more resilient in the face of environmental dynamics.

The external factors above are then calculated using the EFAS matrix. The results of the external environmental analysis (EFAS) can be seen in Table 2 below.

Table 2
EFAS matrix

| **External Strategic Factors** | | **Points** | **Rating** | **Score** |
|---|---|---|---|---|
| | **Opportunities** | | | |
| 1 | Climate Change and Extreme Weather | 0,15 | 4 | 0,600 |
| 2 | Market Price Fluctuations | 0,16 | 3 | 0,480 |
| 3 | New Pest Resistance | 0,10 | 3 | 0,300 |

| | External Strategic Factors | Points | Rating | Score |
|---|---|---|---|---|
| | **Threats** | | | |
| 1 | Support for Sustainable Agricultural Policies | 0,18 | 3 | 0,540 |
| 2 | Development of Superior Varieties | 0,05 | 3 | 0,150 |
| 3 | Wide Market for Both Commodities | 0,10 | 4 | 0,400 |
| 4 | Reduction in Nitrogen Fertilizer Costs | 0,11 | 4 | 0,440 |
| 5 | Improved Local Food Security | 0,09 | 4 | 0,360 |
| 6 | Adaptation to Climate Change | 0,06 | 4 | 0,240 |
| **TOTAL** | | **1,00** | | **3,510** |

According to Rangkuti (2017), it is determined that the total score based on the internal and external factor evaluation matrix must be at least 2.5. If the total score is below 2.5, it indicates that the company is weak internally and externally, while a score above 2.5 indicates a strong internal and external position. The total score based on the IFAS matrix is 2.894, which means it has a good ability to anticipate internal weaknesses. Meanwhile, the EFAS matrix is 3.510, which means it has a good ability to anticipate threats.

| | Strong 3,0-4,0 | Average 2,0-2,99 | Weak 1,0-1,99 |
|---|---|---|---|
| 4,0<br>High 3,0-4,0<br>3,0 | I (Grow and Build) | II (Grow and Build) | III (Hold and Maintain) |
| Medium 2,0-2,99<br>2,0 | IV (Grow and Build) (3,5 ;2,8) | V (Hold and Maintain) | VI (Harvest and Diverst) |
| Low 1,0-1,99 | VII (Hold and Maintain) | VII (Harvest and Diverst) | XI (Harvest and Diverst) |

Figure 1. Matrix IE

Based on Figure 1, it can be seen that the IE matrix on the horizontal axis shows a total score of 2.8 from the IFE matrix, and the vertical axis shows a total score of 3.5 from the EFE matrix. Both scores are then mapped into the IE matrix, placing Pokdakan in position IV with coordinates (2.8; 3.5). This cell position indicates the growth and development of Pokdakan Dukuh Gangga Sedana.

The purpose of this stage is to produce feasible alternative strategies, not to choose the best strategy. Not all strategies developed in the SWOT matrix are selected for implementation. The four types of strategies recommended are the SO (strength-opportunity) strategy, the ST (strength-threat) strategy, the WO (weakness-opportunity) strategy, and the WT (weakness-threat) strategy. The results of the SWOT analysis yielded the following alternative development strategies.

1. Development of a Standardized Polyculture System (S1+S2+O1+O4)

The first strategy (SO) focuses on utilizing internal strengths to seize external opportunities. The integration of rice and peanuts has the advantages of efficient land use and the ability of peanuts to fix nitrogen, which can reduce the need for synthetic fertilizers. This condition is in line with government policy support for sustainable agriculture and opportunities to reduce production costs. Therefore, the steps that can be taken are to develop technical guidelines for polyculture, including planting distances, crop rotation, and superior varieties, and then integrate them into government extension and assistance programs. In this way, productivity can be increased while reducing costs and making it easier for farmers to adapt to double-cropping patterns. An important variable in the productivity of polyculture systems is the Land Equivalent Ratio (LER), which is the amount of monoculture land area required to produce the same yield as intercropping. Other variables include the Area–Time Equivalency Ratio (ATER) and Crop Performance Ratio (CPR) (Evizal & Fembriarti, 2021).

2. Technical Training and Superior Varieties (W3+O1+O2)
The second strategy (WO) aims to overcome internal weaknesses by utilizing existing opportunities. One of the main obstacles in implementing a polyculture system is farmers' lack of technical knowledge and the complexity of land management. Through government policy support and research on superior varieties suitable for polyculture, these obstacles can be overcome by conducting technical training or field schools, establishing demonstration plots in various regions, and providing compatible superior seeds. This strategy is expected to improve farmers' technical skills, reduce the risk of failure due to cultivation errors, and provide stability in productivity and income (Olesen & Bindi, 2002).

3. Market Diversification and Local Food (S3+S5+T2+T1)
The third strategy (ST) relies on internal strengths to anticipate external threats. Diversification of crops and contributions to food security are important assets in facing market price fluctuations and the impacts of climate change. To that end, it is necessary to develop processed products based on rice and peanuts to expand the market, build local marketing networks such as farmer cooperatives to maintain price stability, and implement cropping patterns that are adaptive to changing weather patterns. The diversification of local food products is an effort to develop various types of processed foods based on local raw materials and specific regional characteristics. The development of food processing diversification based on local resources can be focused on strengthening the MSME sector, given that this sector is showing a positive growth trend with an increasing number of businesses every year. This development has a significant impact on the national economy. With the increasing variety of food product innovations produced by MSMEs, it is hoped that the utilization of various local commodities can increase, so that the goal of national food diversification can be realized more optimally (Aulia et al., 2025).

4. Integrated Pest and Climate Management (W1+W2+T3+T1)
The fourth strategy (WT) is aimed at minimizing weaknesses and avoiding threats. Competition for resources between crops and complex cultivation management can increase vulnerability to new pest attacks and extreme weather. Therefore, possible solutions include the application of water-saving irrigation systems such as drip irrigation, crop rotation to break the pest cycle, and the use of botanical pesticides and biological control. This strategy can reduce the risk of losses due to pests and climate, maintain the sustainability of the agricultural ecosystem, and maintain production even in less-than-ideal environmental conditions (Rosenzweig et al., 2003).

**Conclusion**

Based on the results of the analysis, it can be concluded that the integration of rice and peanut cultivation in the polyculture system has great potential to increase land productivity, resource utilization efficiency, and resilience to price fluctuations and climate change. The IE matrix results show the position of the strategy in the "Grow and Build" quadrant, indicating a strong development opportunity. The four main strategies produced include: (1) development of a standardized polyculture system to improve yield and cost efficiency, (2) technical training and provision of superior varieties to overcome farmers' knowledge limitations, (3) diversification of local food-based markets and processed products to expand market access, etc. and (4) integrated management of pests and climate to maintain production sustainability. The implementation of these strategies is expected to optimize the agronomic and economic benefits of rice-peonage integration.

*Suggestions*

Based on the research results, it is recommended that the development of a rice-bean polyculture system be carried out through standardized technical guidance, including planting distance, crop rotation, use of superior varieties, and organic fertilization techniques. The government and related institutions need to provide technical training programs or field schools to improve farmers' skills, while also distributing superior seeds in accordance with the polyculture system. Market diversification is also important by processing crop yields into value-added derivative products and establishing local marketing networks, such as agricultural cooperatives. In addition, the integrated application of pest and climate management, including the use of vegetable pesticides, water-saving irrigation, and crop rotation, needs to be optimized to maintain productivity and business sustainability.

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